Journal of Innovation Management
JIM 5, 2 (2017) 56-80
HANDLE: http://hdl.handle.net/10216/105431
SM: Dec/2016 AM: Jun/2017

The culture of design thinking for innovation

Peter Prud'homme van Reine

Innovation Culture & Change, Consulting & Education
J. van Ruisdaelstraat 99, 3583CC Utrecht, The Netherlands
peter.prudhomme@innovationculture.nl

Abstract. Design thinking has been adopted widely as a tool for innovation by companies and other organizations. However, statements by researchers and practitioners about what design thinking is are often seemingly conflicting with each other. This paper aims to improve our understanding of what design thinking for innovation is and under which conditions it can be implemented successfully. It discusses design thinking for innovation in the broader perspective of organizational culture. A framework of nine innovation culture dilemmas or 'tensions' is used as an organizing device to analyse the existing literature on design thinking for innovation and accounts of using design thinking for innovation in practice. It is argued that the power of design thinking is in the tension between seemingly opposite ways of thinking, such as analytic thinking versus intuitive thinking, and linear thinking versus thinking in iterative processes. For design thinking to flourish, it needs to be embedded in an organizational culture capable of maintaining a dynamic balance on a number of fundamental tensions in innovation processes. It is shown that the innovation dilemmas framework can be used as an analytical tool to evaluate to what extent organizations are equipped to benefit from design thinking for innovation.

Keywords. Innovation, design thinking, organizational culture, dilemmas, creativity

1 Introduction

Design thinking has been adopted by companies, higher education institutes and governments as an approach to innovation. Design thinking has even been dubbed 'the secret weapon for innovation' (Kelley, 2001, p. 8). Originally, design thinking referred to the methodology used by designers to solve complex problems and find desirable solutions for clients (Cross, 1982; Rowe, 1987). For example, Rowe (1987) observed as a distinctive aspect of design thinking that design professionals rely on hunches and presuppositions, not just facts. Theorizing about design thinking for innovation started from the first design thinking symposium in 1991 (Cross et al., 1992). Cross et al concluded that although there was a basic understanding of how designers think and reason, a simplifying paradigm of design thinking was lacking. According to Cross et al, previous attempts to formulate simplifying paradigms, such as viewing design as problem-solving, had failed to capture the full complexity of design thinking. The idea behind design thinking for innovation is that innovators can use design thinking without actually becoming a designer (Tonkinwise, 2011). Dorst (2011) acknowledges that the eagerness to adopt and apply design practices in other

ISSN 2183-0606
http://www.open-jim.org
http://creativecommons.org/licenses/by/3.0

fields has created a demand for a clear definition of design thinking, while the design research community cherishes multiple perspectives and has been reluctant to oversimplify its object of study. Luchs (2016) recently defined designed thinking as "a systematic and collaborative approach for identifying and creatively solving problems". Although this definition adds some elements to the 'simplifying paradigms' mentioned by Cross et al (1992), it still does not seem to fully capture the complexity of design thinking. Brown, the president and CEO of the American design company IDEO, defines design thinking as "a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success" (Brown, 2016). Beverland et al (2015) define design thinking as "a creative and strategic process characterized by the following hallmarks: abductive reasoning, iterative thinking and experimentation, holistic perspective, and human-centeredness". The definitions of Brown and Beverland introduce different elements of design thinking such as designer's skills, technology and user needs (Brown) and abductive reasoning, iterative thinking, experimentation and human-centeredness (Beverland et al). The definitions have in common that they point at the need for several elements to be 'integrated' (Brown) or connected in a 'holistic perspective' (Beverland et al), however, they do not address how these should be connected or integrated.

Researchers and practitioners of design thinking (Kimbell, 2011; Nussbaum, 2011; Plattner et al, 2016) have pointed at the need for a better understanding and a critical rethinking of design thinking. Although there is general agreement that the essence of design thinking is empathy with user needs and putting the final customer central, there is a lot of confusion about what it needs to become a design thinker. Lists of prerequisites for design thinkers focus on individual skills, such as pattern recognition, visual communication, storytelling and empathy (Wroblewski, 2008) and on the need for developing a design thinking mindset (Luchs, 2016). This paper will discuss design thinking for innovation in the broader perspective of organizational culture. Calabretta et al (2008) find indications that for design orientation to flourish in an organization, it needs to be embedded in a conducive organizational culture, but conclude that further research is necessary to identify the characteristics of such a 'design thinking culture'. Other authors have suggested elements of a culture conducive to design thinking for innovation, e.g. inclination to experimenting, tolerance for failure, and stimulating everybody to participate in innovation (Brown & Martin, 2015; Rosenberg et al., 2016), but an overall model is lacking.

Accounts of design thinking in practice support the relevance of organizational culture for the application of design thinking for innovation. The companies best known for their focus on the design thinking approach to innovation are Apple Inc. and IDEO, whose founder David Kelley was part of the team that helped design Apple's very first computer mouse (Martin, 2009; Brown & Martin, 2015). In both companies, the application of design thinking for innovation has been linked to organizational culture. IDEO claims to have a culture 'focused on innovation and driven by design' (Brown 2009). At Apple, co-founder and former CEO Steve Jobs is credited for creating an environment conducive to designers (Buxton 2007). He diffused the principles of design throughout the organization, thereby creating a culture of design thinking. The success of Apple and IDEO has inspired other

companies to develop a design focused culture as well. At Samsung for example, former chairman Lee Kun-Hee is credited for creating a design-focused culture that supports world-class innovation (Yoo & Kim, 2015).

This paper explores under which conditions design thinking for innovation contributes to a culture of innovation and explores the challenges in developing cultures conducive to design thinking for innovation, by relating an analysis of the academic literature on design thinking for innovation to accounts of design thinking for innovation in practice.

2 Research approach

The systematic analysis of the academic literature covered peer-reviewed academic journals such as 'Design Studies', academic books, and journals which connect research- and practice-based knowledge such as Harvard Business Review, Stanford Social Innovation Review, MIT Sloan Management Review and Design Management Review. The literature search of accounts of design thinking for innovation in practice has been extended to professional and business publications such as Fortune, Wall Street Journal and Financial Times; websites known for reliable information on innovation such as FastCompany.com and Wired.com; business books discussing accounts of design thinking for innovation in practice; and corporate websites.

In selecting the theoretical approach to analyse the literature on design thinking for innovation, the comments of Cross et al (1992) about the need to capture the complexity of design and the comments of Dorst (2011) about the importance of multiple perspectives for design research were taken into account. The theoretical approach needs to address the inherent tensions in design thinking (Beverland et al 2015). Design thinking is often presented as a radically new approach to innovation (Brown, 2009; Dorst, 2011), and as the opposite of 'established ways of thinking' (Kimbell, 2011, p. 288). Other proponents of design thinking contrast it with 'traditional linear thinking' (Lenstra, 2016), 'traditional analytic thinking' (Hawryszkiewycz, 2013), or 'engineering thinking' (Courage, 2013). However, there are indications that design thinking is not about shifting completely to the opposite side of 'traditional thinking'. For instance, Martin (2009, p. 137) and Dennehy et al. (2016, p. 162) write about design thinking as balancing analytical thought processes and intuitive thinking, and Ingle (2013, p. 2) writes about design thinking being largely nonlinear although designers need the discipline to be organized and deliberate. This suggests that the challenge of design thinking is in handling the tension between seemingly opposite ways of thinking relevant for innovation processes, such as analytic thinking versus intuitive thinking, and linear thinking versus thinking in iterative processes. Dealing with tensions is actually a main skill of design engineers (Dorst, 2006). Designers are trained to satisfy potentially conflicting considerations simultaneously (Whitbeck, 1998, p. 56). Seeing the challenge of design thinking in handling the tension between seemingly opposite ways of thinking is consistent with the design science paradigm (Van Aken, 2004), which helps to understand how professionals involved in design activities deal with complex realities. Van Aken asserts that the ultimate mission of design science is to develop design knowledge, i.e. knowledge that can be used in designing solutions to problems

in the field in question. According to Van Aken, the development of design knowledge occupies the middle ground between descriptive theory and actual application. This suggests that design thinking should not be seen as the opposite of descriptive and analytic thinking but rather as a synthetic thinking.

The dilemma approach of innovation cultures (Prud'homme van Reine & Dankbaar, 2009), seems to be a promising approach to understand the challenges in developing cultures conducive to design thinking for innovation, because it acknowledges complexity and multiple perspectives, and offers a method for handling tensions by balancing or 'reconciling' the dilemmas. The dilemma approach of innovation cultures is based on the dilemma approach of organizational culture (Trompenaars & Prud'homme van Reine, 2004). In the dilemma approach, cultures are not assessed as a fixed set of value orientations, but by how they pursue seemingly contradictory criteria simultaneously. Innovation cultures are conceptualized as cultures capable of maintaining a dynamic balance between the extreme positions on each dilemma (Prud'homme van Reine & Dankbaar, 2009). Dumaij et al (2009), in a discussion of the possible application of this innovation dilemma framework for healthcare innovation, write that "making the innovation dilemmas explicit does right to the complexity of innovation" and "creating an innovation culture is a dynamic process in which areas of tension and fundamental innovation dilemmas should meet rather than follow a recipe to implement role models and towards success criteria".

The innovation dilemma approach of organizational culture has been used in practice by companies (Trompenaars & Hampden-Turner, 2010) and has been used as the main theoretical framework in empirical research projects (Prud'homme van Reine & Dankbaar, 2011; Clifton et al, 2014). In section 3 and 4 of this paper, the dilemma approach will be used to investigate to what extent design thinking for innovation can be understood as maintaining a dynamic balance on a number of fundamental tensions. In section 3, the tensions behind the innovation culture dilemmas (Prud'homme van Reine & Dankbaar, 2009; Prud'homme van Reine, 2015) will be used as an organising device to analyse the tensions in design thinking for innovation. In section 4, the relationship between design thinking and culture change is discussed for the situation that design thinking for innovation is taken to the strategic level. The examples and cases used in section 3 and 4 of this paper are based on the extensive literature research on culture, innovation and design thinking, and on the own experience of the author as an innovator in an industrial R&D lab, as a coordinator of R&D in a business services sector company, as a manager of innovation processes for a multinational company, as a consultant in developing cultures of innovation in the profit and non-profit sector and as an academic researcher of innovation processes. Section 5 gives conclusions and avenues for further research.

3 Design thinking as maintaining a dynamic balance on fundamental tensions

3.1 Introduction

Table 1 shows the nine organizational culture dilemmas as identified by Trompenaars & Prud'homme van Reine (2004). These organizational culture dilemmas show up as

'innovation dilemmas' in innovation processes as well (Prud'homme van Reine & Dankbaar, 2009; Trompenaars & Hampden-Turner, 2010; Prud'homme van Reine, 2015). Therefore, it is expected that the tensions behind these dilemmas will also show up in design thinking for innovation, as indicated in table 1. The tensions will be used as an organising device to analyse the results of the literature research on design thinking, to investigate to what extent the tensions are relevant for design thinking and to what extent design thinking for innovation can be understood as handling the tensions between seemingly contradictory elements. Each of the tensions will be discussed in detail in the sections 3.2 – 3.10.

Table 1 Organizational culture dilemmas and corresponding tensions expected to show up in design thinking for innovation

	Organizational culture dilemmas (Trompenaars & Prud'homme van Reine, 2004)	**Expected tensions in design thinking for innovation** (derived from innovation culture dilemmas discussed in Prud'homme van Reine & Dankbaar, 2009; Prud'homme van Reine, 2015)
1	Specific (segmented thinking) versus Diffuse (holistic thinking) cultures	Analytic thinking versus Intuitive and creative thinking
2	Internal drive versus Responsiveness	Product push versus User empathy
3	Rational versus Inspirational	Focus on functional aspects versus Focus on aesthetics and emotional aspects
4	Competing versus Partnership orientation	Closed versus Open approaches to innovation
5	Consistency versus Pragmatism	Innovation as a structured process versus 'Bricolage'
6	Stable continuity versus Dynamic change	Linear thinking versus Non-linear, iterative processes
7	Individualism versus Group orientation.	Individual creativity versus Group collaboration
8	Egalitarian versus Hierarchical cultures	Leadership in design thinking: Egalitarian versus Hierarchical leadership
9	Short term versus Long term orientation	Short term versus Long term approach to innovation

3.2 Analytic thinking versus intuitive and creative thinking

Design thinking is often presented as creative and intuitive thinking, and as the opposite to 'traditional' analytic thinking (Hawryszkiewycz, 2013, p. 20). However, Bauer and Eagen (2008) have suggested that analytical thinking is part of, not the opposite of design thinking. Design thinking requires logic *and* creativity. Apple CEO Cook, who has an engineering background himself, pointed out (Isaacson, 2011, p.

360): 'engineers are taught to make a decision analytically, but there are times when relying on gut or intuition is most indispensable'. Design thinkers need to be able to use analytical tools such as spreadsheets next to creative tools such as visualisation, storytelling and pattern recognition. Former Apple-CEO Jobs referred to his experience as leader of a technology company (Apple) and of a company in the creative industry (Pixar) when he said: 'I am one of the few people who understands how producing technology requires intuition and creativity, and how producing something artistic takes real discipline' (Isaacson, 2011, p. 397).

Combining analytic thinking with intuitive and creative thinking in innovation processes is by no means new nor the exclusive preserve of designers. The need for innovators in an industrial R&D setting to combine analytical and intuitive, creative thinking has been observed already in the ''great age of American innovation'' at the Bell R&D labs of AT&T, famous for the invention of the transistor. Mervin Kelly, the president of Bell labs in the 1950s, called it 'an institute of creative technology' (Kelly, 1950). In Kelly's effort to approach innovation as 'organized creative technology', scientists and engineers for Bell Labs were selected based on exceptional analytical skills *and* creativity.

An example of solving a technological problem by rigorous analysis combined with intuition and creativity is the following experience of the author of this paper at the time that he worked as an innovator in the R&D labs of technology company Philips. It concerned a highly profitable product, high-pressure sodium discharge lamps for street lighting. The problem was that the wall material of the discharge tube, consisting of high density translucent polycrystalline aluminum oxide, got attacked by the aggressive high pressure sodium vapour during the operation of the lamps, resulting in microcracks in the discharge tubes and subsequent failure of the lamps. Careful analysis with sophisticated techniques revealed that the process took place along the grain boundaries of the aluminum oxide. It turned out that even an amount of less than 10 ppm (parts per million) of impurities in the aluminum oxide resulted in the segregation of compounds on the grain boundaries which are not resistant to high pressure sodium at high temperatures (Prud'homme van Reine,1983). The 'analytical thinking' solution was to introduce a cleanroom manufacturing process for the aluminum oxide tubes, a very expensive solution. The creative idea was adding a small amount of a compound to the aluminum oxide that would have an impurity-scavenging effect. Combining analytical and creative thought processes resulted in experiments with adding a very small amount of a so-called rare earth oxide (erbium oxide) based on the idea that it would absorb the impurities on the grain boundaries and form a sodium resistant compound at the grain boundary intersections, blocking the path of attack by the aggressive sodium vapour. It worked, and the invention was patented (Prud'homme van Reine, 1987) and utilized in commercial products.

We conclude in line with Ingle (Ingle, 2013, p. 2): 'design thinking is an exploratory approach to problem solving that includes and balances both analytical and creative thought processes'. It can be practiced by innovators across industries, and is not limited to the creative industry or to designers by job title or educational background.

3.3 Product push versus User empathy

In the traditional approach to innovation, companies push their technology and

products on the customer, convinced that what they developed is the right solution for perceived customer needs. Gradually, the insight has grown that understanding customer needs requires user empathy. Designers played a crucial role in this process because of their ability to think from the customer perspective. CEO Brown of IDEO (Brown & Martin, 2015, p. 60): 'In the design-oriented approach popularized by IDEO, the work to understand users was deeper and more ethnographic than quantitative and statistical.' Ethnographic research requires not just different methods, it requires a different mindset. It requires the attitude of an anthropologist rather than that of a salesman or an engineer. Anthropologists are trained in doing ethnographic research using methods such as participant observation. It means getting into the field and observing the process of using a product, a shopping experience, a classroom or an operating room in a hospital. In design thinking, participant observation is key in finding out what people actually do in order to define the problem. Design thinking also requires the 'naïve outsider' attitude of the anthropologist in order to come to a deeper understanding: constantly asking questions *why* things are done in a certain way. Moreover, anthropologists are trained in using triangulation to get insight from various perspectives and to use an interpretive approach to understand meanings behind observed behaviours (Geertz, 1973).

In 1994, even the diehard technology oriented company Philips Electronics started to hire anthropologists for its corporate design department to study customer behaviour, because they realized that competitors such as Sony were paying much more attention to design (Prud'homme van Reine, 1994). Samsung benefited from its investments in ethnographic research in 2003, when anthropologists came up with the apparently obvious observation that TVs are off far more than they are on in most homes. Samsung improved the visual appeal of its TVs and started with models with round curves. It was a huge success (Yoo & Kim, 2015).

The work of Von Hippel (Von Hippel, 1986; Von Hippel et al, 2011) shows that understanding the customer is just a first step in involving users in the innovation process. More and more, consumers and users play a central and very active role in innovation. Involving customers is not just a matter of listening to the voice of the customer, it also includes lead user methods and user co-creation. Design knowledge and tools are nowadays readily available for consumer-innovators. Von Hippel et al (2011) present this consumers-as-innovators pattern as a new paradigm and contrast it with the 'traditional innovation model' that sees consumers simply as the market. Accounts of design thinking in practice show promising results of balancing product push and user empathy by accepting and building upon prototypes developed by users. For instance, 'living labs', which started as places where innovations were being studied and tested in real-life contexts with real users, become more and more places where innovations are co-created with users. Based on recent research, Brankaert, & den Ouden (2017) show the potential of a 'design-driven living lab' approach, involving users as co-creators and including design qualities such as exploration.

An example of using design thinking in balancing 'product push' and 'user perspective' is Apple's introduction of the iPod music player and iTunes music store. Based on the philosophy of the computer as digital hub of lifestyle technology, the

starting point in the design process was that it should be easy to use. Seamless connection between the player and the music store was seen as key (Buxton, 2007). The idea to use a scroll-wheel as user interface to control the player came about because marketing management was already involved in the early stage of the design process. There was a 'push' side in the development of the iPod as well. The iPod/iTunes combination was a closed system, limiting the choice of customers. However, Apple managed to convince its users that a closed system was necessary to provide a stable and reliable customer experience.

Some Apple users feel that Apple has shifted too much to the 'push' side in recent years. The recently introduced iPhone 7 has no headphone jack, apparently to force customers to buy Apple's (expensive) wireless headphones. Reactions of customers were that Apple had become "arrogant" and "user-hostile".

A recent development is that not just product oriented companies, but also business services companies recognize the potential of design thinking. Large consulting companies recently acquired specialized companies in design services (Kolko, 2015), e.g. Deloitte acquired Doblin, Accenture acquired Fjord, and McKinsey acquired Lunar. These consultancy companies acknowledge that in the past, they were basically pushing their existing services onto clients. Now they recognize that the user empathy of design thinking can be fundamental to business success. The concept of design thinking offers opportunities to gather data and insights on how customers behave, think and feel as the basis for innovation of new services. In the design thinking approach, innovation often starts with designing a customer journey map to explore the problem space. An example is how the entrepreneurial company Uber took the traditional taxi branch by surprise. Uber came with the solution to skip the 'middleman' by defining the problem as how to organize mobility, not how to organize a fleet of taxis and a pool of drivers. Uber redesigned the relationship between user and transportation service (Chafkin, 2015). Other examples are airline company KLM which uses design thinking for innovation of flight handling services (Calabretta et al., 2016a) and financial services company Credit Suisse where employees were asked to spend a day in a wheelchair to better understand life from the perspective of disabled customers (Ford, 2012).

We conclude that design thinking is about maintaining a dynamic balance between 'product push', out of passion for the organization's products and services, and 'customer perspective' approaches.

3.4 Focus on functional aspects versus focus on aesthetic and emotional aspects

In the traditional approach to innovation, engineers are responsible for the functional aspect of a product, such as utility and product specifications, and designers turn it into an aesthetic product by making it look nice from the outside. In the traditional approach, innovation processes are engineer-driven. Functional aspects tend to be seen as serious and relevant, and aesthetics as subjective and not quantifiable (Tonkinwise, 2011). In the design thinking approach to innovation, the aesthetic and the overall emotional aspects of the user experience get much more attention: it is about finding motivations, feelings, needs, what makes the experience fun. One of the success factors of Apple is that there is an emotional relation between consumers and Apple products. However, this does not mean that design thinking is only about

aesthetic aspects. As former Apple-CEO Jobs said in interview: 'design is not just what it looks, it is how it works' (Walker, 2003). Design thinking can be seen as an integrative approach which considers both form and function, takes both functional aspects and emotional involvement into account. The challenge is in creating the balance between emotional meaning and functional aspects.

One of the inspirations of the design thinking approach is the German modern architecture movement 'Bauhaus' of the1920s. The Bauhaus style seamlessly integrated form and function. Bauhaus designs are simple and functional, yet expressive. Jobs got inspired by the design philosophy of Bauhaus when he attended the International Design Conferences in Aspen in 1981. He was impressed by the Bauhaus design concepts applied in the buildings and furniture of the Aspen Institute (Isaacson, 2011, p. 126). The influence of design thinking can be seen in Apple's Human Interface Guidelines for App makers: "Aesthetic integrity is not a measure of how beautiful your application is. It's a measure of how well the appearance of your application integrates with its function" (Apple Inc, 2010, p. 31).

Apple products are built with complex technology, but customers experience it as simple to use because of the seamless blend of appearance and functionality. Design thinking is not just about a good looking design, it is about design of the whole user experience and therefore an important part of business strategy (Brown, 2009, p. 7). In a design thinking culture, it is the mindset for all people involved in innovation. As a result of the integrative approach of design thinking, a company such as Apple espouses a feeling as an organization which can be referred to as 'style'. Interestingly, the Bauhaus movement which stood at the foundation of design thinking was in turn influenced by the Dutch art movement "De Stijl' ('The Style') in which the term 'style' stood symbolic for integration of function and form (Janssen & White, 2011). An example of the impact of style is how Sennheiser, the German manufacturer of high quality headphones, was overtaken by Beats Electronics, the headphone company of rapper Dr. Dre, who turned the headphone into a lifestyle product by offering a unique user experience.

The integrative approach requires different methods as well. While the functional approach is fact based, using quantitative methods and statistics, aesthetics requires more qualitative methods such as visual thinking. At airline company KLM, new management trainees get training in drawing to express their ideas (Calabretta et al., 2016a), in line with the advice of Brown (2009, p. 80): "words and numbers are fine, but only drawing can simultaneously reveal both the functional characteristics of an idea and its emotional content". We conclude in line with the findings of Ingle (2013) that design thinking requires a balance between quantitative and qualitative approaches.

3.5 Closed versus open approaches to innovation

Chesbrough (2012) has coined the term 'open innovation' as the alternative for the 'old' model of 'closed innovation' In 'closed innovation', a company controls its innovation processes by investing in internal R&D and protecting innovations coming out of these investments via intellectual property rights (Prud'homme van Reine, 2015). The closed innovation approach is associated with internal focus, sticking to existing company practices, and may lead to faulty assumptions because of 'tunnel

vision'. Open innovation is about accepting that you cannot do everything inside and making the world your laboratory by bringing in external expertise and insights. The Center for Design Research of Stanford University has suggested that design thinking is a form of open innovation (Kim, 2016). Open innovation and design thinking indeed have a lot in common. Both processes involve community generated problem solving and innovation. Design thinking can be seen as a solution oriented process to achieve innovation (Cross, 1982, 2001, 2006), characterized by outward focus, an open, entrepreneurial and 'thinking outside the box' attitude. Design thinking requires bringing together deep insights about humans and therefore looking at a problem from more than one perspective. It relies on sharing resources and leveraging knowledge to understand problems and develop solutions by looking for ideas among competitors, lead users, academics, suppliers and different industries. Outward focus is associated with design because looking outside for information is what designers tend to do. Apple co-founder Jobs famously took the idea for Apple's graphical user interface from Xerox. However, recent research shows that successful innovation strategies *connect* internal and external sources of innovation by developing a dynamic balance between closed and open approaches to innovation (Prud'homme van Reine, 2015). Creating and sharing knowledge and ideas in networks is only possible when companies invest in own R&D and innovation capabilities to acquire 'absorptive capacity': the ability to identify, assimilate and exploit knowledge from the environment. Therefore, introducing design thinking should start with building a culture that embraces network embeddedness, i.e. the willingness and ability to identify, assimilate and exploit external sources of innovation in such a way that it contributes to performance. An example is how the technology needed for the iPod was pulled together by Apple from internal and external sources. We conclude that design thinking for innovation is about maintaining a dynamic balance between closed and open approaches to innovation.

3.6 Innovation as a structured process versus 'bricolage'

Peter Drucker defined systematic innovation as follows: "systematic innovation consists in the purposeful and organized search for changes, and in the systematic analysis of the opportunities such changes might offer for economic or social innovation" (Drucker, 1985, p. 42). This emphasis on 'systematic', 'organized' and 'purposeful' appeals to managers of innovation processes. Many attempts have been made to develop systems and structures that promote consistency and predictability in **i**nnovation processes, such as 'innovation scoreboards', 'innovation scans' and other quantitative measurements of returns of innovation. Although engineers and scientists generally resist control by their managers, the systematic innovation concept appeals to them to some extent as well. Scientists and engineers do like the concept of innovation as a systematic process in which their role is to develop the universal 'one best solution'. Design thinking is a more loosely structured organizational process stimulating innovation (Brown, 2009; Kimbell, 2011). It accepts that design is messy, needs probing, and that showing and testing unfinished work is part of the process. Bricoleurs (from the French word 'bricolage', meaning 'tinkering') are not looking for the 'one best solution', but develop the best possible solution with the tools, materials and other means that happen to be available. It leads

to unique and unpredictable results, often with a personal touch of the designer. Former Apple-CEO Steve Jobs was more of a bricoleur than an engineer, a scientist or a manager, which can be understood by going back to his youth. Steve Job's father was passionate about tinkering with old cars in his garage and he involved Steve at an early age in 'bricolage': repairing cars with whatever they could get for their projects in local junkyards (Isaacson, 2011, p. 7). In the same garage where Jobs learned 'bricolage', he later 'tinkered' the first Apple computer with co-founder Wozniak.

It has been suggested that all design is a form of bricolage (Louridas, 1999). However, design thinking can be better seen as a dynamic balance between structured innovation and bricolage. Paradoxically, structure can actually enhance creativity by forcing the design thinker to come up with a creative solution. Already in 1972, the famous American designer Charles Eames said in an interview: "design depends largely on constraints" (Neuhart & Neuhart, 1989, p. 15). Accepting (or even embracing) constraints, that is, accepting to work within a certain structure, challenges the designer to think out of the box.

The tension between structured innovation and bricolage is related to the reliability versus validity dilemma in design thinking, identified by Martin (2009, p. 37). The goal of reliability is to provide consistent, predictable outcomes. The goal of validity is to produce outcomes that meet a desired objective, which may incorporate aspects of subjectivity and judgment. Validity is open for surprise and gives the designer room for originality, for putting something unique in it. Martin suggests that design thinking blends reliability and validity (Martin, 2009, p. 44). In other words, the challenge is in maintaining a dynamic balance in the tension between systematic innovation and bricolage.

At Apple, the balance between systematic innovation and bricolage was inherent in the combination of the two founders: engineer Wozniak and 'bricoleur' Jobs. In a later stage, Jobs managed to sustain Apple's culture of design thinking as a CEO by being open for surprise while not ignoring reliability and consistency. Jobs repeatedly likened his engineers to 'artists' who had to surprise him, in line with the design philosophy: 'you need to embrace change'. Paradoxically, the transition to new products at Apple was eased by consistency in what to expect from Apple products, i.e. 'style'. 'Stylistic consistency' (Beverland, 2005) is characteristic for the balance between consistency and bricolage in Apple's design thinking culture. Similarly, PepsiCo uses design thinking to balance launching innovative products e.g. new flavours, and developing meaningful, consistent experiences across their portfolio of brands (De Vries, 2015).

3.7 Linear thinking versus non-linear, iterative processes

Traditional innovation follows a linear, milestone based process: from research to development, engineering, design, manufacturing, testing, marketing and distribution. Design thinking organizations are different. In a design thinking organization, you will see prototypes all over the place. These physical, digital, or just visual representations of 'the product in becoming' reveal a bias for action. 'Rapid prototyping' fits a culture that values exploration and experimentation in a fast paced environment. Rapid prototyping is a non-linear, iterative process (Plattner et al, 2014). At design company IDEO, iterative prototyping was introduced to

acknowledge that designers would never be able to fully predict users' reactions to a final product, despite efforts to come to a deep understanding of user needs. It is a process of reengaging with users in parallel to development, in order to get feedback and to come to short cycles to improve the product in.

That design thinking has a circuitous nature doesn't mean that it is completely non-linear or even chaotic. Brown & Wyatt (2010) describe the design thinking process at IDEO as 'a system of overlapping spaces rather than a sequence of orderly steps'. They distinguish the three spaces inspiration (identifying the opportunity or problem), ideation (generating, developing, and testing ideas) and implementation. Dorst & Cross (2001) describe creative ideas as 'bursts of development' on top of a linear process in design thinking. So, design thinking balances planning and experimenting. In design thinking, judgment in formulating the problem statement gets postponed: design thinking is about letting problems and solutions co-evolve (Dorst & Cross, 2001).

Steve Jobs spoke at Apple about 'concurrent engineering' and 'cross-pollination' (Kahney, 2008, p. 97): simultaneous collaboration between departments instead of a sequential development process. The development of the iPod serves again as an example. The technology needed was pulled together in an iterative trial and error design process. Concurrent engineering, or 'synchronizing the sequences' is the ultimate balance between linear and iterative thinking.

3.8 Individual creativity versus group collaboration

Design thinking requires individual creativity but is in the end a group collaborative effort in which sharing information and ideas is essential. Design thinking requires divergent thinking, so that it is crucial to have a diverse group of people. Dunne & Martin (2006) emphasize the need for expanding perspectives by collaborating with individuals unlike oneself. Leonard and Straus (1997) go one step further. They argue for 'creative abrasion': the constructive collaboration of people with different cognitive approaches. The idea is to encourage innovation by hiring and developing people who make one uncomfortable.

Stimulating collaboration between diverse people is a theme that comes back in accounts of design thinking in practice as well. At Apple, Steve Jobs was very much aware that organizing collaboration could generate far more innovation than just relying on the creative ideas of individuals: "the best innovation is sometimes the company, the way you organize a company" (Isaacson, 2011, p. 334). Multidisciplinary people often have the capacity and character for collaboration across disciplines e.g. artists with business insight. A personal experience of the author of this paper as manager of a group of innovation professionals at Philips Electronics serves as an example. Unhappy about the lack of diversity in a glass technology innovation group, I struck an agreement with a glass artist. The artist was allowed to freely use raw materials, heating equipment and energy to heat glass for his experiments in making artistic glass sculptures, under the condition that he would give feedback on the design of process and product innovation going on in the lab. The relationship between the artist and the technologists was initially indeed abrasive, but after a few months it was seen as a mutually rewarding experience. The diversity of backgrounds and perspectives turned out to help in building an innovative culture

in which people dared to challenge what was possible.

Brown (2008) affirms that the best design thinkers don't simply work alongside other disciplines: 'many of them are multidisciplinary themselves'. Brown's design company IDEO employs people who are engineers *and* marketeers, anthropologists *and* industrial designers, architects *and* psychologists. Brown & Wyatt (2010), in a discussion of the traits that IDEO seeks in its new hires to ensure that they can operate within an interdisciplinary environment, talk about the 'T-shaped' person: an individual who has strengths in two dimensions. On the vertical axis of the 'T' is the depth of the skill that allows them to make an individual contribution to the outcome. In order to be or become a design thinker, they need to have at the top of the 'T' empathy for people with different backgrounds and for disciplines beyond their own.

We conclude that design thinking requires striking a dynamic balance between individual creativity and group collaboration by stimulating 'creative abrasion' in diverse groups.

3.9 Leading design thinking: egalitarian versus hierarchical leadership

Ingle (2013, p. 2) describes design thinking as "an egalitarian skill set that can be learned, practiced, and championed by professionals across industries and job titles". The talent and creativity of the entire organization needs to be used: 'a good idea doesn't care who has it' (Flynn et al., 2003). During design thinking brainstorming sessions, everyone is equal regardless of his or her role in the organization. "Design thinking is about creating a multipolar experience in which everyone has the opportunity to participate in the conversation" (Brown, 2009, p. 192). To succeed with design thinking, everyone on the design team must be free to speak and everyone is obliged to listen to the person who speaks. Hierarchy or power based on status discourages deep engagement. Everyone must be encouraged to be creative and to participate.

However, that doesn't mean that there is no such thing as 'design leadership' in the design thinking approach. Accounts of design thinking in practice reveal that a certain balance between egalitarianism and decisiveness is required. Design thinking sessions usually have a moderator with a certain authority in the room. Cloud computing company Citrix grants 'Design Hero' awards to people who demonstrated design leadership (Courage, 2013). Design leadership is needed to ensure that decisions are taken and to focus on priorities. Increasingly, companies appoint a CDO (Chief Design Officer) as a member of their management board in order to overcome the gaps between silos in the organization.

The balance between egalitarianism and leadership in design thinking should be reflected in the notion that everyone can be a design leader. Moreover, the leadership role in design should not be a hierarchical role, but the role of a coach, facilitator and/or sponsor. For instance, cloud computing company Citrix makes sure that every project has a clear executive sponsor. They learned from experience that the complete intervention necessary to implement an innovation based on design thinking requires a strong support system.

At Apple, it was often CEO Jobs himself who took the role of decisive design thinking leader. He was known for always putting on a few priorities and saying no to

many things: "he was in charge and he did not rule by consensus" (Isaacson, 2011, p. 333). Jobs sometimes took his role a bit too far. He has been described as "autocratic" (Isaacson, 2011, p. 362) and even as "one of the great intimidators" (Kahney, 2008, p. 163). However, he was also known as a leader who liked to be challenged himself.

The leadership of Airbnb, a company that successfully applied design thinking to its innovative services, apparently sees Jobs as a role model. Airbnb co-founder and CEO Chesky, who was educated as an industrial designer, recently said: "a consensus decision in a moment of crisis is very often going to be the middle of the road, and they're usually the worst decisions" (Gallagher, 2015).

Summarizing, design thinking is about finding the balance between on the one hand ensuring that everybody involved has a voice and on the other hand ensuring focus by clear leadership. It requires a type of leader that likes to be challenged.

3.10 Short term versus long term approach to innovation

Neumeier (2008) sees design as the cure for the number-one wicked problem cited by corporate leaders in his research: the conflict between long-term goals and short-term demands. Many companies have shifted the horizon of their innovation activities from long-term basic research to shorter-term applied innovation. Design thinking, as it is integrative thinking, has the potential to restore the balance between the short term interests of shareholders and the longer term interest of all stakeholders (Dunne & Martin, 2006). According to Ad van Berlo, CEO of the leading Dutch design company Van Berlo Group and associate professor Entrepreneurial Design of Intelligent Systems at the University of Technology Eindhoven, design thinking combines vision for the future and solving practical problems on the short term (van Berlo, 2012). In an interview van Berlo added: "I want to show that design thinking can make an organization future-proof. We are used to looking into the future and transforming creativity into concrete ideas" (Zeemeijer, 2016). Former Apple CEO Jobs played such a visionary role in Apple. He was known for his ability 'to describe the future' and instilling employees with his passion reflected in the mission statement "we're working to make the world a better place" (Kahney, 2008, p. 151).

In the services industry, balancing short term and long term approaches to innovation is particularly important. Service design is increasingly seen as a means for societal transformation in the direction of a more sustainable society: "Service designers work increasingly across organisations and communities to enhance such transformational processes" (Sangiorgi, 2011, p. 35). One example of how design thinking can connect short and long term thinking is Mindlab, a public sector innovation lab in Denmark. It combines design thinking and social science approaches to capture the subjective realities experienced by citizens and businesses to create new solutions for society (Carstensen & Bason, 2012). At first, Mindlab did short term oriented service design projects but over time it has moved on to projects with more complex dimensions and deliverables, such as engaging in policy making and reform to create the conditions for long-term transformation processes. Mindlab is an example of the 'living labs' approach in which user experience prototype environments are designed and built, with end users immersed as individuals, groups or communities (Meroni & Sangiorgi, 2011, p. 264).

Brown (2009, p. 184) predicted that design thinking would result in longer term oriented innovation processes in the service industry: "Eventually it will be as natural to see innovation labs in service-sector companies as it is to see research and development facilities in manufacturing companies". A recent example is the foundation of Uber Artificial Intelligence Labs in San Francisco. Uber's lab aims at making computers capable of learning more like humans, by extrapolating a system of rules from just a few or even a single example, instead of just feeding them enormous amounts of data (Metz, 2016).

Another company in the services industry using design thinking to connect long and short term perspectives in innovation is the Dutch airline company KLM. Employees trained in design thinking at KLM are asked to think about the passenger experience in 5-20 years' time *and* about what needs to happen now to make that experience possible. The risk of such an approach is that it leads to conflict between the innovators and the operational department, whose response might be like: 'Nice visions for the future, but we are busy to keep this place running'. In order to prevent such conflicts, KLM designated three gates at Amsterdam Schiphol Airport to test new ideas. As a result, the impact of the new solution on the short term and on the long term are considered and culture change takes place as part of the process.

3.11 Design thinking for innovation as balancing contradictory elements

The discussion in this section indicates that design thinking for innovation in products, services and customer experiences requires a mindset that accepts contradictory elements and knows how to deal with the tensions between them. It seems that the prerequisites for design thinking for innovation closely match F. Scott Fitzgerald's famous saying: "The test of a first-rate intelligence is the ability to hold two opposite ideas in mind at the same time, and still retain the ability to function" (Scott Fitzgerald, 1936). A design thinking mindset, then, requires holding in mind the seemingly contradictory elements in the following tensions (see table 1 and paragraphs 3.2 – 3.10):

- analysis versus imagination,
- passion for the organization's products versus user empathy,
- functionalism versus aesthetic ways of knowing,
- closed versus open approaches to innovation,
- consistency versus pragmatism,
- linear planning versus experimenting,
- individual idea generation versus collaboration,
- stimulating everybody to participate versus decisiveness,
- creating immediate benefits versus exploring possibilities of what could be

The discussion indicates that at organizational level, design thinking for innovation requires developing an agile organizational culture capable of maintaining a dynamic balance on each of these tensions.

4 Design thinking as a strategic tool for innovation: cultural challenges

4.1 Design thinking, strategic change and culture change

Over the past decade, many organizations have made efforts to become design-driven at strategic level by using design thinking as a strategic tool for innovation instead of just as a tool for product innovation (Dvorak, 2008; Kolko, 2015; Micheli & Perks 2016). Managers started to show an interest in design thinking because their organizations faced increasingly complex challenges, and they felt the need to broaden their range of strategies to address these challenges (Dorst, 2011).

As pointed out by Brown & Martin (2015), change associated with a design intervention involves two simultaneous and parallel challenges: the design of the artefact in question and the design of the intervention that brings it to life. The latter one involves change at the strategic level. According to Weick (1985), strategy and culture resemble one another and it is becoming increasingly difficult to separate strategic change from cultural change. Ed Schein, another leading thinker on organizational culture, added to this: "culture constrains strategy by limiting what the CEO and other senior leaders are able to think about and what they perceive in the first place" (Schein, 1989, p. 382). Weick's and Schein's observations imply that culture can limit strategic options significantly and can restrict an organization's ability to assess and to adapt to certain environments. Culture influences which solutions organizations and leaders tend to prefer. Adopting design thinking as a strategic tool for innovation is, therefore, not just a matter of implementing some design practices that can simply be copied or appointing a Chief Design Officer. Using design thinking at strategic level cannot be seen separately from developing a culture conducive to design thinking. Adopting design thinking as a strategic tool requires an organizational culture that can keep itself in a constant state of inventiveness by maintaining a dynamic balance on the tensions as described in section 3 of this paper. Neumeier (2008) refers to this as developing a 'designful mind' and a 'designful company'. Organizations interested in using designing thinking as a strategic tool for innovation have to take these organizational culture challenges into consideration. Luchs et al (2016) mention four type of organizations that will face organizational culture challenges when they use design thinking at the strategic level: start-ups with an entrepreneurial culture; large companies with traditional organization cultures; companies that use design thinking for innovation of business models; and services organizations. For each of these organizations, the organizational culture challenges in design thinking for innovation at the strategic level will be discussed in section 4.2, on the basis of cases and examples.

4.2 Organizational culture challenges in design thinking for innovation Startup company using design thinking

According to Luchs et al (2016), grounding the product development process in design thinking will help the rising number of relatively 'green' entrepreneurs to succeed as they encounter investors and in the marketplace. An example of a startup company that successfully used design thinking for innovation is Airbnb.

Joe Gebbia, chief product officer and co-founder of Airbnb tells the following story about how design thinking transformed Airbnb from an almost failing startup to a successful business (First Round Review, 2015). In 2009, the leadership team of Airbnb was in a brainstorming session at its headquarters in San Francisco, trying to figure out why people weren't booking rooms and growth had come to a standstill. The pattern they discovered was that the photos of listed properties on the company's website were amateurish and unattractive. They decided on the spot to travel to New York, the company's biggest anticipated growth market. They rented a professional camera, visited the listed properties and made some more professional high-resolution pictures. After arriving back at headquarters they upgraded the website. Within a week after publishing the improved pictures, revenues doubled. Gebbia calls this 'an example of design thinking that changed the trajectory of their business' (First Round Review, 2015). Although Airbnb is a data driven company, the team did not respond reactively to data but came up with a creative hypothesis, spontaneously decided to do an experiment, implemented change, reviewed the impact of the change and then repeated the process.

The example of Airbnb shows that to use design thinking for strategic innovation, several tensions need to be balanced at the same time. The leadership team balanced an analytic, data driven approach with intuitive and creative thinking; balanced passion for the company's product with customer empathy; and balanced linear planning and experimenting. Airbnb was able to use design thinking for innovation at a strategic level because it already had the required mindset among its leaders and a dynamic, adaptive or 'agile' culture as a startup. The two co-founders, CEO Chesky and Gebbia, are both designers by education. Moreover, CEO Chesky is reportedly 'particularly obsessive when it comes to culture' (Gallagher, 2015).

Challenges for design thinking in traditional organizational cultures. Airbnb was able to assess the environment and adapt to it because of its agile culture as a startup. Tonkinwise (2011) discusses the organizational culture challenges that more traditional companies face when they want to use design thinking as a strategic tool for innovation. According to Tonkinwise, managers of more traditional companies who are interested in design thinking as a strategic tool often downplay the emotional and aesthetic part of design. They are uncomfortable with the stylistic aspects of design because these are not easy to quantify. Tonkinwise even claims that style is often repressed in managerial design thinking. Design thinking implies tolerance for failure, but most managers do not like the risks involved in styling. Tonkinwise emphasises that style is central to design, and that seeing style as strategic helps designers to design. Avoiding the primacy of the aesthetic in design runs the risk of blocking innovation. Likewise, Neumeier, in his plea for 'the designful company' (Neumeier, 2008, p. 10), calls for 'the rebirth of aesthetics': "Innovation without emotion is uninteresting. Products without aesthetics are not compelling". Tonkinwise and Neumeier both show the need to maintain a dynamic balance between functionalism and aesthetic ways of knowing while the emphasis in many organizational cultures is still too much at the functional side. A case in point is traditional car manufacturer Ford. Ford has adopted design thinking but still "has a long road ahead after decades as an engineering-led company" (Kuang, 2016). In

2012, Ford has established a Research and Innovation Center within walking distance of the Palo Alto headquarters of Tesla, the car company that positions itself as a design company focused on energy innovation. According to Ford's director of interaction and ergonomics, creating a new balance between functionalism and aesthetics is one of the goals of tapping into Silicon Valley's design thinking for innovation processes: 'a more beautiful product is almost inevitable if you create a more beautiful process'. In the change process, Ford struggles with several of the other tensions in design thinking for innovation:

- passion for the organization's products and user empathy. Part of creating a new mindset at Ford are mobility experiments set up around new user experiences such as peer-to-peer car hiring arrangements. However, these initiatives meet internal and external scepticism: "you have to wonder how much Ford actually can change" (Kuang, 2016).
- linear planning and experimenting. Not everybody at Ford's headquarters appreciates that experimenting might mean driving around barely working prototypes.
- stimulating everybody to participate and decisiveness. Ford struggles with adapting the organization and how decisions are made in such a way that the user's point of view is represented.

Ford's CEO acknowledged: "challenging our cultural norms takes time" (Kuang, 2016).

Business model innovation and design thinking. Organizational culture challenges are also likely to come up in business model innovation e.g. when product based companies change to service based offerings. It has been shown that design professionals can support companies in addressing such challenges in strategic change by instilling service-oriented practices and by maintaining commitment to the servitization transition (Calabretta et al., 2016b). The contribution of design consultancies in such innovation efforts is that they help the organization to change the culture: from a product oriented culture to a culture that balances passion for its products and connecting deeply with users, from a rational culture to a culture that balances rationality and emotion, and from an analytic culture to a culture that balances analytic and intuitive approaches. A recent case of business model innovation using design thinking is the Dutch company Wavin, a supplier of plastic pipes and connectors for building projects worldwide. Their direct customers, general contractors of building projects, demanded lower prices. The response in Wavin's traditional organizational culture was to make a thorough financial spreadsheet analysis, suggesting building a new local factory as a solution. However, Wavin's supply chain and operations director personally drove a design thinking initiative to find creative other options based on user empathy. Wavin decided to send a team abroad to observe their customers at work on construction sites (van der Pijl et al., 2016) and gave team members freedom and trust to experiment and come up with an innovative solution. They found out that their real customers, the plumbers, were more interested in working smarter by gaining more knowledge than in lower prices per se. They wanted to become more competitive and deliver higher quality to their customers. Based on these new insights, Wavin established a local 'Wavin Academy', a training centre where plumbers receive free training in using materials and tools.

The result is that Wavin has a much closer relationship with its customers, the plumbers, and learns from them as well. The Wavin case shows that using design thinking to develop an innovative business model requires creating a dynamic balance on several tensions: product focus versus user empathy; rational (focus on price) versus emotional (close relationship with plumbers), and analysis (financial spreadsheets) versus creativity.

Design thinking for innovation in public services. Another example of organizational culture challenges in using design thinking as a strategic tool for innovation is innovation in public services. Innovation in public services often reveals tensions between creating immediate benefits (short term orientation) and exploring possibilities of what could be (long term orientation). Dorst (2011) reviews the case of a city council dealing with problematic behaviour of youngsters in an urban entertainment area with bars and clubs. Dorst uses the term 'new frame creation' to show what design thinking can do. The problems in the entertainment area were framed by authorities as 'a law and order problem'. They proposed short-term solutions such as increasing police presence. It didn't help, actually, the situation got more grim. Designers reframed the problem as 'how to organize a group of young people who want to have a good time'. Now, the broader problem situation could be addressed in an innovative way, with solutions similar to how one would organize a youth festival e.g. additional activities to prevent boredom, organizing transport, creating relaxed spaces and focusing on safety instead of on security. The designers created a new frame, based on the themes that emerged from their investigation, moving away from the frame in which the problem was originally expressed, thereby removing constraints and providing a long term solution. In this case, it was necessary to hire designers as external consultants to bring a new frame to the problematic situation. Dorst's concept 'new frame creation' is close to 'creating a new mindset' or 'instilling culture change'. It would be better to integrate design orientation into the organizational culture from the very beginning (Beverland, 2005) to link design practices and organizational innovation to create new frames.

4.3 Discussion: cultures conducive to design thinking for innovation

The exploratory research of organizations using design thinking for innovation at strategic level leads to the following tentative conclusions. The cases and examples discussed indicate that organizations interested in using design thinking as a strategic tool for innovation need to develop an organizational culture that can keep itself in a constant state of inventiveness by maintaining a dynamic balance on the tensions in design thinking for innovation. Using design thinking as a strategic tool for innovation often requires balancing several of the tensions simultaneously. The framework of nine fundamental tensions can serve as a tool to identify which of the tensions in the framework need to be addressed to develop a culture conducive to design thinking for innovation.

5 Conclusions and further research, Insights and managerial implications

Design thinking for innovation should be seen as a mindset (at individual level) and as a culture (at organizational level). Design thinking is often presented in the published literature as a radically new approach to innovation, as the opposite of 'established ways of thinking', 'traditional linear thinking' , 'traditional analytic thinking' and 'engineering thinking'. By relating an analysis of the academic literature on design thinking for innovation to accounts of design thinking for innovation in practice, this paper comes to the tentative conclusion that design thinking for innovation can be better seen as an approach that helps to establish a dynamic balance on a number of fundamental tensions in innovation. The power of design thinking is in the tension between seemingly opposite ways of thinking, such as analytic thinking versus intuitive thinking, and linear thinking versus thinking in iterative processes. Design thinking for innovation needs to be embedded in an organizational culture capable of continuously anticipating and adjusting to change. Conceptualizing organizational culture as how the organization handles a number of fundamental tensions or innovation dilemmas in such a way that a dynamic balance is maintained, makes it possible to operationalize such an 'agile' culture. All the nine tensions or innovation dilemmas derived from an existing model of organizational culture turn out to be relevant for understanding design thinking. The framework of nine tensions as listed in 3.1 can be used by managers as a tool to evaluate to what extent organizations are equipped to benefit from design thinking for innovation, by exploring the dynamics of how each tension is handled: is the organization capable of maintaining a dynamic balance on each tension?

Copying design practices from other organizations as 'a secret weapon for innovation' is not a viable option – how to maintain a dynamic balance on each of the tensions depends on the existing culture of the organization, its history and its environment. The analysis of how the tensions are handled will reveal the strengths and weaknesses in the capacity of the organization to apply design thinking for innovation and the organizational culture challenges that can be expected. Based on such an analysis, the framework can be used to identify innovation approaches that have the potential to create a dynamic balance on all the dilemmas relevant for the organization. For instance, it has been shown in sections 3.3 and 3.10 of the paper that the living lab approach can contribute to balancing the product push versus user empathy dilemma and the long term versus short term dilemma. Recent research (Brankaert & den Ouden, 2017) suggests that 'design-driven living labs' have the potential to help balancing other tensions as well, such as closed versus open approaches to innovation, by giving more room for input from various stakeholders, and linear thinking versus non-linear, iterative processes, by exploring innovative solutions to complex societal challenges potentially leading to more disruptive, open-ended development of innovation.

Detailed guidelines on how dilemmas can be balanced or 'reconciled' by using scorecards can be found in other publications on dilemma methodology (Trompenaars & Prud'homme van Reine, 2004; Trompenaars & Hampden-Turner, 2010).

Limitations and further research. A limitation of the research is that the examples and cases used in this paper are based on literature research and on the own experiences of the author as an innovator, manager, consultant and researcher. Systematic empirical research of organizational culture challenges of different type of organizations using design thinking for innovation is still lacking and is recommended as an avenue for further research.

6 References

Aken, van, J. (2004). Management research based on the paradigm of the design sciences: the quest for field-tested and grounded technological rules. *Journal of Management Studies*, 41(2), 219-246.

Apple Inc (2010). *iPhone Human Interface Guidelines: User Experience*. Cupertino (CA): Apple Inc.

Bauer, R. & Eagen, W. (2008). Design thinking: epistemic plurality in management and organization. *Asthaesis: International Journal of Art and Aesthetics in Management and Organizational Life* 2(3), 64-74.

Berlo, van, A. (2012). *Design + / = & Ondernemerschap*. Eindhoven: Technische Universiteit Eindhoven.

Beverland, M. (2005). Managing the Design Innovation–Brand Marketing Interface: Resolving the Tension between Artistic Creation and Commercial Imperatives. *Journal of Product Innovation Management* 22(2), 193–207.

Beverland, M. (2015). Wilner, S. & Micheli, P., 2015. Reconciling the tension between consistency and relevance: design thinking as a mechanism for brand ambidexterity. *Journal of the Academy of Marketing Science* 43(5), 589-609.

Brankaert, R., & den Ouden, E. (2017). The Design-Driven Living Lab: A New Approach to Exploring Solutions to Complex Societal Challenges. *Technology Innovation Management Review*, 7(1), 44–51.

Brown, T. (2008). Design Thinking. *Harvard Business Review 86(6),* 84-92.

Brown, T. (2009). *Change by design, How design thinking transforms organizations and inspires innovation*. New York: Harper Collins.

Brown, T. (2016). *Design thinking*. Accessed 15th December 2016. http://www.ideou.com/pages/design-thinking

Brown, T. & Martin, R. (2015). Design for action. *Harvard Business Review* 93(9), 56–64.

Brown, T. & Wyatt, J. (2010). Design thinking and social innovation. *Stanford Social Innovation Review* 8(1), 30-35.

Buxton, B. (2007). *Sketching User Experiences*. San Francisco: Morgan Kaufmann.

Calabretta, G., Montaña, J. & Iglesias, O. (2008). A cross-cultural assessment of leading values in design-oriented companies. *Cross Cultural Management: An International Journal* 15(4), 379 - 398

Calabretta, G., Gemser, G. & Karpen, I. (2016a). *Strategic Design, Eight Essential*

Practices Every Strategic Designer Must Master. Amsterdam: BIS Publishers.

Calabretta, G,. DeLille, C., Beck, C & Tanghe, J. (2016b). Service Design for Effective Servitization and New Service Implementation. In N. Morelli, A. De Götzen, F. Grani, *Service Design Geographies. Proceedings of the Service Design Conference* (pp: 91-104). Linköping University Electronic Press.

Carstensen, H. & Bason, C. (2012). Powering Collaborative Policy Innovation: Can Innovation Labs Help? *The Innovation Journal: The Public Sector Innovation Journal*, 17(1), 1-25.

Chafkin, M. (2015). *What makes Uber run*. Accessed 15th December 2015. https://www.fastcompany.com/3050250/what-makes-uber-run

Chesbrough, H. (2012). Open Innovation Where We've Been and Where We're Going. *Research Technology Management* 55(4), 20-27.

Clifton, N., Gartner, S. , Rehfeld, D. (Eds.) (2014). *Companies, Cultures, and the Region. Interactions and Outcomes*. London: Routledge.

Courage, C. (2013). *Reweaving corporate DNA: building a culture of design thinking at Citrix*. Accessed 15th December 2015. http://www.managementexchange.com/story/reweaving-corporate-dna-building-culture-design-thinking-citrix

Cross, N. (1982). Designerly ways of knowing. *Design studies* 3(4), 321-327.

Cross, N. (2001). Designerly ways of knowing: design discipline versus design science. *Design studies* 17(3), 49-55.

Cross, N. (2006). *Designerly ways of knowing*. Berlin: Springer.

Cross, N, Dorst, K. & Roozenburg, N. (eds.) (1992). *Research in design thinking*. Delft: Delft University Press.

Dennehy D., Adam, F, & Carton, F. (2016). Leveraging design thinking to innovate. In A. Mention & M. Torkelli (Eds.), *Open Innovation: A Multifaceted Perspective Part 1* (pp 159-179). Singapore: World Scientific Publishing Co.

De Vries, J. (2015). Pepsico's chief design officer on creating an organization where design can thrive. *Harvard Business Review*. Accessed 15th December 2016. https://hbr.org/2015/08/pepsicos-chief-design-officer-on-creating-an-organization-where-design-can-thrive

Dorst, K. (2006). Design problems and design paradoxes. *Design issues* 22(3), 4-14.

Dorst, K. (2011). The core of design thinking and its application. *Design Studies* 32(6), 521-532.

Dorst, K. & Cross, N. (2001). Creativity in the design process: co-evolution of problem-solution. *Design studies* 22(5), 425-437.

Drucker, P. (1985). *Innovation and Entrepreneurship: Practice and Principles*. New York: Harper & Row.

Dumaij, A. , Mooij, R. & Blank, J. (2011). A High Road to Dutch Healthcare Reform. In: L. Bos, A. Dumay, L. Goldschmidt, G. Verhenneman. and K. Yogesan (Eds.). *Handbook of Digital Homecare* (Pp. 1-14). Berlin: Springer-Verlag.

Dunne, D. & Martin, R. (2006). Design thinking and how it will change management

education: an interview and discussion. *Academy of Management Learning and Education* 5(4), 512-523.

Dvorak, P. (2008). Businesses take a page from design firms. *The Wall Street Journal*, November 10, p. B4.

First Round Review, (2015). *How design thinking transformed Airbnb*. Accessed 15th December 2016. http://firstround.com/review/How-design-thinking-transformed-Airbnb-from-failing-startup-to-billion-dollar-business/

Flynn, M. , Dooley, L., O'Sullivan, D. &. Cormican, K. (2003). Idea Management for Organisational Innovation. *International Journal of Innovation Management* 7(4), 417-442.

Ford, S. (2012). *Reports Of Design Thinking's Death Were An Exaggeration*. Accessed 15th December 2016. https://www.fastcompany.com/1811688/reports-design-thinkings-death-were-exaggeration

Gallagher, L. (2015). The Education of Brian Chesky. *Fortune* July 1 issue. Accessed 15th December 2016. http://fortune.com/brian-chesky-airbnb/

Geertz, C. (1973). Thick Description: Toward an Interpretive Theory of Culture. In C. Geertz, *The Interpretation of Cultures: Selected Essays* (pp. 3–30). New York: Basic Books.

Hawryszkiewycz, I. (2013). *Design Thinking for Business: A Handbook for Design Thinking in Wicked Systems.* Fremantle (Australia): Vivid Publishing.

Ingle, B. (2013). *Design Thinking for Entrepreneurs and Small Businesses: Putting the Power of Design to Work*. Berkeley, CA: Apress.

Isaacson, W. (2011). *Steve Jobs*. New York: Simon & Schuster.

Janssen, H. & White, M. (2011). *The Story of De Stijl*. London: Lund Humphries.

Kahney, L. (2008). *Inside Steve's brain*. New York: Portfolio.

Kelley, T. (2001). *The Art of Innovation: Lessons in Creativity from IDEO*. New York: Currency.

Kelly, M. (1950). The Bell Telephone Laboratories: an example of an institute of creative technology. *Proceedings of the royal society of London Series A. Mathematical, Physical and Engineering Sciences* 203(1074), 287 -301.

Kim, S. (2016). *Design thinking open innovation joint project with Stanford center for design research*. Accessed 15th December 2016. http://www.sohkim.com/research/#/design-thinking-open-innovation-joint-project-with-stanford-center-for-design-research/

Kimbell, L. (2011). Rethinking design thinking. *Design and Culture* 3(3), 285-305.

Kolko, J. (2015). Design thinking comes of age. *Harvard Business Review*. 93(9), 66–71.

Kuang, C. (2016). Ford's quest to remake itself into a master of UX. Accessed 15th December 2016. https://www.fastcodesign.com/3057494/fords-quest-to-remake-itself-into-a-master-of-ux

Lenstra, R. (2016). *Design thinking for beginners*. Antwerp Management School blog Business Design & Innovation. Accessed 15th December 2016.

http://blog.antwerpmanagementschool.be/en/design-thinking-for-beginners

Leonard, D. & Straus. S. (1997). Putting your company's whole brain to work. *Harvard Business Review* 75(7), 110-122.

Louridas, P. (1999). Design as bricolage: anthropology meets design thinking. *Design Studies* 20(6), 517-535.

Luchs, M. (2016). A brief introduction to design thinking. In M. Luchs, K. Swan & A. Griffin (eds.), *Design thinking : new product development essentials from the PDMA* (pp. 1-12). Hoboken: (NJ): Wiley.

Luchs, M., Swan, K. & Griffin, A. (eds.) (2016). *Design thinking : new product development essentials from the PDMA*. Hoboken: (NJ): Wiley.

Martin, R. (2009). *The design of business. Why design thinking is the next competitive advantage*. Cambridge MA: Harvard Business School Press.

Meroni, A. & Sangiorgi, D. (2011). *Design for services*. Burlington: Gower.

Metz, C. (2016). *Uber Buys a Mysterious Startup to Make Itself an AI Company*. Accessed 15th December 2016. https://www.wired.com/2016/12/uber-buys-mysterious-startup-make-ai-company/

Micheli P., Perks, H. (2016). Strategically embedding design thinking in the firm. In M. Luchs, K. Swan & A. Griffin (eds.), *Design thinking : new product development essentials from the PDMA* (pp. 205-220). Hoboken: (NJ): Wiley.

Neuhart, J. & Neuhart, M. (1989). *Eames Design*. New York: Harry Abrams Publishing.

Neumeier, M. (2008). The designful company. *Design Management Review* 19(2), 9-15.

Nussbaum, B. (2011). *Design thinking is a failed experiment, so what's next?* Fast Company blog. Accessed 15th December 2016. https://www.fastcodesign.com/1663558/design-thinking-is-a-failed-experiment-so-whats-next

Pijl, P. van der, Lokitz, J. & Solomon, L. (2016). *Design a better business: new tools, skills and mindset for strategy and innovation*. Hoboken (N.J.): Wiley.

Plattner, H., Meinel, C. & Leifer, L. (eds.) (2014). *Design thinking research: Building innovation eco-systems.* Heidelberg: Springer.

Plattner, H., Meinel, C. & Leifer, L. (eds.) (2016). *Design thinking research: Taking breakthrough innovation home.* Heidelberg: Springer.

Prud'homme van Reine, P. (1983). The influence of impurities and dopes on the thermophysical stability of translucent Al2O3. *Science of Ceramics* 12, 741–49.

Prud'homme van Reine, P. (1987). *United States Patent 4699774,* 13 Oct. 1987

Prud'homme van Reine, P. (1994). Philips, marketing en de antropologie. *Facta* 3(8), 16-18.

Prud'homme van Reine, P. (2015). A networking culture to benefit from open innovation. *Journal of Innovation Management*. 3(2), 71-105.

Prud'homme van Reine, P., & Dankbaar, B. (2009). Mythe en realiteit van het creëren van innovatieculturen. In: R. van Es & J. Boonstra, *Cultuurverandering: mythe*

en realiteit (pp. 77-94). Deventer: Kluwer.

Prud'homme van Reine, P., & Dankbaar, B. (2011). The dynamic interaction between corporate and regional cultures. *Journal of Economic and Social Geography*,102(5), 532-547.

Rosenberg, N, Chauvet, M. & Kleinman, J. (2016). Leading for a corporate culture of design thinking. In M. Luchs, K. Swan & A. Griffin (eds.), *Design thinking : new product development essentials from the PDMA* (pp. 173-186). Hoboken: (NJ): Wiley.

Rowe, P. (1987). *Design Thinking*. Cambridge (MS): MIT Press.

Sangiorgi, D. (2011). Transformative Services and Transformation Design. *International Journal of Design* 5(2), 29-40.

Schein, E. (1989). *Organizational culture and leadership, second edition*. San Francisco: Jossey Bass.

Scott Fitzgerald, F. (1936). The crack-up. *Esquire 5 (*February): 41, 64.

Tonkinwise, C. (2011). A taste for practices. Unrepressive style in design thinking. *Design studies* 32(6), 533-545.

Trompenaars, F. & Hampden-Turner, C. (2010). *Riding the waves of innovation*. New York: McGrawHill.

Trompenaars, F., & Prud'homme van Reine, P. (2004). *Managing change across corporate cultures*. Chichester: Capstone-Wiley.

Von Hippel, E. (1986). Lead users: a source of novel product concepts. *Management Science* 32, 791–805.

Von Hippel, E., Ogawa, S., de Jong, J. (2011). The age of the consumer-innovator. *MIT Sloan Management Review* 53(1), 27-35.

Yoo,Y. & Kim, K. (2015). How Samsung became a design powerhouse. *Harvard Business Review* 93(9), 72–78.

Walker, R. (2003). The Guts of a New Machine. *New York Times Magazine.* Accessed 15th December 2016. http://www.nytimes.com/2003/11/30/magazine/the-guts-of-a-new-machine.html

Weick, K. (1985). The Significance of Corporate Culture. In P. Frost, L. Moore, M. Louis, C. Lundberg & J. Martin (eds.), *Organizational Culture* (pp. 381-389). Beverly Hills: Sage.

Whitbeck, C.(1998). *Ethics in engineering practice and research*. Cambridge UK: Cambridge University Press.

Wroblewski, L. (2008). *Influencing Strategy by Design: Design Skills*. Accessed 15th December 2016. http://www.lukew.com/ff/entry.asp?613

Zeemeijer, I. (2016). Design thinking helpt om in de toekomst te kijken. *Financieele Dagblad* 20 maart 2016. Accessed 15th December 2016. https://fd.nl/morgen/1143633/design-thinking-helpt-om-in-de-toekomst-te-kijken