Design thinking as practical approach for boundary objects creation among non-designer engineers in idea generation

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Abstract
Designers’ creativity is nowadays targeted towards creating opportunities for creative collaboration among different people. We introduce design methods as a mediating process and the produced artefact as a boundary object between different stakeholders. This paper seeks the answer to the explorative qualitative research question: how to help non-designers make sense of design methods applied in their own context? We suggest that design thinking is a way to make the boundary object concept tangible. The data has been collected from workshop observations and survey questionnaires among non-designer engineers from industry. The research was conducted between 2009-2010. This paper is multi-disciplinary, based on studies in innovation management, knowledge management and utilization of design processes in industrial management. The concepts of the boundary object is introduced in the conceptual part of the paper. Even though design is widely seen as an integrative discipline it is still searching for its autonomy as an academic discipline. The ability of design to communicate with established disciplines such as economics or engineering on an equal basis remains challenging. This paper combines design practice with more familiar theories for managers, those of innovation management and organizational learning. We suggest collaborative processes based on design thinking methods to make the boundary object concept more tangible. The value that design may provide is that people should be able to benefit from more efficient use of their tacit and embodied knowledge in contexts where this kind of knowledge is not often recognized.

KEYWORDS: idea generation, boundary object, design thinking, art-based initiative
1 Introduction

“Design is not technology because it deals with fuzzy, discursive criteria rather than objective criteria, even though design shares many functional objectives. Design is not science because it does not offer new explanatory models of reality, but changes reality more or less purposefully, and yet the experimental process of research resembles the design process. Obviously design is something very special.” (Jonas 2010, p 38)

This paper deals with the challenge of the proposition that design should play a more strategic role in organizations. Tim Brown challenges “companies to incorporate design into their organizational DNA”. Design thinking needs to move closer to the executive suites, where strategic decisions are made. (Brown 2009) Therefore it would be reasonable to make design thinking familiar to “executives-to-be,” like the engineers in our study.

Design thinking has many definitions. Here it means an exploratory, iterative, nonlinear process using early, fast, rough and cheap prototyping. (Brown 2009) Design thinking happens using new methods. The new design methods are suited to early design process for what should be designed. Since design aims to understand subjective emotions and lived experiences of users and since existing scientific methods are incapable of uncovering such qualities, the human centred design community has introduced new types of design methods during the past decade. The new design methods are suited to early design process for what should be designed. (Keinonen 2009)

Examples of the design methods are cultural probes (Gaver, Dunne, & Pacenti 1999), empathy probes (Mattelmäki & Battarbee 2002), different workshop practices with various visual tools such as collage composition and design games (e.g., Brandt & Messer 2004).

Many design scholars propose a more holistic and systematic viewpoint to design, instead of traditional form-giving, for example Richard Buchanan’s concept of “fourth order design – culture, system and integration”. (Buchanan 1992). The motivation also comes from the changing business environment.

Business is changing
The business environment has become more chaotic and therefore organizations have shifted increasingly from single-company hierarchies to flatter, more networked, multi-organizational
structures (Barlett & Ghoshal 1998). Following a century that focused on the efficiencies gained through mechanistic and reductionist techniques, now wholeness and meaning are being sought in operations. Leaders recognize that we cannot create financially successful companies and an equitable, peaceful, sustainable world by simply applying yesterday’s approaches to business (Hamel 2000; Adler 2006). The managerial approaches are moving towards improvisation, and core skills are shifting from sequential planning-then-doing to simultaneous listening-and-observing-while-doing. Collaborative innovative processes must be a part of the organizational culture available for all, not a one-man show (Lockwood and Walton 2009).

This paper deals with the proposition that design should have more strategic role in the organisations as is explained below. Strategy can be defined as a chosen method or plan to bring about a desired future in the form of an achievement of a goal or solution to a problem (Luthra 2012). Human-centred design is paying increasing attention to exploring future design opportunities than to solving existing problems. Design research methods suit well in envisioning what could be. The conventional methods that are borrowed from more established disciplines of human research, such as psychology, anthropology or sociology may hinder (designer’s) imagination and creativity. (Lee 2012)

According Roger Martin design thinking enables an organization to both exploit existing knowledge and create new knowledge and achieve lasting and regenerating competitive advantage. Design thinking accelerates the pace of the knowledge to advance from mystery (unexplainable problem) to heuristic (the rule of thumb that guides us toward a solution) and finally to algorithm (a replicable success formula). Martin calls this process “knowledge funnel”. (Martin 2009)

In the design context Turkka Keinonen (2009) proposes three conceptualizations of design method: method as an instrument, as a competence and as an agenda. When perceived as a competence a method can be redesigned by a design researcher for each particular design setting, and is thus seen as a part of the situated action of a researcher. The researcher utilizes his or her skills and intentions depending on the context. (Keinonen 2009) This adaptability may be yet another reason, why design thinking can be applied in the non-designers knowledge building facilitated by design researcher.

The search for integrative disciplines to complement the traditional arts and sciences has become one of the central themes for both scholars and practitioners in the twenty-first century. Without integrative disciplines of action, understanding and communication there is little hope of sensibly extending knowledge beyond the library or laboratory in order to enrich human life. Design thinking is given the role of being one such integrative discipline. (Buchanan 1992) The design methods are rooted in various sciences (Jordan 2009). This gives design thinking some bridging qualities.
The aim of the modern organization is to establish a creative working culture. Therefore open leadership, meaning the use of social media tools and positive thinking, is a starting point for collaboration. (Luukka 2012)

Designer creativity is increasingly targeted towards creating opportunities for creative collaboration among different people and developing tools that enhance the creativity of the others. (Sanders & Dandavate 1999; Brant 2006) Tim Brown (2009) argues that “design is too important to be left to designers”, by which he is referring to designers’ abilities for creative problem solving and the tools for it.

Also business schools are redesigning business education for the 21st century. Stanford University have started during recent years to apply design thinking in order to educate future leaders capable of collaboratively developing “game changing ideas”, and being more creative. (Datar S. et al 2010) The Rotman School of Management of Toronto University builds the curriculum on integrative thinking: more features of the problem are considered as relevant to its resolution and multi-directional and non-linear causality between the salient features is concerned. (Rotman 2013)

There have been some quite radical experiments to apply design thinking among different disciplines or mixed groups. For example, the Project Platypus: Reinventing Product Development at Mattel in 2005. In that project, mixed teams from different disciplines experimented for three months in ways they had never been able to in their normal jobs. (Brown 2009)

We discuss these paradigm changes from the perspective of the organization; how this new emerging role of design relates to some other key components of organizational life such as the need for continuous learning. Design is still seeking its autonomy as an academic discipline and the ability of design to communicate with established disciplines such as economics or engineering on an equal basis seems to remain a challenge. (Buchanan 2010).

To tackle this challenge with established disciplines we introduce design methods as a mediating process and the produced artefact as a boundary object between different stakeholders. This paper is multi-disciplinary, based on studies in innovation management, knowledge management and utilization of design processes in industrial management.

Organizational perspective

Regarding collaboration of disciplines, many authors have recognized the importance of boundary objects. Efficient and effective knowledge distribution is a critical success factor in companies. It can only take place without boundaries. However, different silos exist since people
tend to build up their own boundaries, for example by creating overly technical terminology that prevents other people from participating. Different stakeholders from separate levels of the organization and network have different boundaries (Koskinen 2005).

New knowledge is perhaps most abundantly used in the innovation process than in any other function of the enterprise (e.g. Roussel et al. 1991). In the innovation management process, the knowledge is shared with the help of a boundary object (Koskinen 2005). This opens up the challenge of boundary object creation in which the unique worldviews of different people or organizations are made visible and accessible to others (Koskinen 2005).

While recognizing the challenge of creating boundary objects in innovation management, there is another process going on among design scholars, who are making a strong effort to transform design from its simple, sometimes even naïve purposes, into generative purpose programs with specific modes of interaction, as well as codes and values that are relative to the general context. A stronger disciplinary autonomy might initiate evolution in which a design would turn from a fuzzy subsystem towards a clear and distinct co-system of economy. (Jonas 2010)

Design thinking

The different models of applying design thinking are seen as possible solutions for organizational development. Design thinking consists of imagination, playfulness, social intelligence, and above of all, experimenting with prototypes (Brown 2009). This idea is supported by the assumption that designers seem to have a special integrative way of thinking. A designer keeps in mind many disparate factors that may have little or no relation to each other. A designer’s work can be described as a mental juggling act in which the drawings are a kind of external memory (Lawson 2009). We test and observe design thinking in order to enhance the creative processes of non-designers. We are interested in whether boundary objects can be created using design methods, namely quick prototyping, mock-ups and sketching. Could these tangible components of the design process be perceived as boundary objects? Next, as the background for our study, we explain the changes in society, education and the business environment in which innovation, creativity, social skills and networking skills are important capabilities.

Richard Florida lists three things that the most creative organizations have in common: openness, diversity and tolerance (Florida 2006). Knowing what others know is a necessary component for co-ordinated action to take place. Therefore in the era of open innovation the critical question is, how to bring different knowledge together? One critically important issue is to share, explicate and describe the context dependent practical designer work. The outcomes of which do not consist of the rules to follow but of stories to reflect upon. Jung-Joo Lee (2012) promotes the correct way of using innovative methods, by which she means the recent design research methods, and she suggests sensitive reflection. In the correct way of using innovative methods
researchers and designers reflect creatively upon why a particular method design makes sense in a given design situation. (Lee 2012)

This sensitive reflection is particularly essential when innovative methods are adapted to fit different epistemological framework and practices. (Lee 2012, p. 108) Creatively reflecting the shared process can lead us towards renewing the organizational cultures.

In the modern organization, a democratic and participative leadership style is needed (Andriopoulos and Gotsi 2002). In new organizational cultures, there is not only room but also a need for the art-based methods first adopted by management educators. An increasing number of companies are including artistic processes in their approaches to strategic management and leadership (Schiuma 2011; Adler 2006; Taylor 2009). This is due to the fact that designing options worthy of implementation calls for the levels of inspiration and passionate creativity that have been more the domain of artists and artistic processes than of most managers (Adler 2006).

According to modern cognitive research, emotions are extremely important in goal-oriented actions and in controlling social relations. We adjust our activities and adapt to our environment with the help of emotions. Emotions help us keep our goals and maintain our spirit. Even the top researchers are often motivated by pure excitement.

Motivation is also a concept concerning emotions. Owning a problem through self-initiated activity can lead to enhancing intrinsic motivation (Robinson and Stern 1997).

2 The concept of the boundary object

Boundary objects can be artefacts, documents and even helping vocabulary or a richly perceived metaphor (Star 1989; Star and Griesemer 1989; Henderson and Clark 1990; Boland and Tenkasi 1995; Arias and Fischer 2000; Carlile 2002; Koskinen 2005). Boundary objects seem to be useful for collaborative knowledge building and knowledge sharing to occur in face-to-face situations with multi-disciplinary teams. Knowledge here refers to both tacit and explicit knowledge (Polanyi 1966). Tacit (experience-based) knowledge is about what things work, explicit (theory-based) knowledge has the potential to explain why things work. Boundary objects support social interaction and help to create shared understanding among different stakeholders.

In boundary object creation, the diverse knowledge of individuals and/or organizations must be represented in its uniqueness, and made available to others. Creating a boundary object and therefore shared understanding requires a culture in which the participants see themselves as reflective practitioners rather than all-knowing experts (Schön 1983). Re-knowing one’s own thoughts in a new light requires a great deal of humility. The creation of a boundary object
depends on an individual’s perspectives and a given context. Everything known is attached to a particular point of observation and changing the point changes the knowledge about a phenomenon (see also von Krogh and Roos 1995).

The challenge of knowledge in firms is not simply combining, sharing or making information commonly available. The problem is the creation of a boundary object in which the unique world views of different people and/or organizations are made visible and therefore accessible to others. However, creating a boundary object is never a one-to-one mapping of meanings. Boundary objects increase tolerance in organizations since it is assumed that members of an organization will not necessarily reach full consensus, and members of different organizations cannot simply adopt meanings from others. In fact, in order for boundary object creation to proceed, the diverse knowledge held by individuals and/or organizations must be represented in its uniqueness. This specific knowledge must be made available to others to incorporate in their boundary object creation (Koskinen 2005). Despite this obvious need, a lack of common concepts has been recognized concerning the implementation of boundary objects in real-life situations. Moreover, efforts to provide practices that would help the players are limited.

3 Process of design thinking

Design research has been intensive during the last decade (e.g. Laurel 2003; Battarbee 2004; Kotro 2005; Valtonen 2007). Design thinking is also often applied among non-designers, but mainly to support knowledge gathering for design purposes. Different methods for user studies have been developed. In different co-design, participatory design or experience design processes, participants use artefacts or probes that are specially produced by designers. There is still some confusion in terminology. The Cottam and Leadbeater (2004) concept of co-design of services comes close to our perception of design thinking in the sense that it “is a creative and interactive process, which challenges the views of all parties.” However, remainder of the sentence does not apply “seeks to combine professional and local expertise in new ways.”

In our concept, the participants of the innovation team, mainly experts, create artefacts and construct knowledge collaboratively for their own purposes, and the designer facilitates the process by providing tasks for ideation (Aramo-Immonen & Toikka 2009, 2010; Toikka & Aramo-Immonen 2010).

The challenge of representing diverse knowledge can be faced using design. Design is the ability to imagine that-which-does-not-yet-exist, to make it appear in a concrete form as a new, purposeful addition to the real world (Nelson and Stolterman 2003).
Visual representations are typical tools to outline alternatives in design and they provide a common language for multidisciplinary teams. The representations should be concrete enough to allow freedom for creativity. Simple models seem to open up a solution space whereas more detailed models narrow it. Creativity can be applied to designed representations such as mock-ups. These generate hands-on experience and support idea generation. In the ideation phase, the draft and unfinished nature of simple mock-ups help people understand their meaning as tools in ideation. Thus high artistic skills are not essential. (Mattelmäki, Vaajakallio, 2007).

Creativity requires constant experimentation. Experimentation forces behaviour change (Darso 2009). Cognitive change is transformed into change in a person’s behaviour through experimental learning (Crossan and Sorrenti 2002). Mistakes are a natural part of the process. A fearless attitude is an essential component of innovation. In the design process, there is no one and only right solution, but many (Andropoulos 2002).

4 Research design

This paper seeks the answer to the explorative qualitative research question: how to help non-designers make sense of design methods applied in their own context? The data has been collected from workshop observations and survey questionnaires among the attendees. The design methods used in the workshops were truly context driven as will be shown below. The research was conducted between 2009-2012.

The design thinking workshops were conducted for non-designer engineers with different professional back grounds and from 2 to 25 years of experience. These workshops can be categorized as art-based interventions on a continuum of art-based initiatives (ABIs by Schiuma 2011, p.48). Artefacts are created as boundary objects in idea generation in the scope of innovation management (Figure 1).
Figure 1. On the left, a hands-on workshop situation where tacit knowledge about weaving with three strips is delivered. On the right, mixed age cross-disciplinary working teams attending an ABI.

Researchers gathered data using questionnaires after the design workshops and made a video recording to aid observation during the workshops. There were two workshop sessions of four hours. In both sessions there were 16 attendees divided into groups consisting of four members. These four groups worked in the same room in parallel on the same task (but not competing with each other). The researchers made observations during the sessions.

The qualitative data was gathered during and after the four-hour design thinking workshops. One workshop topic was “Managing competencies”. The workshop group task was to make collage mock-ups representing the “competence map” of a manager. Various colourful and inspirational materials were available. The grouping of four engineers per team was made by the researchers randomly. The engineers were given “warming-up drawing exercises,” which turned out to be very important, since the engineers felt insecure at the beginning, and the design context was perceived as unfamiliar. The design context was introduced with a short lecture on information design.

5 Results

The results to our research questions are presented in Table 1. The column on the left explains the characteristics of boundary objects gathered from the literature review, and the boundary object criteria are shown in the middle. The column on the right concerns the data collected from the design workshop questionnaires. The researchers made a thematic analysis of the answers and the themes that relate to the boundary objects criteria are expressed here. As a result, a close relation was found between the boundary object criteria and the design process as experienced in the workshops. In this paper we have shown that quite a lot of features are interrelated in the knowledge sharing and collaborative knowledge building process. The issue is complex and therefore a very interesting one to continue studying.

Table 1. The categorization of boundary objects (Koskinen 2005) in connection with the design process (Aramo-Immonen & Toikka 2009, 2010; Toikka & Aramo-Immonen 2010).
<table>
<thead>
<tr>
<th>Boundary object</th>
<th>Boundary object criteria</th>
<th>Design process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Horizontal knowledge sharing</td>
<td>Knowledge held by individuals and/or organizations made available to others to incorporate in their boundary object creation.</td>
<td>Use of tacit knowledge in transformation of the idea into a tangible piece of art or artefact.</td>
</tr>
<tr>
<td>2. Usage of metaphors</td>
<td>Through metaphors, people put together what they know in new ways and begin to express what they know but cannot yet say.</td>
<td>Artefact as a vehicle for explaining abstract concepts.</td>
</tr>
<tr>
<td>3. Valuing diversity</td>
<td>In order that boundary object creation may proceed, the diverse knowledge held by individuals and/or organizations must be represented in its uniqueness.</td>
<td>Accessible process for all. Mock-ups and sketches easy to produce. Cross-disciplinary mixed groups.</td>
</tr>
<tr>
<td>4. Support of social interaction</td>
<td>Support both social interaction and create shared understanding among various stakeholders, i.e. contextualise knowledge to the task at hand.</td>
<td>Sharing knowledge in a fearless atmosphere. Using hands and showing.</td>
</tr>
<tr>
<td>5. Creating shared understanding</td>
<td>A culture in which the stakeholders see themselves as reflective practitioners rather than all-knowing experts (Schön 1983).</td>
<td>Collaborative team work. Dialogue and co-creation.</td>
</tr>
<tr>
<td>6. Sharing tacit knowledge</td>
<td>Tacit knowledge represents knowledge based on the experience of individuals (Polanyi 1966). It is expressed in human actions in the form of evaluations, attitudes, points of view, commitments, motivation, etc. (e.g. Nonaka and Takeuchi 1995).</td>
<td>Problem solving - tacit approach. Hands-on experimenting. Dialogue and co-creation.</td>
</tr>
</tbody>
</table>

6 Discussion

Based on the study we conducted, the design process can be applied to a non-designer’s ideation process. Furthermore, it is described in Table 1 how this helps non-designers make sense of design methods in their own context. The process of how to facilitate the non-designers ideation process with help of design is also described in this paper.

With the help of boundary objects, an individual can “re-know” already known phenomena from a new perspective. The term “re-know” is used intentionally in this connection. For a paradigm innovation, the repositioning of ideas and innovations already known is required. Therefore innovators need to re-know their thoughts in a new light. Furthermore, they have to be able to share this new meaning with others. We propose collaborative processes based on design thinking for this very purpose: to make the boundary object concept more tangible. There
is no single one best way of conducting design methods as there are no one kind of boundary objects. According Jung-Joo Lee (2012) the materials, forms, structures, rules and interpretation strategies of design methods are different depending on the context. (Lee 2012) Further studies are needed to fully explain the ideal process of boundary object creation with the help of the design process.

Originality and value of research

This methodology provides evidence that design workshops, which can be categorized as art-based interventions on a continuum of art-based initiatives (ABIs by Schiuma 2011, p.48), function as mediating processes and the artefacts created act as boundary objects in idea generation in the scope of innovation management. The recent research on design provides multiple approaches for involving people in the process of design. Our approach is that design thinking serves the ideation and knowledge building of other disciplines and that the designer is in the role of facilitator and the process is planned together with the case owner. The process does not necessarily aim at designing but for example defining a problem space. Perhaps this activity should be described using another term than those used in the design context, something like the “designer way of ideation”. This concept definition will be a topic for another paper.

Practical implications

This study opens up ideas for closer collaboration between business strategists, managers and leaders with design professionals as facilitators of boundary object creation. The value that design may provide is that people can benefit from more efficient use of their tacit and embodied knowledge in contexts where this kind of knowledge is not often recognized. The assumption is that this would give them job satisfaction and make them feel more empowered. This of course depends on the organizational culture, the role of which is another object for further study.
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