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edited by
Erik Bohemia
Cees de Bont
Lisbeth Svengren Holm
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Editorial: Research Perspectives on Creative Intersections

DE BONT Cees\textsuperscript{a}; HOLM Lisbeth Svengren\textsuperscript{b} and BOHEMIA Erik\textsuperscript{c}

\textsuperscript{a} Honk Kong Polytechnic University, Honk Kong
\textsuperscript{b} University of Gothenburg, Sweden
\textsuperscript{c} Loughborough University London; United Kingdom
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The conference general theme \textit{Research Perspectives on Creative Intersections} captured the overall conference spirit. It also reflects the conference planning and organisational processes which involved the community of international scholars located in different institutions, faculties, schools and departments.

The interdisciplinary nature of the conference enabled active intersections of scholars from the fields of design, social sciences and business studies. The mingling of researchers from diverse disciplines reflects the need for interdisciplinary approaches to research complex issues related to innovation.

The intersection between emerging and established researchers was an intended aspect of the conference. The reason was that today’s PhD candidates will drive the future research. The conference succeeded by attracting significant number of PhD candidates who represented a third of the conference delegates. This provides a good indication for the future growth research related to design innovation.

Altogether, 295 authors have submitted: 140 full papers and 31 workshop proposals. These numbers indicate that a single authored research is no longer the norm. The intersection which stems from collaboration amongst researchers to undertake and disseminate research is now becoming the established practice within the design innovation research.

The 19 conference tracks, for which the papers were submitted, were organised within 7 overarching themes (see Table 1). The track facilitators ultimately shaped the overall conference scope and direction. The tracks’ topics acted as the focal points for the overall Call for Papers. Thus, our thanks you go to all the 69 tracks’ facilitators. It was them who collectively were responsible for the conference programme and we would like to thank them for their valuable services on the International Scientific Programme Committee.
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We would like to also thank the over 150 expert reviewers who provided their valuable time to provide critical peer feedback. Their service on the International Board of Reviewers was invaluable as the good quality peer reviews provided a vital contribution to this international conference. Each reviewer scored papers on a scale of 0 to 10 and provided critical review comments.

Most papers were reviewed by two people, though some had three or even four reviewers, and in a very small number of cases only one review was submitted. Total number of submitted full papers was 140. After the blind peer review process 66 papers (47%) were accepted and 49 (35%) papers were provisionally accepted as these needed major revisions, and 25 (19%) papers were rejected.

In making the final decisions about papers, the Review Committee first looked at all papers where the difference of opinion between reviewers was 4 points or greater and moderated the scores if necessary. The Review Committee then discussed all papers that were just under the general level of acceptance to determine outcomes, before finally looking at any exceptions.
At the end of the review process 103 (73%) paper submissions were accepted for presentations of which 95 (68%) were included in the proceedings and 38 (27%) papers were rejected. Seven accepted papers were presented at the conference as research in progress and they were not included in the proceedings.

The workshops provided another intersection on how delegates and workshop facilitators interacted. Altogether, 31 workshop proposals were submitted and 17 (54%) workshops were accepted by the International Workshop Organising Committee. We would like to thank the International Workshop Organising Committee members: Katinka Bergema, Nuša Fain, Oriana Haselwanter, Sylvia Xihui Liu, Ida Telalbasic and Sharon Prendeville for providing their expertise.

We would like to thank both keynote speakers, Professor Jeanne Liedtka and Mr Richard Kelly, who generously gave their time to share their insights with the conference delegates. Their generosity allowed us to offer bursaries to five emerging researchers to attend the conference. The bursar recipients were selected from close to 40 applicants. The number of applicants indicates the need to setup funding schemes to allow emerging researchers to attend international events such as this conference.

The PhD Seminar event which took place a day prior to the conference was attended by over 100 delegates. The PhD Seminar was chaired by Dr Sylvia Xihui Liu and Professor Jun Cai. Initially 40 submissions were received of which 36 were presented at the event. The event culminated with a debate organised by the PhD students who were inspired by the “Open Letter to the Design Community: Stand Up for Democracy” by Manzini and Margolin (2017). We are grateful to the debate organisers.

The location of the conference in the Jockey Club Innovation Tower designed by Zaha Hadid at the Hong Kong Polytechnic University has also provided delegates with visible cultural intersections of a rapidly transitioning major interconnected global city from one political sphere of influence into another. The conference would not have happened without the solid work provided by the local organising team which was led by Professor Cees de Bont and consisted of: Ms Rennie Kan who took up the role of the fixer; Mr Pierre Tam who in his role as the Conference Secretary tirelessly worked on satisfying at many times conflicting requirement; Ms Flora Chang who checked and checked again all delegates registrations; Mr Rio Chan wizard of IT and Mr Jason Liu who provided the visual direction for the conference.

The Design Management Academy’s international research conference was organised under the auspices of the Design Society’s Design Management Special Interest Group (DeMSIG) and Design Research Society’s Design Innovation Management Special Interest Group (DIMSIG) in collaboration with: The Hong Kong Polytechnic University, Loughborough University, Tsinghua University, University of Strathclyde, Politecnico di Milano and Delft University of Technology. The conference was a culmination of two years of planning and the 2019 conference planning commenced well before the 2017 conference programme schedule was finalised. It is a hope that the conference will act as a platform to build a diverse community of scholars who are interested to explore and discuss design innovation practices.
Reference


About the Editors

Cees de Bont is dean of School of Design, Hong Kong Polytechnic University. His research interests are in the areas of early concept testing of consumer acceptance, branding, networked innovation and design education.

Lisbeth Svengren Holm is professor in Design Management at University of Gothenburg, Director of Business & Design Lab. Her research interests include design management, design & strategy, design & innovation, and the interaction between design and other functions.

Erik Bohemia is the Programme Director in the Institute for Design Innovation at Loughborough University London. He is interested in Design as a cultural practice and the material effects of design.
Section 5.b
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Really new products (RNPs) are often difficult to comprehend, which may hinder consumers’ adoption. It is generally believed that designers can stimulate consumers’ comprehension by embodying RNPs in the form of product metaphors. However, empirical evidence for this is lacking. This study empirically examines the effects of product metaphors on consumers’ comprehension of RNPs. The findings of an experiment (N= 114) demonstrated an interaction effect of the presence of a product metaphor and a textual clue that explains the product metaphor on consumers’ comprehension of RNPs. Specifically, embodying a RNP in the form of a product metaphor will confuse consumers and reduce comprehension, unless the product metaphor is also explained through a textual clue.

Keywords: consumers’ comprehension, really new products (RNPs), innovations, product metaphor.

Introduction
Designers are often involved in developing really new products (RNPs). RNPs (a.k.a. discontinuous or radical innovations) refer to new products that integrate highly advanced technology that has been rarely used in the industry before. Different from incrementally new products (INPs) that provide better product performance based on current products, RNPs provide consumers with highly innovative functions that allow consumers to do things that they could never do before (Garcia & Calantone, 2002). An example of a RNP is “SmartThings” of Samsung, which is a smart home system (see figure 1). The smart home...
system contains a hub and multiple smart devices that are connected to it. The smart devices collect various information about the home, such as energy consumption, the presence of family members, door locks, and entry movement that people can access through an app, allowing them to monitor and control their home from a distance.

figure 1. “smartthings” of samsung (source: https://www.smartthings.com/)

although RNPs can offer significant benefits, consumers often do not readily adopt them (Ram & Sheth, 1989) because consumer experience difficulty understanding the innovative functions provided by RNPs (Hoeffler, 2003). RNPs integrate advanced technologies that are totally different from current technologies used in products on the markets, due to which comprehending RNPs requires a shift in consumers’ thinking patterns (veryzer, 1998). The previously accumulated knowledge and experience are not effective for explaining RNPs because understanding RNPs require completely new knowledge (Gatignon & Robertson, 1985). As a result, consumer often encounter difficulty comprehending RNPs, which is one of the main barriers for the success of RNPs (Hauser, Tellis, & Griffin, 2006).

To stimulate consumers’ comprehension of RNPs, current research explores several marketing strategies, such as analogical learning (Gregan-Paxton, Hibbard, Brunel, & Azar, 2002) and product bundling (Reinders, Frambach, & Schoormans, 2010). These strategies aim to relate a RNP with another product that consumers are familiar with. Thus, consumers can learn the RNP through making use of the knowledge of the familiar product, which lead to enhanced comprehension. Although product appearance has been demonstrated to influence consumer responses to RNPs (Cheng & Mugge, 2015, 2016; Mugge & Dahl, 2013), the potential of designing product appearances to facilitate consumers’ comprehension of RNPs is largely overlooked. In fact, relating a RNP to a familiar product can also be achieved through product design. Specifically, using product metaphors is a common practice that designers use to stimulate consumers to relate a RNP to a familiar product (Hekkert & Cila, 2015). For example, similar to “smartthings” (see figure 1), “mother” is a smart home system that is embodied in the product metaphor of a mother (see figure 2). It is expected that consumers can relate the benefits of the smart home system to the role of a mother at home, resulting in better comprehension of the smart home system.
Although product metaphors hold great potential to facilitate consumers’ comprehension of RNPs, current studies have not yet empirically investigated the effects of product metaphors. As designers and design managers are responsible for deciding whether and/or how to use product metaphors to embody RNPs, it is important to equip them with the knowledge of how to make better use of product metaphors to influence consumers’ comprehension of RNPs. This study aims to fill in this gap.

**Product Metaphors**

Product metaphor is a specific kind of metaphor. A metaphor is defined as “understanding and experiencing one kind of thing in terms of another” (p.5) (Lakoff & Johnson, 1980). A metaphor relates two entities: target and source. Based on the shared similarities, the properties of a source are selected and assigned to a target, to express certain characteristics of the target. Following this, product metaphors are defined as product appearances that “intentionally reference the physical properties of another entity for specific, expressive purposes” (Hekkert & Cila, 2015). A product metaphor entails conceptual and physical associations between the source and the product. On the conceptual level, the product and the source are associated in terms of certain meanings. On the physical level, the product resembles the shapes of the source (Forceville, Hekkert, & Tan, 2006; Hekkert & Cila, 2015; Van Rompay, 2008). As shown in figure 3, the smart home system “Mother” can be used to explain these two levels. On the conceptual level, a conceptual association is built between the smart home system that collects all the information surrounding the home and a mother who often knows everything at home. In this way, the benefits of the smart home system are related to the role of a mother at home. Furthermore, a product metaphor not only builds a conceptual association, but also translates such a conceptual association physically in the product appearance. In addition to the conceptual association, the design of “Mother” resembles the shape of a doll.
Various studies have been conducted to examine the effects of metaphors on consumer response in different contexts. In advertisements, using metaphors has been demonstrated to improve consumers’ comprehension and consumers’ attitudes (Phillipes, 2000). Involving metaphors in product designs can trigger surprise while users operate the product (Lin & Cheng, 2014). Based on these findings, we propose that product metaphors can play a role in facilitating consumers’ comprehension of RNPs as well. However, different from a verbal metaphor that states the source clearly (e.g., in ads), consumers need to interpret a product metaphor by identifying the source themselves. Visual metaphors often carry certain levels of ambiguity (Van Rompay & Veltkamp, 2014), which may hinder consumers to identify the source precisely, leading to consumers’ confusion. In the example of “Mother,” consumers may link the product design to multiple sources, such as a Russian doll, a cartoon character of Barbamama, and/or the role of a mother at home. This ambiguity could hinder the further knowledge mapping and transfer, resulting in reduced consumers’ comprehension. It is possible that the positive effects of product metaphors on consumers’ comprehension of RNPs can be triggered with the help of textual clues. For the “Mother” smart home system, the textual clue of “Mother knows everything” is stated in the product introduction. In this way, the source is activated precisely and the possibility for misinterpreting is largely avoided. Therefore, this study will empirically test the effects of product metaphors on consumers’ comprehension of RNPs in either the presence or absence of a textual clue.

The potential of product metaphors on facilitating consumers’ comprehension

The facilitating role of product metaphors on consumers’ comprehension of RNPs is similar to analogical learning that has been demonstrated to facilitate consumers’ learning of RNPs. Analogical learning refers to knowledge transfer from the source to the target domain (Gregan-Paxton & John, 1997). The analogical learning contains three steps: 1) identification of the source domain, 2) mapping the source domain to the target, and 3) transferring the knowledge from the source domain to the target. Prior research has demonstrated that when describing a RNP with an analogy in an advertisement, consumers’ comprehension of RNPs will increase because consumers can identify the source, build the association between the source and the target, and transfer important characteristics from the source to the target (Houssi, Morel, & Hultink, 2009).
Using a product metaphor in a RNP can relate a source to the RNP, which can trigger an analogical learning process, resulting in enhanced consumers’ comprehension. The associations between the source and the RNP are essentially integrated when the RNP is embodied through a product metaphor (Hekkert & Cila, 2015). As the RNPs and the sources are conceptually related, the knowledge related to the source can be activated and transferred to the RNPs through analogical thinking, resulting in enhanced consumers’ comprehension. Furthermore, in addition to the conceptual associations between a source and a RNP, product metaphors express such a conceptual association physically in the appearance of a RNP (Hekkert & Cila, 2015). The physical resemblance between the source and the RNP can help consumers to identify the source domain. Prior research has demonstrated that physical similarities between source and target can help consumers’ identification. By looking at the physical signal, consumers can retrieve the source from their memory and further map and transfer relevant knowledge (Forbus, Gentner, & Rattermann, 1993). Such identification is crucial for further mapping and transferring.

However, a precondition for facilitating consumers’ comprehension of RNPs by triggering analogical learning through product metaphors is consumers’ identification of the source. It is necessary that consumers can identify the source that designers intended. Otherwise, a different source can be activated, which will lead to consumers’ confusion while mapping the similarities and a failure to transfer the relevant knowledge. If consumers fail to draw a conclusion, consumers’ learning and comprehension of RNPs will be strongly reduced.

The uncertainty of identifying one specific source is caused by ambiguity essentially associated with visual metaphors. In comparison to verbal metaphors, visual metaphors often carry a certain level of ambiguity. Generally, consumers tend to perceive a visual metaphor more ambiguous when the distance between the source and target is large (Van Rompay & Veltkamp, 2014). A moderate level of ambiguity in visual metaphors presents consumers with a “puzzle to be solved” that further pushes them to pay more cognitive efforts to process (Kardes, 1988). Visual metaphors with a low level of ambiguity can be understood immediately, while visual metaphors with a high level of ambiguity lead to consumers’ confusion and frustrations (Mick, 1992; Steen, 2004; Ward & Gaidis, 1990). To reduce ambiguity, the provision of explanatory information can be helpful. By providing a textual clue to explain the product metaphors, consumers’ identification of the source domain is directed to the one that designers intended and the possibility of interpreting it in different ways is avoided. Moreover, an explicit textual clue provides a link between the target and the source, which reduces the amount of cognitive efforts for identifying the source domain (Alba & Hutchinson, 1987). The positive effects of providing explanatory information have been demonstrated in consumers’ comprehension of artworks (Leder, Carbon, & Ripsas, 2006) and visual metaphors in ads (Phillipes, 2000), and consumers’ appreciation of packaging designs (Van Rompay & Veltkamp, 2014).

In line with the above, to trigger the positive effects of product metaphors while preventing the risk of consumers’ misinterpretation, we propose that the presence of a textual clue can be helpful. When product metaphors are used in RNPs, a relatively high ambiguity is associated. Because RNPs are very different from what consumers know, the distances between RNPs and the source domains are large, and thus high ambiguity is
associated with the product metaphors. Such a high level of ambiguity can hinder consumers’ comprehension of RNPs because resolving the ambiguity is difficult for consumers. When processing a RNP embodied as a product metaphor, consumers need to firstly identify the source, next figure out in what ways the RNP resembles the source, and transfer the knowledge from the source to the RNP. If a high level of ambiguity is associated, consumers could encounter difficulty identifying the source, leading to confusion and frustration of understanding the similarities. However, if a textual clue is offered that provides a link to the source domain, the risk of consumers’ failure to identify the source is reduced. More cognitive efforts can be directed to figuring out similarities and transferring related knowledge, resulting in enhanced comprehension. Therefore, we expect that the presences of a textual clue with a product metaphor in an RNP can lead to enhanced consumers’ comprehension.

H1: When product metaphors are used in RNPs, consumers’ comprehension is moderated by the presence of a textual clue. Specifically, when product metaphors are used in RNPs, the presence of textual clues can enhance consumers’ comprehension, in comparison to the absence of textual clues.

Method

An experimental study was conducted to test the hypothesis. To generate appropriate stimuli for this study, we conducted two design sessions and two pretests to generate and select product metaphors for the main study. In design session 1, participants were asked to generate metaphors at a conceptual level. Next, pretest 1 tested the relatedness between these metaphors and the RNPs. Design session 2 was conducted to integrate the selected concepts into physical forms. The designed product metaphors were validated in pretest 2.

Stimuli Creation

Design session 1

Twelve participants were invited to generate metaphors at a conceptual level. These participants were Master candidates who studied design (-related) subjects, so they were equipped with the expertise of searching for sources (Cila, Hekkert, & Visch, 2014). RNPs were collected from the Consumer Electronic Show (CES) 2016, which is famous for launching innovative products. Among these innovative products, we selected RNPs that target the mass market and challenge consumers’ learning. Six RNPs were selected: an alarm clock that wakes up people by odor, a pan that measures calories, an oral health monitor, a molecular sensor that detects the composition of objects, an activity measuring sensor for running, and a standalone shortcut button to control various digital devices. In the briefs, the key functions and benefits of the RNPs were described. The challenge was to think of other products or concepts that can help consumers to understand the innovative functions of these products. The concept of metaphors at a conceptual level was explained and two examples of existing product metaphors were given. Each participant was asked to think of metaphors for three RNPs. For each RNP, participants were first asked to generate as many metaphors as possible, and select one to finalize by sketching. For each RNP, two or three product metaphors were generated. For four RNPs, the same conceptual metaphors were mentioned several times by participants, but no
consistent conceptual metaphors were generated for the two other RNPs (activity measuring sensor for running and standalone shortcut button), suggesting that no prominent association was found. We selected the four RNPs with the consistent conceptual metaphors for the next tests.

Pretest 1: soundness of the generated conceptual metaphors
To test whether the generated metaphors were considered sound to explain the innovative functions of the RNPs, pretest 1 was conducted. Soundness refers to the extent to which the deep underlying relational similarities are shared by the base and target (Gentner, Rattermann, & Forbus, 1993). A sound metaphor shares strong relationships, which is more likely to result in consumers’ successful identification and comprehension. Forty students (53% male) participated in pretest 1. In total, six conceptual metaphors were tested. Each participant evaluated three generated conceptual metaphors. The order of presenting them were randomized. Participants were first presented with the descriptions of the RNPs. They were explained that because these RNPs were highly innovative to consumers, companies aimed to use metaphors to explain these RNPs and their task was to evaluate whether the generated conceptual metaphors are proper to explain the RNPs. Next, following Gentner et al. (1993), soundness between the generated conceptual metaphors and target RNPs was measured by the following three statements: “the generated conceptual metaphor matches very well with the new product,” “the generated conceptual metaphor shares essential similarities with the concept of the new product,” and “the generated conceptual metaphor is strongly associated with the concept of the new product” from 1 (strongly disagree) to 7 (strongly agree) (α ranging from = .77 to .92). In addition, the soundness in terms of experience was especially measured through asking participants to respond to the question “to what extent, is the usage experience of WK01 similar to experiencing a flower?” from 1 (not similar at all) to 7 (very much similar). Analyses were conducted separately for each generated conceptual product metaphor. Results are presented in Table 1. The generated conceptual metaphors with higher ratings on soundness and soundness in terms of experience were selected: the conceptual metaphor of flower for the alarm clock with odors (WK01), a scale for the smart pan with calories measurement (PN01), a mint container for the oral health monitor (XT01), and a magnifying glass for the molecular sensor (MS01).
Table 1: Results of pretest1: soundness between generated product metaphors and RNPs.

<table>
<thead>
<tr>
<th>Target RNP: WK01</th>
<th>Soundness in terms of experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>The conceptual metaphor of Flower</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Target RNP: WK01</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>The conceptual metaphor of Perfume</td>
<td>3.98 (1.30)</td>
</tr>
<tr>
<td>Target RNP: PN01</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>The conceptual metaphor of Thermometer</td>
<td>2.45 (1.64)</td>
</tr>
<tr>
<td>Target RNP: PN01</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>The conceptual metaphor of Scale</td>
<td>3.40 (1.39)</td>
</tr>
<tr>
<td>Target RNP: XT01</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>The conceptual metaphor of Mint Container</td>
<td>3.75 (1.74)</td>
</tr>
<tr>
<td>Target RNP: MS01</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>The conceptual metaphor of Magnifying Glass</td>
<td>3.90 (1.37)</td>
</tr>
</tbody>
</table>

Design Session 2
The aim of design session 2 was to integrate the conceptual associations into physical forms. One professional designer was invited to design product metaphors. This designer had a Master degree in industrial design and had several years’ experience in practicing product design. The descriptions of the four RNPs were provided, accompanied with the generated conceptual metaphors. It was highlighted that the generated conceptual metaphors were aimed to aid consumers’ learning of the corresponding RNPs and the task was to translate the conceptual metaphors into tangible product designs. Four product metaphors were firstly generated in the form of sketches. Among these four product metaphors, the product metaphor of a magnifying glass for the molecular sensor (MS01) and a mint container for the oral health monitor (XT01) were selected to further 3D modeling and rendering for the usage of final stimuli (see table 2). The RNPs of WK01 (odor alarm clock) and PN01 (smart pan) were excluded from the research because the overall product category of clock and pan are mature, due to which categorization effects are likely to confound with the effects of product metaphors. For example, if WK01 (odor alarm clock) is employed in the shape of a flower, the category of flower is activated and the category knowledge can possibly be activated as well. This categorization can confound with the analogical learning process that triggers by the presence of product metaphors, which challenging the validity of the experiment. Consequently, the design of XT01 and MS01 for the condition with product metaphors resembles a typical mint container and a typical magnifying glass. For the condition of RNPs without product metaphors, the original product appearances were used as stimuli. The brand information was digitally removed. For both conditions, the color and details of product appearances were made as similar as possible. The pictures of RNPs were presented in the same background, size and perspective for both conditions (see table 2).
Table 2. Results of design session 2: stimuli for conditions with and without product metaphors for both product categories

<table>
<thead>
<tr>
<th></th>
<th>With product metaphor</th>
<th>Without product metaphor</th>
</tr>
</thead>
<tbody>
<tr>
<td>XT01</td>
<td>![Image of XT01 with product metaphor]</td>
<td>![Image of XT01 without product metaphor]</td>
</tr>
<tr>
<td>MS01</td>
<td>![Image of MS01 with product metaphor]</td>
<td>![Image of MS01 without product metaphor]</td>
</tr>
</tbody>
</table>

**Pretest 2: relatedness between physical form and the intended product metaphors**

Pretest 2 aimed to test whether people were able to relate the physical form to the intended conceptual metaphors for the two target RNPs.

A 2 (product metaphor: present vs. absent) × 2 (product category: oral health monitor vs. molecular sensor) mixed experiment was conducted, with the presence of product metaphors as between-subject factor and product category as within-subject factor. Each participant was assigned to one of two conditions and evaluated two products. The order of the products was counterbalanced. Forty participants were collected (mean age= 21.87, 56.4% male).

In pretest 2, for both conditions, we measured relatedness between generated product metaphors and RNPs, novelty, and attractiveness of generated product metaphors. The relatedness was measured in terms of the space for interpretation and the strength of relatedness. By measuring the space for interpretation, we aimed to learn whether the generated product metaphors allowed for multiple interpretations. We attempted to learn whether consumers can identify the source intended when seeing the product metaphors. The space for interpretation was measured by an open question “after seeing the picture of the product, what comes to your mind immediately? Could you relate it to any familiar things (e.g., familiar product, animal, plant, or person)? Please write them down below.” Next, the strength of relatedness was measured, aiming to learn the extent to which the generated product metaphors were strongly associated with the source intended for. Participants were asked to respond to the three statements “by seeing the picture of this product, I am confident to draw the conclusion that this design is related to a mint container/magnifying glass,” “by seeing the picture of this product, I am able to relate it to a mint container/magnifying glass,” and “after seeing the picture of this product, a mint container/magnifying glass immediately comes to my mind” on 7-point
scale from strongly disagree to strongly agree (α’s ranging from .71 to .91). In addition, to avoid confounding effects, attractiveness and novelty were measured. Attractiveness was measured by 7-point scale anchored by “ugly/beautiful” and novelty was measured by “common/novel.”

Results were analyzed separately for each product category. For the molecular sensor, in the open question, 18 out of 20 participants mentioned a magnifying glass in the product metaphor condition. For the oral health monitor, 17 out 20 participants mentioned a mint container in the product metaphor condition. In addition, t-tests were conducted with the presence of product metaphors as the independent variable, and relatedness, attractiveness, and novelty as the dependent variables. Results revealed that participants’ ratings differed significantly on relatedness for the molecular sensor $t(38)=17.45$, $p<0.001$ and the oral health monitor $t(38)=11.029$, $p<.001$. No significant differences were detected in terms of attractiveness and novelty (see table 3).

<table>
<thead>
<tr>
<th></th>
<th>Relatedness</th>
<th>Novelty</th>
<th>Attractiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>XT01 with product</td>
<td>5.73 (1.28)</td>
<td>3.05 (1.05)</td>
<td>3.25 (1.21)</td>
</tr>
<tr>
<td>metaphor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XT01 without product</td>
<td>2.12 (0.72)</td>
<td>2.95 (1.10)</td>
<td>3.75 (1.02)</td>
</tr>
<tr>
<td>metaphor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MS01 with product</td>
<td>6.53 (0.81)</td>
<td>3.50 (1.43)</td>
<td>4.35 (1.27)</td>
</tr>
<tr>
<td>metaphor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MS01 without product</td>
<td>1.82 (0.89)</td>
<td>3.40 (1.60)</td>
<td>4.40 (1.43)</td>
</tr>
<tr>
<td>metaphor</td>
<td></td>
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</tbody>
</table>

**Main study**

**Design and participants**
The main study used a 2 (product metaphor: present vs. absent)×2 (textual clue: present vs. absent)×2 (product category: oral health monitor vs. molecular sensor) mixed experimental design, with the presence of product metaphor and the textual clue as between-subject factors and product category as within-subject factor.

One hundred and fourteen participants were collected (mean age=43.28, 36.9% male) from a consumer panel. People who were younger than 55 years old were invited to participate in this study because older people could have difficulty with accepting new products (Loudon & Bitta, 1993).

**Final Stimuli**
The product designs from pretest 2 (product metaphors: present vs. absent) were combined with the textual clue (present vs. absent) to create the final stimuli for the main study. The textual clue was created “it is like a mint container/magnifying glass.” This textual clue intended to explain the integrated product metaphor by informing consumers about the source domain.
Procedure and measurements
Each participant was assigned to one of the four conditions and evaluated two products on several measures. The order of presenting two products was randomized. A short product description for each product category (see table 4) was presented to participants together with the final stimuli. The short product descriptions were identical across four conditions.

Table 4. Product descriptions

| Product category of XT01 | XT01 is a portable device to improve the oral healthcare by monitoring breath quality and hydration levels. XT02 draws a sample of air from the mouth and analyzes this sample by measuring the organic compounds released by various bacteria. Subsequently, XT02 reports the state of the oral and breath health to the smartphone app within seconds. Furthermore, XT02 tracks the changes of breath quality and hydration levels in time, and provides personalized guidance on cleaning routine and diet. XT02 is small and easy to carry. |
| Product category of MS01 | MS01 is a molecular sensor that enables people to examine objects for their chemical composition and identification. MS03 projects a light source to illuminate the object at 2cm from the object. By measuring the interaction between the light and the molecular vibrations of the object, MS03 can detect the composition of the object and provide results on the smartphone app within seconds. Furthermore, MS03 can detect compositions for all kinds of things, such as objects, food, medicine, etc. MS03 is small and easy to carry. |

Comprehension of the RNP was measured by asking participants to indicate to what extent they agreed the following four statements (Feiereisen, Wong, & Broderick, 2008): “after looking at the picture of the product and reading the description, I found the product” anchored by “difficult to understand/easy to understand” and “confusing/straightforward” from 7-point scale, and “after looking at the picture of the product and reading the description, I completely understand the various features of this new product,” and “I understand what the main benefits of this product are” on 7-point scale from 1(strongly disagree) to 7(strongly agree) (α’s equaling to .888 to .890). To avoid confounding effects, attractiveness of product appearances was measured by two 7-point scale items: “ugly/beautiful” and “unattractive/attractive” (Pearson’s r’s equaling to .69 to .73).

Results

Manipulation check
To test the success of the manipulation of product metaphors, a 2×2×2 mixed ANOVA was conducted with the presence of product metaphors, presence of textual clues, and product category as independent variables, and the ratings of relatedness as the dependent variable. The results confirmed the success of the created stimuli (F (1, 110) = 646.14, p < .01; M with product metaphor = 6.26, M without product metaphor = 1.98). For both product
categories, in comparison to when a product metaphor was absent, participants reported significantly higher scores on the measure of relatedness when a product metaphor was present. No effects were found for the presence of a textual clue and the interaction between a textual clue and product metaphor ($p > .10$).

**Test of hypotheses**

**H1:** Effects of the presence of product metaphors and textual clues on consumers’ comprehension of RNPs

To test hypothesis 1, a 2×2×2 mixed ANOVA was conducted with the presence of product metaphors, the presence of textual clues and product categories as independent variables, and consumers’ comprehension as dependent variable. No main effects of the presence of product metaphors and the presence of textual clues were detected ($p > .10$). A significant interaction effect was found between the presence of product metaphors and textual clues on consumers’ comprehension ($F (1,110) = 11.67, p < .05$) (see figure 4). Across two product categories, when product metaphors were present, participants reported better comprehension when the textual clue was provided, in comparison to the absence of the textual clue ($F (1, 52) = 7.33, p < .05$; $M_{with\ textual\ clue} = 5.34$, $M_{without\ textual\ clue} = 4.51$). When a textual clue was absence, the presence of product metaphors resulted in a significant decrease of consumers’ comprehension ($F (1, 54) = 7.67, p < .05$; $M_{with\ product\ metaphor} = 4.51$, $M_{without\ product\ metaphor} = 5.37$), which suggests that the sole presence of product metaphors confuses consumers. For both product categories, the pattern of means were analyzed separately. The means for the variable consumers’ comprehension were in the expected direction (see table 5). These results provide support for H1.

![Figure 4. The interaction effect of the presence of textual clues and product metaphors on consumers’ comprehension](image-url)
Table 5. Results of main study: adjusted means for consumers’ comprehension, relatedness, and innovativeness by product category.

<table>
<thead>
<tr>
<th></th>
<th>With product metaphor</th>
<th>Without product metaphor</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>With textual clue</td>
<td>Without textual clue</td>
</tr>
<tr>
<td>XT01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumers’ comprehension</td>
<td>5.44</td>
<td>5.10</td>
</tr>
<tr>
<td>Relatedness</td>
<td>6.22</td>
<td>5.94</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>5.58</td>
<td>5.44</td>
</tr>
<tr>
<td>MS03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumers’ comprehension</td>
<td>5.25</td>
<td>3.92</td>
</tr>
<tr>
<td>Relatedness</td>
<td>6.42</td>
<td>6.46</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>5.51</td>
<td>5.36</td>
</tr>
</tbody>
</table>

General Discussion

This study demonstrates that using product metaphors can improve consumers’ comprehension of RNPs, but only when a corresponding textual clue is provided as well. Because the distance between a product metaphor and a RNP is generally large, consumers face a high level of ambiguity when identifying the source. The presence of a textual clue directs consumers to the source that designers intended and the risk of identifying a different source is reduced. As a result, the correct source is activated, which leads to enhanced consumers’ comprehension.

These findings contribute to previous research on product metaphors. Although previous studies suggest that product metaphors could facilitate consumers’ comprehension of RNPs (Hekkert & Cila, 2015; Phillipes, 2000), empirical studies are lacking to support designers to make effective use of product metaphors. Results of this study contribute by empirically demonstrating that the sole presence of product metaphors is insufficient to enhance consumers’ comprehension. Consumers’ comprehension can be improved by the presence of both product metaphors and textual clues that state the source clearly.

These findings can provide valuable support for design managers and designers in practice. For design managers, the results of this study suggest that the positive effects of product metaphors on consumers’ comprehension can be triggered by accompanying the product appearance with textual clues. If design managers decide to embody RNPs by using product metaphors, they need to collaborate with marketing managers to make sure that marketing materials state the source clearly. Otherwise, the sole presence of product metaphors will lead to confusion and a decrease in consumers’ comprehension.

Although positive interaction effects of product metaphors and textual clues on consumers’ comprehension of RNPs are found, designers should interpret the results from this study carefully. The positive effects were found based on strong soundness and relatedness between product metaphors and target RNPs. Thus, while designing, designers need to carefully select sources and integrate them into physical forms precisely. The sources should be strongly related to the targeted RNPs in terms of the benefits they provide, and also align with the target RNPs in terms of experience.
Moreover, consumers should be able to easily identify the sources based on the physical forms.

Limitations and future research
To facilitate consumers’ comprehension of RNPs, marketers and designers can trigger consumers’ learning through making use of accumulated knowledge. Specifically, consumers’ learning can be facilitated through category-based and analogy-based knowledge transfer (Hoeffler & Herzenstein, 2011). For category-based knowledge transfer, a RNP is labelled as one of member from an existing product category. Then, the category knowledge will be transferred into the RNP. Differently, for analogy-based knowledge transfer, only certain benefits from the source product category will be transferred into the RNP. In this study, we aimed to examine the effects of RNPs on triggering analogy-based knowledge transfer. Thus, we selected those RNPs that do not belong to any existing product category, in order to prevent potential confounding effects resulting from category-based knowledge transfer. Future research can examine the effects of product metaphors on consumers’ comprehension of RNPs that belong to a mature product category. Specifically, it could be possible that both category-based and analogy-based knowledge transfer are triggered, which together contribute to consumers’ learning. In the example of WK01 (odor alarm clock), when it is embodied in the product metaphor of a flower, it is possible that the categories of a clock and a flower are activated. Thus, consumers can transfer the knowledge of a clock to the RNP and consumers can also relate with the innovative function of releasing odor, leading to enhanced consumers’ comprehension of the RNP. However, it could also be possible the presence of a product metaphor triggers the analogy-based knowledge transfer but hinders the category-based knowledge transfer. Following the example of WK01, the flower product metaphor could facilitate consumers’ retrieval of characteristic of a flower to have a smell, but it hinders consumers’ recognition of the product as an alarm clock. The shape of a flower conflicts with the prototype of an alarm clock, and thus consumers may not recognize it as a clock, resulting in reduced comprehension. Therefore, future research can investigate the effects of using product metaphors in RNPs that belong to mature product category. It is necessary to examine which mechanism dominates consumers’ processing.

References


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**About the Authors**

**Peiyao Cheng** is a PhD candidate in School of Design, Hong Kong Polytechnic University. Her research focuses on the influence of product appearance on consumer response to product innovations.

**Dr. Ruth Mugge** is associate professor of consumer research in the Faculty of Industrial Design Engineering at Delft University of Technology. Her main research focus is on understanding consumer response to product design at purchase and during ownership.

**Prof. Cees de Bont** is dean of School of Design, Hong Kong Polytechnic University. His research interests are in the areas of early concept testing of consumer acceptance, consumer behaviour, innovation adoption, and networked innovation.
Using proximity in sustainable product design

MAGNIER Lise*; MUGGE Ruth and SCHOORMANS Jan

TU Delft, Netherlands
* Corresponding author: l.b.m.magnier@tudelft.nl

This research examines proximity as a new interesting strategy to include in the design of more sustainable products. Drawing from the construal level theory, we posit that the environmental sustainability of a product embedding a form of proximity to an environmental solution in its design will be perceived as more concrete and will trigger higher prosocial product experience. To test this assumption, we used spatial proximity by manipulating the location from where the recycled plastic of a bottle of dishwashing soap was reclaimed. Based on the responses of 130 individuals recruited from a panel of consumers, we found that product environmental sustainability is perceived as more concrete and prosocial product experience is higher when proximity is embedded in product design than when far distance or no distance are embedded in the product design. This paper contributes by investigating how product design itself can help to enhance the acceptance of more sustainable products and by applying the Construal Level Theory to the field of product design.

keywords: sustainable product design; proximity; concreteness; prosocial product experience

Introduction

Prior research demonstrated that people can experience difficulty understanding the added value of sustainable product innovations because their benefits for the environment are often too abstract (Jensen, 2011) and people have difficulty understanding information that is not perceptible. Therefore, a major challenge for designers is to design sustainable products that bring a concrete solution to an environmental issue in order to enhance people’s choice.
To encourage individuals to choose more sustainable alternatives, research has so far focused on policies and nudging programmes that trigger selfish benefits such as social status (Griskevicius, Tybur, & Van den Bergh, 2010) or promote money savings (Camilleri & Larrick, 2014). Strikingly, very little is known on how the sustainable design of the product itself and precisely how the concreteness of the solution to the environmental issue influences responses to the product.

To design more concrete products, the construal level theory and the concept of psychological distance can be of great value. Psychological distance can be temporal, spatial, social and probabilistic and is related to the construal level (abstract vs. concrete) of individuals. Psychological proximity refers to individuals’ perception of being close to an object/event/person on these four dimensions of distance. Research has demonstrated that the more an object is perceived as close (far), the more it is construed at a concrete (abstract) level (Trope & Liberman, 2010). However, such a relationship has not been tested in the context of sustainable product design. More environment-friendly products are different from other objects as environmental problems are generally seen as global and complex. It is therefore relevant to test whether psychological proximity to an environmental solution participates in making product environmental sustainability more concrete to individuals.

Next, research has demonstrated that individual’s construal level influences their attitudes and behaviours. Precisely, it has been demonstrated that reducing the psychological distance between individuals and a target object has a significant influence on behaviours in different contexts. For example, research showed that people are willing to pay more for local products (Carpio & Isengildina-Massa, 2009).

In this paper, we will test whether embedding proximity in sustainable product design represents a good strategy to improve consumers’ experience of the product. Will psychological proximity have an effect on prosocial product experience? Assessing this effect is of major importance as unselfish or prosocial benefits represent an important motivation for consumers’ to choose more sustainable products because it expresses their ethical values and their interest for the common good (Thøgersen, 2011). We define prosocial product experience as the positive feeling one experiences when using a product derived from actions that benefit “others” but are not obligatory by moral standards. Although product environmental-friendliness may lead to positive egoistic benefits (e.g. perceived healthiness of organic products), prosocial benefits are even more important for individuals when considering a sustainable alternative (Thøgersen, 2011). As a result, prosocial product experience can be recognized as an important competitive factor for companies commercializing environment-friendly products.

In the domain of sustainability, literature in environmental psychology has started to examine, mostly theoretically the influence of psychological distance on perception of and actions against climate change (McDonald, Chai, & Newell, 2015; Spence & Pidgeon, 2010; Spence, Poortinga, Butler, & Pidgeon, 2011; Spence, Poortinga, & Pidgeon, 2012). However, the influence of psychological distance embedded in sustainable product design on consumers’ responses has received less attention.

The paper is organised as follows. First, we describe the relationships between psychological distance, construal levels, attitudes and behaviours. Next, we describe how
the construal level theory could be applied in the field of sustainable product design and develop our hypotheses. These hypotheses are tested in a study manipulating spatial distance for a recycled packaging of dishwashing soap. Finally, we discuss the theoretical and managerial implications of the research for the field of design as well as its limitations and avenues for future research.

**Psychological distance and the construal level of individuals**

*Influence of psychological distance on construal levels*

Psychological distance refers to the extent to which an object is distant from the self – socially, in time, in space, or in probability of occurrence (McDonald et al., 2015; Trope & Liberman, 2010). According to the Construal Level Theory, psychological distance is associated with different construals of object and events. Precisely, when an object is perceived to be psychologically proximal or close to the self, it tends to be perceived more concretely, on a low level of construal. Conversely, when an object is perceived to be distant from the self, it tends to be perceived in abstract or high level terms.

As mentioned above, psychological distance is composed of four dimensions (Trope & Liberman, 2010). Spatial distance refers to the distance in space between a target and a perceiver (Fujita, Henderson, Eng, Trope, & Liberman, 2006). Temporal distance refers to the amount of time that separates the perceiver’s present time to a target event (Trope & Liberman, 2000, 2003). Social distance refers to how distinct the social target is from the individual self (Trope, Liberman, & Wakslak, 2007; Zhao & Xie, 2011). Finally, hypotheticality or probabilistic distance refers to the likelihood of an event to happen or in other terms, how close it is to reality as perceived by the individual (Wakslak, Trope, Liberman, & Alony, 2006). These four different dimensions of psychological distance affect mental construals and these construals, in turn, guide prediction, evaluation, and behaviours (Trope et al., 2007).

*Attitudinal and behavioural implications of construal levels*

The construal level of consumers influences their attitudes and behaviours. Prior research demonstrated that emotions were stronger when individuals construed objects or events at a low or concrete level. For example, it appears that the more an individual is primed with a far distance, the less (s)he reports negative affects when confronted with a violent story (e.g. a violent accident) (Williams & Bargh, 2008). In addition, research has revealed that individuals were more motivated to attain goals with close outcomes (Karniol & Ross, 1996; Loewenstein, 1988). Furthermore, it appears that individuals are willing to pay more for local products (Carpio & Isengildina-Massa, 2009; Feldmann & Hamm, 2015).

Considering that changes in consumers’ behavioural patterns with regards to sustainability are urgent, using psychological proximity to encourage sustainable consumption may represent an interesting opportunity.

*Psychological distance, construal levels and sustainability.*

Much of the research linking the Construal Level Theory to sustainability has been realized in the context of climate change (McDonald et al., 2015; Spence & Pidgeon, 2010; Spence et al., 2012).
It appears that solutions to environmental issues are often perceived as having an effect far in the future (temporal distance), uncertain (probabilistic distance), or as not having results in the direct environment of individuals (spatial and social distance) which could explain why consumers do not always act according to sustainability principles.

For example, in the case of global warming, the effects of an individual’s carbon emissions are difficult to allocate to a certain environmental issue. Moreover, the effects of gas emissions reduction are often perceived as distal and uncertain. Considering that distal targets are generally construed at an abstract level, it is likely that consumers consider climate change, as well as other environmental issue, as abstract.

Studies have demonstrated the importance of the influence of psychological distance on climate change mitigation behaviours. For example, spatial distance in the domain of climate change plays an important role in climate change mitigation actions (McDonald et al., 2015). In a study where the effects of climate change were framed to occur either at local or distant locations, it appeared that participants were significantly more positive in their attitudes towards climate change mitigation when the effects were framed as occurring locally (McDonald et al., 2015; Spence & Pidgeon, 2010). Next, personal experience of weather and climate-related events was related to engagement in energy conservation to mitigate climate change (Spence et al., 2011), as well as behaviours aimed at reducing carbon footprint such as recycling (Reser, Bradley, & Ellul, 2014).

These studies suggest that proximity to climate change may work for influencing people to act against it. Our research is different in two ways. These studies manipulate the proximity of the effect of climate change (Spence et al., 2011) while we aim to manipulate the proximity of the sustainable solution in the design of the product. Furthermore, these studies test the effect of the psychological distance of climate change on mitigation behaviours (e.g. energy conservation), while we aim to explore consumers’ reaction toward a more sustainable product embedding psychological proximity in its design.

**Proximal and concrete solutions in sustainable product design**

*Including proximity in the design of more sustainable products*

Research has demonstrated that sustainable product design can be optimized to convey environmental sustainability to consumers (Magnier & Crié, 2015; Diego-Mas, Poveda-Bautista, & Alcaide-Marzal, 2016) and to trigger benefits related to environmental sustainability (Magnier & Schoormans, 2015). For example, in the context of packaging design, it has been demonstrated that certain materials are more likely to convey environmental sustainability and higher quality (Magnier, Schoormans & Mugge, 2016). However, in some situations, a change of material or a visual alteration of the product may not be possible (e.g. liquid hand soap in a bottle of recycled paper). Yet, a material can be more sustainable while looking conventional (e.g. recycled plastic).

We propose that embedding proximity in the design of more sustainable products may represent an interesting strategy to make product environmental sustainability more concrete to consumers. For example, egg cartons with a QR code that links to a live webcam showing free-range chicken in their environment may promote psychological proximity. Integrating recycled materials reclaimed from a proximal spatial distance in a product may also favour perceptions of proximity. In the case of products made from
ocean plastic, embedding a system that enables to check in real time the amount of ocean plastic collected for the production of the product may reduce probabilistic distance.

In this paper, we aim to test whether psychological proximity embedded in the design of a more sustainable product makes product environmental sustainability more concrete to consumers and triggers higher prosocial product experience.

**Influence of proximity on concreteness of product environmental sustainability**

As described above and according to the Construal Level Theory, when an object is framed in a proximal (vs. distal) manner, individuals are more likely to construe this object in a concrete (vs. abstract) way. For example, it was demonstrated that consumers tend to construe events that occur far from where they live as abstract whereas they tend to construe events that occur near where they live as concrete (Fujita et al., 2006). In this research, we define the concreteness of product environmental sustainability as the extent to which the environmental benefit of a sustainable product innovation is concrete. A concrete object is usually defined as existing in reality, as being perceptible by the senses or real.

We posit that a more sustainable product that embeds psychological proximity to a sustainable solution in its design will be perceived as more concrete than an object that embeds far distance to a sustainable solution or does not embed any form of psychological distance.

**Influence of proximity on prosocial product experience**

The literature demonstrates that proximity is often more powerful than far distance to influence positive responses towards a sustainable alternative (McDonald et al., 2015). Research on spatial distance showed that proximity, as opposed to distance, is generally framed in positive terms (Te Vaarwerk, Van Rompay, & Okken, 2015). For example, it has been demonstrated that people who share space and time generally like each other better, and find themselves more attractive than people who are further apart (Festinger, Back, & Schachter, 1950).

In this paper, we aim to examine whether psychological proximity to a sustainable solution influence prosocial product experience. As described above, we define prosocial product experience as the positive feeling one experiences when using a product derived from actions that benefit ‘Others’ but are not obligatory by moral standards. Prosocial experiences usually relate to or denote altruistic behaviours that are positive and helpful to society in general. Prior literature has revealed that prosocial experience was an important motivation for individuals to consume more sustainable products (Thøgersen, 2011).

We propose that a more sustainable product that embeds psychological proximity to the sustainable solution in its design will convey more prosocial product benefits than an object that embeds far distance to the sustainable solution or does not embed any form of psychological distance. Specifically:

**H1:** Prosocial product experience will be higher when psychological proximity is embedded in the product design than in a distal condition or when no distance is embedded in the product design.
The mediating effect of concreteness of the product environmental sustainability

We posit that proximity to the environmental solution embedded in product design will positively affect concreteness of product environmental sustainability, which in turn will enhance the prosocial product experience. In other words, we suggest that concreteness of product environmental sustainability can explain the influence of proximity to the environmental solution on the prosocial product experience. More formally:

H2: Concreteness of product environmental sustainability will mediate the influence of proximity on prosocial product experience.

Current research

In order to test whether concreteness of product environmental sustainability and prosocial product experience are higher when psychological proximity is embedded in the design of a product, we performed an experimental study. We used a one factor between-subject design experiment in which we compared the effect of spatial distances integrated in a product design by manipulating the location from where the recycled plastic of a bottle of dishwashing soap was reclaimed (control condition: no distance vs. proximal condition vs. distal condition). The distal location was used in order to ensure that proximity and not only the presence of a location triggered a higher concreteness of product environmental sustainability.

We decided to focus on spatial distance, as it is especially relevant for circular product design. Indeed, circularity implies that raw materials are used and reused efficiently limiting harmful emissions into the environment (MacArthur Foundation, 2016), and it is therefore possible for designers to use recycled materials reclaimed from specific locations.

First, we realized a pretest in order to determine the locations to be used in the study. In the main study, we used the locations that were perceived the furthest apart and that did not differ in terms of attitudes.

Method

Pretest

We asked 19 individuals from the Netherlands to evaluate a series of Western and Central European cities or region (namely, Delft, Amsterdam, the province of Zuid-Holland, Rome, Venice, Paris and Prague. We ensured that these individuals lived in the same region as the participants of the main study.

First, respondents were asked how they perceived the distances between themselves and the locations (How far do you perceive [location] to be? - Very close / very far). Next, we measured their attitudes towards the different cities (How would you describe your attitude towards [location]? – Very negative / Very positive).

We chose cities of Western and Central Europe in order to avoid potential negative effect caused by the pollution created by the transport of the plastic to be recycled from very far away location to the place of the study.
When comparing cities, most pairs were showing a significant difference in terms of perceived distance. We decided to keep the city of Delft for the proximal condition and Venice for the distal condition because the perceived distance between these two cities was the greatest and because they are comparable in that they are both touristic cities where canals are playing an important role. Paired-samples t-tests were conducted to compare the perceived distances of the locations. Venice ($M = 5.26$, $SD = .99$) was perceived as significantly further than Delft ($M = 1.32$, $SD = .58$); $t(18) = -15.24$, $p < .001$. There was no difference in terms of attitude towards the two locations ($p = .13$).

**Participants**

One hundred and thirty individuals (Female: 57.7%) recruited from a University-based consumer panel responded to our questionnaire. The sample was diversified in terms of socio-demographics. The average age of the participants was 51.32 years ($SD = 13.40$; *age range*: 22 – 71 years). The number of people in their household ranged from 1 to 6 ($M = 2.7$; $SD = 1.37$). The net monthly incomes in the household were diverse ([<1500€]: 6.3%; [1500€-3000€]: 26.1%, [3000€-4500€]: 28.8%, [>4500€]: 38.7%).

**Procedure and stimuli**

A bottle of dishwashing soap made from recycled plastic was used as stimuli. In the control condition, no location was displayed on the package. In the proximal condition, the package design communicated that the bottle was made of recycled plastic reclaimed from the canals of Delft (city where participants were recruited from) and in the distal condition the canals of Venice were used (Figure 1). The brand that was used ‘Dawn’ is not sold in the Netherlands and therefore unfamiliar to the participants.

![Figure 1](image-url)  *Stimuli used in the study. From left to right: control condition, proximal condition, distal condition.*

Participants were presented with one of the three packages and asked to rate it on several measurement scales.

**Measures**

Concreteness of product environmental sustainability:

Concreteness of product environmental sustainability is defined as the extent to which the environmental issue tackled by the sustainable product innovation is abstract or concrete.
Participants rated concreteness of product sustainability on one 7-point semantic differential scale (How would you evaluate your perception of the environmental issue the brand Dawn engaged in with this packaging? Abstract / Concrete).

Prosocial product experience:

Prosocial product experience was assessed using 3 items measured on 7-point Likert scales (I would feel good about buying this dishwashing liquid, I would contribute to a better world by buying this product, By purchasing this dishwashing liquid, I have a positive contribution to the environment; α = .85).

Results

Test of the influence of distance on concreteness of product environmental sustainability

In order to check whether the environmental issue in which the brand Dawn engaged in was more concrete for the proximal condition than for the distal condition, we performed a one-way ANOVA (analysis of variance). Results revealed a marginally significant main effect of the distance on the concreteness of product environmental sustainability ($F(2;127) = 2.89; p = .06$). Planned contrasts indicated that participants perceived product environmental sustainability in the proximal condition as more concrete than the product sustainability in the distal condition ($M_{\text{proximal}} = 4.90$ vs. $M_{\text{distal}} = 4.11$; $t(127) = 2.07, p < .05$). Participants also perceived product environmental sustainability in the proximal condition as more concrete than in the control condition ($M_{\text{control}} = 4.09$; $t(127) = -2.31, p < .05$). However there was no significant difference between the control condition and the distal condition ($p > .90$).

Test of the influence of distance on prosocial product experience (H2)

We performed another one-way ANOVA with distance as the independent variable and prosocial product experience as the dependent variable. Results revealed a significant main effect of distance on prosocial product experience ($F(2;127) = 3.82; p < .05$). Planned contrasts indicated that the prosocial product experience of participants in the proximal condition was higher than in the distal condition ($M_{\text{proximal}} = 4.64$ vs. $M_{\text{distal}} = 4.04$; $t(127) = 2.22, p < .05$). The prosocial product experience of participants in the proximal condition was also higher than in the control condition ($M_{\text{control}} = 3.94$; $t(127) = -2.57, p < .05$). These results confirm Hypothesis 2. Moreover, there was also no significant difference between the control condition and the distal condition ($p > .70$).

Table 1  Descriptive statistics (Means and Standard Deviations) for each condition

<table>
<thead>
<tr>
<th></th>
<th>Control condition</th>
<th>Proximal condition</th>
<th>Distal condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concreteness of product sustainability</td>
<td>4.09 (1.58)</td>
<td>4.90 (1.68)</td>
<td>4.11 (1.97)</td>
</tr>
<tr>
<td>Prosocial product experience</td>
<td>3.94 (1.35)</td>
<td>4.64 (1.06)</td>
<td>4.04 (1.47)</td>
</tr>
</tbody>
</table>

Standard deviations in parentheses
Test of the mediating effect of concreteness (H2)

In order to test for the mediating effect of concreteness in the relationship between distance and prosocial product benefits, we used the bootstrapping technique with 5000 iterations (Zhao, Lynch, & Chen, 2010) and the PROCESS macro for SPSS (Hayes, 2013). Considering that our independent variable was multicategorical with a control condition and two experimental conditions (proximal and distal), we followed the procedure of Hayes and Preacher (2014) in which the mediation method for such a case is described. The proximal and the distal conditions were dummy coded and the control condition was used as the reference category. Analyses were run twice. First, we executed a mediation model with the first dummy variable (i.e. the proximal condition) as the independent variable and the second dummy (i.e. the distal condition) as a covariate. Then, we executed the same mediation model with the second dummy (i.e. the distal condition) as the independent variable and the first dummy (i.e. the proximal condition) as a covariate. The two bootstrap confidence intervals were based on the same set of bootstrap samples.

The first bootstrapping analysis tested whether concreteness of product sustainability mediated the impact of the proximal condition on prosocial product benefits. Results revealed that concreteness did mediate this relationship. Specifically, a 95% bootstrapped confidence interval for the indirect effect (.0251, .4316) indicated a significant mediation effect at the $p < .05$ level.

Not surprisingly, the second bootstrapping analysis testing whether concreteness of product environmental sustainability mediating the impact of the distal condition on prosocial product benefits was not significant (-.1598, .1484).

General discussion

Theoretical and managerial implications

The need for more research on the role of product design to convey environmental benefits to consumers has been acknowledged in past research (Diego-Mas et al., 2016).

Research has shown that different elements of product design such as aesthetics (Luchs, Brower, & Chitturi, 2012), materials (Magnier & Schoormans, 2015) or product attributes (Diego-Mas et al., 2016; Gershoff & Frels, 2015) influence consumers’ perception and acceptance of more sustainable products. However, little research has examined how to influence perception and responses to a more sustainable without altering its visual appearance.

In order to fill this gap in the literature, this research examined the influence of psychological proximity to convey concrete product environmental sustainability and trigger higher prosocial product experience. Results revealed that the concreteness of product environmental sustainability was higher when the recycled plastic of a bottle of dishwashing soap was reclaimed from a proximal location than when it was reclaimed from a distal location or than when no location was mentioned. Furthermore, our results showed that prosocial product benefits were also higher in the proximal condition than in the distal and the control condition. Finally, we showed that the concreteness of product environmental sustainability mediated the relationship between the proximal location and prosocial product benefits.
This paper contributes to the literature in two ways. First, it applies the Construal Level Theory to the field of sustainable product design. So far, the Construal Level Theory was used in sustainability to promote climate change mitigation behaviours (McDonald et al., 2015; Spence & Pidgeon, 2010). Results of these studies show that framing the effects of climate change as happening close to individuals influence them to adopt climate change mitigation behaviours. With this study, we extended the use of the Construal Level Theory to the field of product design. Our results represent interesting new insights for the use of psychological proximity in product design to enhance the experience of more sustainable products.

Second, this study complements the literature on improving consumers’ acceptance of more sustainable alternatives. As product sustainability is generally complex to grasp, it is important to define strategies that improve consumers’ reactions to these products. By making the environmental benefit of a product more concrete to individuals, designers are able to make these products more appealing. Our results also complement literature in design aiming at reducing the environmental impact of product use with design strategies for sustainable behaviours (Lockton, Harrison, & Stanton, 2013). In this research, design strategies aim to enhance the concreteness and the perceived prosocial experience of a product with a reduced environmental impact.

This research has several implications for designers and companies. Many companies consider sustainability as a strategic objective and target environmentally conscious consumers. Yet, most of them adopt a low-hanging fruit strategy that is a moderate position where actions taken are environment-friendlier but also economically beneficial. These companies are often reluctant to develop costly eco-friendly programs. Producing more sustainable products may require large investments for research and development, and may involve a change of business-model (Bocken, Short, Rana, & Evans, 2014). It is therefore important for the industry to know that consumers will respond positively to the product. By doing so, they can create a competitive advantage, as consumers’ sensitivity to environmental initiatives is high (Olsen, Slotegraaf, & Chandukala, 2014). The results of this research offer several interesting prospects for the development of proximal solutions in the field of sustainable product design that may improve reactions towards more sustainable products. Designers may use proximity as a principle to design more sustainable products that will evoke positive consumers’ responses.

Limitations and Future research
Although our study offers valuable implications for researchers and practitioners, some limitations deserve attention and should be taken into account in further research.

First, in this study, spatial distance is manipulated. Psychological distance also encompasses temporal, social and probabilistic distances. Further research should test the influence of these different forms of proximity on consumers’ responses to more sustainable products. For example, a QR code linked to the amount of plastic removed from the ocean framing individuals on short-term or long-term results could be interesting for the case of the temporal distance. By framing the effects of a sustainable consumption behaviour on the short-term, individuals may perceive environmental issues as more concrete and be more motivated to perform the target environmental behaviour. Framing
the type of people (similar vs. different) who would benefit from the environmental initiative could also represent an alternative for the social distance.

Second, the distances could have been manipulated differently. It would be interesting to replicate the results with different proximal and distal locations. It would especially be interesting to uncover how close a location should be to trigger concreteness and enhance the subsequent reactions. This would be especially important to improve the scalability of such an initiative. Moreover, in this study we do not take into consideration the personal experience of the environmental issue. Yet, personal experience seems to play an important role in influencing consumers’ mitigation behaviours of climate change (McDonald et al., 2015; Spence et al., 2011).

Third, the dependent variables in the study are related to attitudes. Although prosocial product experience has been described as a motivation to consume more sustainable products (Thøgersen, 2011), further research could focus on behavioural aspects of the influence of proximity to the environmental solution and focus on variables such as choice decision or willingness-to-pay.

Fourth, the experiment reported in this research focusses on the dishwashing soap product category, and our results are possibly limited to some context specificities. In the future, this study could be replicated with the same settings across other product categories in order to enhance the generalizability of our results.

Finally, more sustainable products often come with drawbacks, such as a higher price or a less attractive appearance. Further study could examine how proximity may lower the importance of these drawbacks and ultimately increase choice decision for these more sustainable products.

References


**About the Authors**

**Lise Magnier** is Assistant Professor of Consumer Research at the Delft University of Technology, the Netherlands. Her research interests lie in the fields of consumer behaviour, sustainability and packaging design.

**Ruth Mugge** is Associate Professor in Consumer Research at the Delft University of Technology, the Netherlands. Her research focuses on understanding how consumers respond to product design with a specific interest in designing for the circular economy.

**Jan Schoormans** is Professor of Consumer Research and Director of Education at TU Delft, Faculty of Industrial Design Engineering, the Netherlands.
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Introduction: Foresight by Design: Dealing with uncertainty in Design Innovation

BUHRING Jorna\textsuperscript{a}; BUCOLO Sam\textsuperscript{b} and JONES Peter\textsuperscript{c}

\textsuperscript{a} The Hong Kong Polytechnic University School of Design, Hong Kong
\textsuperscript{b} University of Technology Sydney, Australia
\textsuperscript{c} OCAD University Toronto, Canada

Introduction

The role of design in business has gradually expanded beyond merely creating and communicating better products. Design is now being understood by its totality of value-creating activities, and the competencies that span across innovation, product development, marketing and strategic decision-making. Design has moved from historical product and branding functions to formative ideation and coordination of product and processes across all dimensions of organizational value-creation. Design practices rely on engaging with multidisciplinary stakeholder teams responsible for creating sustainable value propositions that ensure the organization’s future.

Ensuring an organization’s future requires another emerging practice, that of strategic foresight. The dynamic complexity of business in globally networked markets and partnerships requires product and service design teams to engage fully with foresight scenarios, continual trend scanning, and futures creation. There is a growing awareness that business organizations, regardless of industry or size, are faced with unprecedented uncertainties over social analyses, globalization, and technology revolutions, as observed by the increasing interest in future studies.

Indeed, organizations are required to transform themselves, rethink their business models, innovate, and envisage alternative futures in order to adapt their approach to business, and the way they engage with informed and often empowered internal and external stakeholders. The necessity for businesses to transform, just to survive in their business segment, has created new demands for foresight, value co-creation, envisioning, and design research for assessing value for users and markets.

As design and innovation are becoming increasingly synonymous in both meaning and reach (e.g. products, services, business models, eco-systems, etc.), the priority task of the
world’s top management, economic, and educational leaders is to effectively manage knowledge and to generate an innovative (corporate/community/learning) culture.

The themed track features 5 submissions from 12 authors, who share important insights, knowledge, and research outputs relevant to design research, strategic design and innovation management.

The papers explore varying foresight methods (Delphi, Three Horizons and futures scenarios) and futures thinking approaches through co-design, improvisation, business model prototyping and sensemaking. Design methods and approaches have been applied in a number of diverse contexts and applications to help better understand how designers can deal with uncertainty in design innovation.

The goal of this track is to draw out patterns and themes from these respective cases to begin to formulate an emerging proposal or framework applicable to Foresight by Design. The track features 5 submissions from 12 authors, who share important insights, new knowledge, and research outputs relevant to foresight research methodologies, strategic design and innovation management.

Introducing a design-inspired foresight approach, Buhring’s paper contributes to our limited understanding of how designers and interdisciplinary innovation teams realize futures that are desirable. Through applied research, the author employed a Delphi-like method to gain insights from industry experts, while eliciting their consensus of distant horizons as a foundation to develop futures scenarios in core pillars of the economy (Financial Services, Wealth Management, and Private Banking). Through lessons and first-hand experiences, we learn about design approaches that can assist interdisciplinary innovation teams apply futures thinking techniques to deal with uncertainty in Design innovation.

In a similar vein, Price, Wigley and Metthews present a design-led innovation approach and its relationship to sensemaking as a future-oriented mechanism within its framework. Through action research, the authors present their findings that support sensemaking as a value-creating activity during the design and innovation process, while highlighting critical skills needed by innovation catalysts that must develop and managing knowledge at interpersonal levels.

Still within design and innovation, Sarantou and Miettinen describe in their paper the connective role of improvisation in dealing with uncertainty during the invention and design process stages. Their work highlights the role of improvisation in design thinking, which is supported by several years of field studies in Namibia and Australia. A framework is presented, which is designed to bridge the gap between design process theory and practice through improvisation techniques. With this approach, the authors advocate improvisation as an important aspect of managing uncertainty in design thinking and inventions.

Applying design thinking competencies to business model innovation, Amano, Brassett, Green, and Hestad highlight in their paper the literature that supports the need for prototyping, and the process dimensions applied during the development stages. To this end, the authors argue that prototypes are not simply representations of objects, instead, they are tools that enable designers can employ to envisage hypotheses about the future. As such, their contribution is the analysis of existing prototyping process models, while
drawing attention to the importance of defining intangible prototyping perspectives in context of business model innovation.

Finally, this themed track offers insights as to the value of design residencies in future Design museums. Here Coulson and Valentine’s paper presents through exploratory workshops with diverse groups of designers, a conceptual model on how future museums can fully embrace designer-community collaborations by engaging patrons in active learning activities through co-creation, visualization, and the imagination of new possible futures.

With this eclectic mix of ideas and contributions, the Foresight by Design track wishes to further emphasize the value of strategic and creative foresight in design and innovation. Moreover, the underpinning goal is improving the designer’s and the organization’s learning to adopt new methods in their innovation practices.

About the Track Facilitators

**Dr Jorn Buhring** is a Research Assistant Professor at the PolyU School of Design; his research focus is on human-centred value innovation with emphasis on user engagement in experiential settings. Addressing future perspectives, Jorn explores design foresight, vision and fiction approaches through applied research. His aim is to advance emerging design processes in business through vision-provoking futures thinking.

**Dr Sam Bucolo** is a Professor of Design Innovation at UTS, who’s role is to help organisations grow through Design Led Innovation, a process which enables firms to better understand the problem they solving and develop new leadership mindsets to transform their organisation. Sam has collaborated widely with a diverse set of industry partners and sectors, he has led many government initiatives on embedding design within organisations.

**Dr Peter Jones** is Associate Professor at OCAD University where he teaches in the Strategic Foresight and Innovation, and Design for Health MDes programs. For over 20 years Peter has led large complex software design projects through human-centred research for emerging technologies on a large scale. He was involved in expert systems and knowledge engineering at AT&T Bell Labs projects, client-server and early distributed computing applications.
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Design-inspired Foresight: Strategic foresight techniques for preferable futures

BUHRING Jorn H
The Hong Kong Polytechnic University, China
joern.buehring@polyu.edu.hk
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The external environment in business is becoming increasingly a major source of uncertainty, especially for decision-makers in charge of sustaining the advantage of the organization over time. Whether they are leaders in organizations, entrepreneurs, or designers responsible for the strategic direction of the enterprise, looking further into the future is important. However, while tools and practices have been developed to envisage likely evolutions of trends, this paper is motivated by our limited understanding of how designers and interdisciplinary innovation teams consider desirable futures, especially, when the planning horizon is 5, 10, or even 15 years. Accordingly, this paper engages with the literature to present different perspectives between strategic planning in business, and foresight as emerging activities in strategic design. A design-inspired foresight approach is presented through applied research, where the author employed qualitative data collection and analysis techniques (Delphi, Three Horizons scanning, and futures scenarios building techniques) in a Financial Services industry study to the year 2030. By engaging decision-makers in futures thinking, the value of foresight in business and design as preferred-change provoking, is supported through lessons from this futures study as an emerging practice of foresight in design.

**keywords:** strategic design; managing uncertainty; design-inspired foresight; desirable futures

**Introduction**

The external environment in business is becoming increasingly a major source of uncertainty, especially for decision-makers in charge of sustaining the advantage of the organization over time. Whether they are leaders in organizations, entrepreneurs, or designers responsible for the strategic direction of the enterprise, looking further into the future is important. However, while tools and practices have been developed to envisage likely evolutions of trends, this paper is motivated by our limited understanding of how designers and interdisciplinary innovation teams consider desirable futures, especially, when the planning horizon is 5, 10, or even 15 years. Accordingly, this paper engages with the literature to present different perspectives between strategic planning in business, and foresight as emerging activities in strategic design. A design-inspired foresight approach is presented through applied research, where the author employed qualitative data collection and analysis techniques (Delphi, Three Horizons scanning, and futures scenarios building techniques) in a Financial Services industry study to the year 2030. By engaging decision-makers in futures thinking, the value of foresight in business and design as preferred-change provoking, is supported through lessons from this futures study as an emerging practice of foresight in design.

**keywords:** strategic design; managing uncertainty; design-inspired foresight; desirable futures
future is essential for navigating inevitable change, and for envisaging next-next-generation of product or service propositions. That is, making decision based on simply projecting today’s market trends into the future is no longer possible (Saritas & Smith, 2011; Vecchiato, 2015).

Meanwhile, progressive organizations have noted the favourable use of design principles applied to problem-solving, sparking the popularity of design thinking processes and applications toward transformative innovations in a global economy (Dunne & Martin, 2006; Oster, 2008). Generally, design and innovation has become increasingly synonymous in both meaning (e.g. design thinking) and reach (e.g. strategy, business models, products, services, and systems). Indeed, Design is now being understood by its totality of activities and the competencies spanning across innovation to strategic decision-making. Moreover, as are the dependences on interdisciplinary stakeholders who collectively are responsible for delivering sustainable value propositions that ensure the organization’s future (Bohemia, Rieple, Liedtka, & Cooper, 2014; Lojacono & Zaccai, 2004).

This development, as scholars from diverse disciplines have proposed, calls for a deeper understanding of future perspectives and the methodologies, methods, and approaches needed to engage business stakeholders, designers and interdisciplinary innovation teams in futures thinking (Bohemia et al., 2014; Candy, 2010; Gavigan, 2001; Irmak, 2005; Kelliher & Byrne, 2015; Woudhuysen, 1997).

In the field of design, several practices have been central to the development future images, such as performative techniques designed to empathise with stakeholders through ethnography and user observation studies, or probing deeper into emerging needs through the study of extreme users (Djajadiningrat, Gaver, & Fres, 2000; Keinonen, Kokkonen, Piira, & Takala, 2004). However, extending future images beyond the horizon is needed to envisage next-next generation value propositions, which requires a mindset of futures thinking (Evans, 2003). Despite the growing interest in studying the future, and more specifically, the role of futures thinking in design and business, empirical evidence in deploying or adapting foresight techniques is still relatively scant (Newbury, 2014).

The problem to be addressed in this paper is motivated by our limited understanding of how designers and inter-disciplinary innovation teams realize futures that are desirable (Coughlan & Prokopoff, 2004), and when major events or changes could affect their industry. If we are unable to explain the how, then we are also unable to take advantage of approaches that could help designers and interdisciplinary innovation teams apply futures thinking (methods, techniques, approaches) to envisage next-next-generation products, services, system, or imaginary value propositions.

Therefore, the aim of this paper is to address two important questions:

10. How can designers and interdisciplinary innovation teams engage with, and prepare for the future, when the strategic planning horizon is some 5, 10, or even 15 years?
11. How can they systematically develop a vision of futures in a world that could be while considering varying perspectives: an organization desired, the marketplace to come, the industry to be, or the human equation that defines future consumers by their demands, behaviours, and cultural patterns.
To address these questions, an applied research case study is presented, were the aim was to combining a well-known foresight method with futures techniques. In this study, the author of this paper consciously tried to create a mixed methodology (identified as design-inspired foresight) that would be understandable and inspiring to designers and non-designers alike. The method used as a basis for foresight was Delphi, a proven foresight technique in the field of future studies. To gain access to a high-calibre group of experts in the field of inquiry (Private Banking), the study was supported by a leading global Financial Services brand “ABC”.

Important lessons in the application of elected foresight techniques are presented; these focus on (1) the Delphi method (Linstone & Turoff, 1975), (2) a horizon scanning model “Three Horizons” (Baghai, Coley, & White, 1999), and (3) future scenarios building techniques (Ogilvy & Schwartz, 2004). In that, the focus is placed on the value of design *futures* thinking as a creative and divergent thought process in business and design, which has the potential to produce much broader organizational reforms needed to sustain in today’s rapidly evolving business environment (Buchanan, 2015; Irmak, 2005; Muratovski, 2016).

The paper is structured as follows: Firstly, the strategic planning process as a traditional business practice of dealing with the future - and its inherent limitations toward long-range planning, are compared to the activities in strategic design that may inform opportunities for future product, service, or integrated system innovations. The design-inspired foresight approach is introduced, which is designed to elicit expert opinions concerning issues and topics that might be impacted by future events, and, as demonstrated in applied research, could define the organization (e.g. Private Bank) in distant futures (e.g. 2030). Resulting from the methodology applied in this futures study, important lessons in employing, or adapting, design-inspired foresight techniques, are presented. An example outcome demonstrates the Delphi method, which allows designers and interdisciplinary innovation teams to engage with futures in form of scenario statements. Derived through synthesis and consensus from industry and academic experts, these statements are their shared visions for desirable futures.

**Strategic Planning in Business**

In business, the purpose of strategic planning is to assess a current status against a set of environmental factors, thus determining an organizational roadmap (mission goals) based on a vision for the future (Kaplan & Beinhocker, 2003). The success of a strategic plan is reliant on adequate information that inform the objectives, strategies, decision-making, and measuring of results against a set of goals (Miller & Cardinal, 1994). The limitation of strategic planning, however, is that strategic decisions are primarily based on interpreting information about the past and present (Mintzberg, 1994). Similarly, the lack of applying strategic thinking techniques as a creative and divergent thought process, and as a conscious, explicit, and collective business capacity, can be a limiting factor in the conventional strategic planning process (Heracleous, 1998).

When applying a creative thought process, the objective is to think about the future and to consider different ways (alternative futures) in which the external environment may evolve over the next 5 - 10 years, or even longer. In other words, what would the response have to be if a future were to unfold that was distinctively different from the one
anticipated in the current strategic plan? Hence, the purpose of futures thinking in design and business is based on the belief that future outcomes can be influenced by choices made in the present.

**Strategic activities in Design**

Strategic design are activities that integrate systems of products, services, and communications in organizations highly dependent on shared value creation across different groups of participants, clients, and relevant stakeholders (Manzini & Vezzoli, 2003; Meroni, 2008). As a decision-making tool, strategic design activities enable the designer to consider hard constraints imposed by an organization (internal environment), against ecological and social impacts, and the cultural sensibilities and symbolic meaning that inform external environments in a rapidly changing society (Meroni, 2008).

Historically, strategic design has played a key role in Product Service Systems (PPS), shifting the innovation focus from product (or service) design to an integrated product-service solution. However, due to globalization, technological advancements, and a power shift toward the consumer, increasing business complexity and the associated risks place new demands on strategic design to go beyond satisfying short-term innovation goals (Manzini & Meroni, 2007). Indeed, strategic design activities applied to foresight may offer decision-makers a holistic view on looming issues. It is here where creative thinking, visualization, and prototyping techniques can further advance images of futures that are preferable (Koh, Slingsby, Dykes, & Kam, 2011; Manzini & Vezzoli, 2003).

**Design-inspired Foresight**

Comparing the business and design practice of dealing with the future, noticeable intersections between strategic planning and strategic design processes are the creation of future value, and the development of perceptions about the future that may inform decisions, or strategies needed to prepare for a desired future. While most organizations fail to look beyond a narrow set of factors, evidence suggests that firms who have recognized the value of strategic design as an important resource in the innovation process, are indeed those who achieve sustainable competitive advantages (Grant, 2010; Heskett, 2009; Martin, 2009). This development further emphasises the need for theoretical and practical knowledge in strategic foresight activities linked to design (Bohemia et al., 2014; Evans, 2012; Grand & Wiedmer, 2010). Indeed, the purpose of employing a design-inspired foresight approach is to combine expert insights with trend analysis, and signs of early change, thus develop a deeper understanding of forward-looking perspectives that may help shape the future.

Moreover, a design-inspired foresight approach affords opportunities for visualization design, and storytelling techniques to enhance the impact of the research findings. Consequently, futures thinking and elected foresight techniques may help advance an organizations’ readiness and ability to deal with the increasingly uncertain business environment, or, at the very least, as Glenn (2003) proffers: to enhance [the organization’s] anticipatory consciousness. Too often, as we are reminded, the apparent benefits of foresight may only become obvious in hindsight (Simonton, 2012).
Applied research case study: Envisaging futures of Private Banking to the year 2030

An industry increasingly at risk in dealing with uncertainty is the Financial Services industry. As a core pillar of economic activity, changing consumer and user behaviours, technological advances, and disruptive business models are among major drivers of change. Furthermore, globalization and decades of banking deregulations have resulted in the blurring of banking, insurance and capital market boundaries, which are further causes of innovations that create uncertainty and other complications. Indeed, legacy players in the financial services industry are showing signs of losing their competitive edge, while start-up companies (e.g. FinTechs) are using advanced technologies, innovative business models, and value created for a social consumer to disrupt, and fundamentally change the way financial services are being delivered (Chishti & Barberis, 2016). Against this backdrop of inevitable change, designers and interdisciplinary innovation teams have to make sense of evolving trends, and spot the early signs (signals) that may inform discontinuities, which could jeopardise an organization’s strategic direction (Saritas & Smith, 2011).

Research Design and Theoretical Framework

Anticipating the future is not commonly practiced by business decision-makers as the focus, too often, is directed toward the short-term horizon and the financial objectives linked to the organization’s financial plan. To gain a deeper understanding of future perspectives, and the methodologies, methods, and approaches needed to engage business stakeholders in futures thinking, two key attributes in applying foresight techniques must be considered: a) concerning the nature of inquiry (qualitative, quantitative or semi-quantitative), and the methods to gather and process information (Butter, Brandes, Keenan, & Popper, 2008). To engage foresight techniques as issue identification, researchers often must rely on the opinions of experts who are better aware of what is going to happen in the future (Rowe & Wright, 2001). Since experts possess tacit knowledge over specific business aspects, these can be identify and judge as the most critical uncertainties (Linstone & Turoff, 1975).

Among the established foresight methods is the Delphi technique first introduced by the RAND Corporation in the 1950s (Linstone & Turoff, 1975). The Delphi technique is a qualitative research method, ideally suited to capture experts’ forward-looking perspectives, as this structured technique allows a group of individuals, as a whole, to consider, reflect upon and provide opinions on complex issues (Linstone & Turoff 1975). It has proven to be a popular instrument to engage experts in group communications to deal with complex issues, elicit individual opinions, and subsequently seek group consensus as a whole. Researchers who have applied the Delphi method often cite a key strength in that experts remain anonymous throughout the Delphi communication, thus making this technique more conducive to independent thought on the part of each participating expert (Denzin & Lincoln, 2000).

A further strength of the Delphi method is that it allows experts to be geographically dispersed, which means that participants can interact around the subject topic, and receive sequential feedback during several rounds of questioning, without ever having to meet as a group (Garrod & Fyall, 2005). To guide a Delphi futures study, a horizon...
(environmental) scanning model serves as an appropriate theoretical framework, as the focus in futures studies is on identifying external trends and developments that may suggest potential implications through early signs of change. Horizon scanning may be defined as “the acquisition and use of information about events, trends and relationships in an organization’s external environment, the knowledge of which would assist management in planning the organization’s future course of action” (Choo, 2002, p.84). While many horizon scanning models have been developed by those practicing foresight (Talwar, 2010), their commonalities are scanning, analysing, and synthetizing stages as central components of a model framework. An applicable horizon scanning model is the “Three Horizon Model” - first introduced by Baghai, Coley, and White (1999). As Curry and Hodgsen (2008) suggest, the “Three Horizons” model enables diverse futures and strategic methods to be integrated to systems and structures, and connected to different speeds of change as appropriate (Figure 1).

![Figure 1 Schematic of the futures-oriented Three Horizon model](image)

As the schematic depicts, potential transition points can be identified based on their likely disruptive or incremental innovation tendencies. As such, the 1st Horizon focuses the conversation on the prevailing systems (status quo); it has high strategic fit to the organization’s mission. However, over time it loses its fit as external forces or factors come into play. The 3rd Horizon, conversely, deals with weak signals, options or arguments about the future of systems that may have consequences to the present environment as it is known. In-between these two horizons is the space (2nd Horizon) where the transition from the known to the unknown (or untested) occurs, and where systems are typically unstable. The time distance between horizons depends on the industry domain or nature of inquiry; the third horizon often requires that systems can be allowed to change significantly (Sharpe & Hodgson, 2006). Fundamentally, foresight methodologies combine foresight techniques such as macro trend analysis and expert knowledge to explore alternative futures (Voros, 2001). To
engage participants in futures thinking, Hancock and Bezold’s (1994) futures cone (Figure 2) serves as a valuable metaphor of four types of alternative futures (possible, plausible, probable, preferable), whereby the emphasis is placed on envisaging (or inventing) preferable futures. The strength of the futures cone lies in the thought process applied by the participants in futures studies, as the cone allows planners to track relevant trends against the scenarios’ plausibility in a systematic and logical progression (Voros, 2001).

As business stakeholders become increasingly mindful of the reforms needed to adapt to the relentless change of the business environment, a design-inspired foresight approach, elected methods and techniques applied in the 2030 futures study, are presented. Furthermore, important lessons in employing, or adapting, foresight techniques in the design and innovation process are discussed.

**Applied Research Case Study - Lessons and Discussion**

*Lesson 1: Research Design – Theoretical Framework in Design-inspired Foresight*

As a theoretical framework, the “Three Horizon” model (see Figure 1) offered study participants opportunities to engage simultaneously with short-term, medium-term, and long-term futures thinking, thus approaching a given subject over three distinct time horizons. For example, to engage Delphi experts across distinctive time horizons, participants were asked an opening question linked to the present: What are the important topics/issues that define the core of the business, and which will need defending and keep expanding? This question related to the 1st Horizon, and addressed issues that concern images of continuous growth (Dator, 2009). Exploring issues relating to the 3rd Horizon, Delphi panel participants were asked to consider: What are the important drivers of change (early signs) that will radically influence the nature of the (business) in 2025, and 2030?
Survey questions were designed to take into consideration varying perspectives, which the Delphi participants had to identify with. As an example, beyond the experts’ views on what may impact an organization in a given time horizon, a response to the industry, market, and consumer perspectives were sought. At the completion of the analysis phases, it was anticipated that this approach would present holistic insights into the early warnings of potential threats and opportunities of the extended external business environment.

Important for designers and interdisciplinary innovation teams who employ the horizon scanning model, is that the 3rd Horizon perspective is deeply informed by worldviews and the values in which the individual expresses his/her opinion. It is here where expert informants exercise their power of voice and experiment, which Inayatullah (2004) suggests, makes the “Three Horizon” model such a useful tool as alternative scenarios are informed by different worldviews and logic. In a long-range futures study (e.g. 5-10 years), it is therefore plausible that experts are no longer constrained by their current views of organizational bias, thus expressing their deep-founded believes and values that inform a desirable, or indeed preferable future organization.

Discussion
As foresight methodologies are usually qualitative rather than quantitative in nature (see Cuhls 2003), a key objective in conducting a design-inspired foresight study is to produce futures scenarios that help prepare for, or indeed actively shape visions of the future. Figuratively speaking, in foresight the focus is directed on “…the world as it could be, through the imagination and realization of possible futures…” (Grand & Wiedmer, 2010, p.2). In this sense, a design-inspired foresight approach is based on creative interpretations derived from various trends, STEP (Socio-cultural, Technological, Economic, and Political) drivers of change, and the opinions and knowledge of subject matter experts who are the key informants in the process. Consequently, a design-inspired foresight approach can prepare key stakeholders to make sense of complexity, thinking and planning for the future, while coordinating creative resources at all levels of decision (Kelliher & Byrne, 2015).

Moreover, as designers and interdisciplinary innovation teams dependent on multi-disciplinary participants to work together to remove uncertainty and anticipating possible futures (Baraquero, 2014), the design-inspired foresight paradigm can be regarded as a collective problem-solving, preferred-change, and vision-provoking undertaking.

Lesson 2: Data collection - the Delphi technique
The main purpose in Delphi is to gain insights on how individual industry and scholarly experts express their understanding to a set of survey questions, and the synthesized opinions they are presented with in subsequent survey rounds (Figure 3). The technique itself involves a set of opening questions, which are presented to the Delphi panel through an online (web-enabled) survey tool. Once individual experts have completed their questions, the data is summarized and a set of new questions are designed based on the findings from the first round. This process is then repeated until consensus is reached (Turoff & Hiltz, 1995).
Although the Delphi method is well established in a majority of research disciplines (Powell, 2003), many challenges remain to be dealt with during the application stages. This holds true in particular for the first-time user of this method (Ayton, Ferrell, & Stewart, 1999). Addressing these challenges, toolkits have been developed to adapt the Delphi method and meta-analyses to specific fields of inquiry including health care (de Meyrick, 2003), tourism management (Donohoe & Needham, 2009), information and management systems (Okoli & Pawlowski, 2004). A tool kit that has proven to be of value in foresight surveys (Buhring, O'Mahony, & Laitamaki, 2011), is Day and Bobeva’s (2005) “Generic Delphi Toolkit” (GDT), which help guide the preparatory, convergence, and consensus stages in classic or modified Delphi surveys.

**Discussion**

Preparing for a Delphi survey is perhaps most important in achieving a successful outcome, as the focus is placed on identifying and communicating the main research problem to be addressed. During this stage, the research team has to identify and select expert participants, design and test a data collection tool, develop a series of carefully constructed survey questions, and decide on the data analysis framework and method (Day & Bobeva, 2005). When formulating the problem statement, one important consideration should be the overall aspiration of the study purpose and objectives. According to Andranovich (1995), the study problem (purpose) and questions posed should match the study participants’ interests in order to ensure meaningful participation. For example, is the inquire intended to be broad: ‘What will the future look like?’, or is the
issue under inquiry quite specific to an organizational aspect or hypothetical future? Targeted participants may have varying motives; for example, some are interested in exploring ways of navigating change, while others are keener on making sense of disruption. Others still may see the most important outcome in gaining a collective understanding of emerging markets, competitors, or uncovering the deeper changes in stakeholder values, behaviours and beliefs.

It is advised that researchers preparing for a design-inspired foresight study should allow ample time to describe the study aims and objectives, articulate the research problem and ensuing questions, and identifying experts needed on the Delphi panel to achieve the overall study outcome (Donohoe & Needham, 2009).

**Lesson 3: Think about images of the future – pre-survey participant engagement**

It is highly recommended to develop relevant content in form of an information document to be issued to study participants in the lead-up stages of the Delphi. The aim in that is to encourage Delphi panel experts to open their minds, and start thinking about images of the future prior the official commencement of a Delphi survey. For example, in the lead-up to the 2030 Delphi survey, a “Delphi Information Handbook” was issued to each panel expert at least two weeks prior to the launch of the first survey-round. The objective was to present experts with a foundational futures question, intentionally to start the conversation from a known perspective of the present, while considering the official version of the future. Supporting materials may combine appropriate social, technological, economic, and political mega trends, as well as thought-provoking images of alternative futures (Dator, 2009).

Gaining access to the appropriate calibre of experts can determine the outcome quality; in this research case study, support was sought from a global industry organization “ABC” who is widely considered as a leader in Wealth Management and Private Banking. Under these circumstances, quite often, research teams can gain access to otherwise difficult to engage senior decision-makers, and the professionals identified for their specific commercial and functional expertise.

**Discussion**

It is important for the research team to remain resourceful in securing the right candidates as there are no certainties that targeted experts are committed to participate in a time-consuming Delphi study. Moreover, the selection process has to remain rigours and adhere to a set of predetermined selection criterion relevant to the study focus (Donohoe & Needham, 2009). The selection criterion can be determined based on obtaining a more holistic understanding from experts across functional disciplines. In this futures study, these were sought from experts in strategy, innovation, client engagement, product development, Information and Technology Systems [ITS], and Marketing. To achieve a balanced view from different inside/out perspectives, a small group of academic scholars from social science, cultural, and technology backgrounds were also invited to join the Delphi panel.

Considerations toward the size of the expert panel was based on the review of the Delphi literature. The method’s application suggests that the Delphi technique has been successfully used with expert panels comprising of as few as 4 and as many as 904
participants, and that the panel size should be determined based on the number of experts available (Smith 1995). Following the recommendations obtained from a comprehensive review of the Delphi literature, a heterogeneous group comprising of between 9 and 12 experts was deemed adequate for this study. This was further acknowledged by the high calibre of expertise, and far-reaching areas of responsibility identified among the targeted group of industry and scholarly experts. At the completion of this study (when consensus is reached), the Delphi panel composed of 13 experts, reached consensus on several key futures scenario statements after two consecutive survey rounds. From the launch of the first survey round to the consensus-reaching final round, the Delphi survey took four months to complete.

**Lesson 4: Data Analysis in a design-inspired foresight study**

Collecting qualitative data through a Delphi method, a general inductive approach to analysing raw data is recommended. The main focus is on the findings to emerge through issues identification, and the rational each individual expert provides for the issue they nominate. From the data analysis, frequent, dominant, and significant issue groups - and their related themes, will emerge. This process allows the data obtained from the experts to be coded and sorted across time horizons (e.g. 2020, 2030). This approach is consistent with the description of how qualitative data should be sorted, coded and analysed through data reduction and display techniques (Miles & Huberman, 1994).

Miles and Huberman (1994) described the three elements of qualitative data analysis as, “Data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming the data that appear in written up field notes or transcriptions” (p.10). The authors also highlighted the benefits of using a matrix approach to analysing large amounts of data, thereby organizing information coherently; while at the same time, focusing on the relevant portions of data needed to answer the research questions.

**Discussion**

In this case study, an 8-step analysis process was developed; these steps are outlined in the following table (Table 1).

---

**Table 1  Data Analysis – the 8 Process Steps**

<table>
<thead>
<tr>
<th></th>
<th>Data Coding Method – Delphi Round 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Data capture – Round 1</td>
</tr>
<tr>
<td>2.</td>
<td>Data analysed for issue types (current and emerging)</td>
</tr>
<tr>
<td>3.</td>
<td>Data analysed for “units of meaning” (emerging issues and themes)</td>
</tr>
<tr>
<td>4.</td>
<td>Data analysed for issue and theme definitions</td>
</tr>
<tr>
<td>5.</td>
<td>Emerging data categories</td>
</tr>
<tr>
<td>6.</td>
<td>Data sorted by issues, themes, categories, and across time horizon</td>
</tr>
<tr>
<td>7.</td>
<td>Data synthesized by (four) perspectives</td>
</tr>
<tr>
<td>8.</td>
<td>Scenario statements for each perspective, and across time horizon</td>
</tr>
</tbody>
</table>

---
Following this data coding process, further analysis in form of ‘key words’ can be obtained from the rationale each panel participants provided for their nominated issues. The outcome of steps 1 – 7 produced a series of scenario statements (an example statement is to follow) that captured the combined opinions obtained from the expert panel. Scenario statements were developed as a synthesis; a method of qualitative content analysis designed to explore issues at a deeper level (Minichiello et al., 1990), thereby presenting panel participants with an expression of an idea derived from their combined responses in subsequent Delphi rounds.

**Lesson 5: Futures Scenario Statements**

Key business stakeholders and corporate planners are increasingly dependent on the use of scenario building and analysis techniques to produce a vision of preferable futures. From the traditional approach of applying strategic planning techniques based on the assumption that tomorrow’s business environment will be much the same, new creative thinking approaches are needed to define the firm’s vision and direction, and to implement the reforms needed in an entirely new business environment of heightened risk and uncertainty.

**Discussion**

The data analysis in this design-inspired foresight study was designed to produce a series of futures scenario statements that captured the combined opinions obtained from the Delphi expert panel. Presenting the findings of the first Delphi round to the expert panel, occurs at the launch of the second-round survey. Participants have the opportunity to reflect on the statements, and confirm the essence of their combined opinions on the issues that were considered important, now and in the future.

In the second Delphi round, experts were presented with scenario statements (10 in total) that expressed ideas analysed and synthesised from their combined responses in the first round. A likelihood of occurrence rating index was provided for each statement, which had been designed as consensus-reaching indicators through mean value analysis of the group’s consensus on each scenario statement.

The following statement provides a futures scenario example derived from the synthesis of expert opinions reached at the completion of the second Delphi-round. This example emphasizes their combined responses addressing the organization perspective, and the early signs (weak signals) that are characteristic of the 3rd Horizon:

*In 2030, the traditional Private Bank (organization) has ceased to exist, while the Private Bank 2030 operates through client-facing identities that are backed by powerful backend platforms, thus fully embracing the benefits of a highly-streamlined entity with geographical proximity to key markets. This future entity is supported by global systems and specialist teams deploying the highest standard of wealth management advisory services. Operating within prevailing regulatory constraints, services are curated effectively across a network of strategic partnerships. Through open architecture platforms, the Private Bank 2030 specializes in offering primarily investment management and advisory services, while some innovative players are experimenting with holistic, lifestyle-related, and*
behavioural-driven client touch-points most relevant to client interests and talents. To this end, efficient and decentralized product innovation capabilities will provide unique competitive advantages, which will enable the Private Bank 2030 (greater China) to withstand challenges presented by external forces.

Conclusion
This paper is a response to calls for a deeper understanding of future perspectives, and the methodologies, methods, and approaches needed to engage business stakeholders, designers, and interdisciplinary innovation teams in futures thinking. Looking beyond strategic planning in business based on historical and current knowledge and trends, the emphasis in this paper was placed on foresight in design and business as the imagination and creation of possible futures. Through applied research, a design-inspired foresight approach was introduced in a 2030 futures case study, emphasising the value of foresight as an emerging activity in strategic design and innovation.

To demonstrate the use of elective foresight methods, techniques, and models, five lessons were drawn from a design inspired foresight study in the Financial Services industry to the year 2030. This futures study was designed to address two important questions, namely: How can designers and interdisciplinary innovation teams engage with, and prepare for the future, when the strategic planning horizon is some 5, 10, or even 15 years ahead? And, how can they systematically develop a vision of futures in a world that could be while considering the organization, market, industry, and consumer perspectives.

Employing a design-inspired foresight approach, the focus is directed toward gaining deeper insights through Delphi-like techniques, thus moving away from the traditional management practices of predicting the future based on current knowledge. In the 2030 futures study presented in this paper, the goal was to help individual stakeholders identity and agree on desirable futures. As seasoned researchers in foresight acknowledge, whichever methodology or method may be applied to futures studies, challenges remain to connect the present with preferable futures in ways that “…helps to identify the divergent futures which may emerge as a result of conflict between the embedded present and these imagined futures” (Curry & Hodgson, 2008, p.2).

Conversely, the value of employing a design-inspired futures approach comes through developing futures scenarios that become powerful visions of desirable futures. From this position, designers and interdisciplinary innovation teams can engage with decision-makers to develop innovation strategies, and pathways on how the organization might achieve its mission across different time horizons. Thus, important contributions can be made to theoretical and practical knowledge in design foresight processes, while offering design researchers practical lessons of employing, or adapting existing foresight methods, such as those described in this paper. Indeed, as the role of design in business is expanding across all aspects of futures thinking, design-inspired foresight activities aspire to prepare key stakeholders to shape the organizations’ future.

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About the Author

**Dr Jorn Buhring** is a Research Assistant Professor at the PolyU School of Design; his research focus is on human-centred value innovation with emphasis on user engagement in experiential settings. Addressing future perspectives, Jorn explores design foresight, vision and fiction approaches through applied research. His aim is to advance emerging design processes in business through vision-provoking futures thinking.


Design-led innovation and sensemaking: opportunities to connect

PRICE Rebecca\textsuperscript{a}; WRIGLEY Cara\textsuperscript{b} and MATTHEWS Judy\textsuperscript{c}\textsuperscript{*}

\textsuperscript{a} Delft University of Technology, Netherlands \\
\textsuperscript{b} University of Sydney, Australia \\
\textsuperscript{c} Queensland University of Technology, Australia \\
* Corresponding author: jh.matthews@qut.edu.au \\

Design-led innovation (DLI) is a framework with particular focus on developing design capability. Implementation of DLI has been observed to positively influence firm innovation performance. As the framework is of relative infancy, there is opportunity to learn from and integrate methods and practice from other fields to strengthen the implementation of DLI. Therefore, the aim of this paper is to make explicit, the similarities DLI shares with sensemaking as in order to provide clearer approaches to managing the design process. An action research design is applied for 14 months within a major Australian Airport Corporation (AAC) to implement DLI. Qualitative data is collected and analysed, with the findings showing there are implicit similarities between the practice of DLI and mandates of sensemaking. The paper contributes opportunities to strengthen DLI by incorporating mandates of sensemaking consciously to enrich interpersonal interactions during the design process.

keywords: uncertainty; complexity; foresight; retrospective

Introduction

Common practice for business is to explore future possibilities as a strategic exercise, while simultaneously exploiting current operations to sustain profitability (O’Reilly & Tushman, 2004). Where knowledge is created from uncertainty, sensemaking can occur (Weick, 1995). Where ambiguity or complexity are present, sensemaking can be consciously applied to create new knowledge and new value within an organisation (Gioia
& Thomas, 1996). Within this arrangement, knowledge is viewed as a verb, an action of knowing and unknowing (Dervin, 1998).

While Kolko, (2010; 2015) proposes that design can allow sensemaking to be harnessed as future orientated mechanism, the theoretical grounding of such a claim remains untested. This paper does not seek to bridge this claim empirically, but rather continue to bring the two fields closer through discussion of implicit similarities. The scope of the design discipline is narrowed to the framework of DLI, given its recent interest from the design community (Wrigley, 2016).

DLI is a framework with particular focus on developing design capability. Implementation of DLI been observed to positively influence firm innovation performance (Wrigley, 2016). As the framework of relative infancy, there is opportunity to learn from and integrate methods and practice from other fields. Therefore, the aim of this paper is to make explicit, the similarities DLI shares with sensemaking in order to provider clearer approaches for interacting with users customers and stakeholders. This contribution will benefit organisations and individuals seeking to become design-led in the future. To achieve this aim, this paper reports on an action research study within an Australian Airport Corporation (AAC) for fourteen (14) months, whereby DLI was implemented within a strategically critical project. The following research questions are observed and guide this paper:

RQ1: What similarities does design-led innovation share with sensemaking?

RQ2: How can the implementation of design-led innovation be strengthened through sensemaking?

It is important to note that this paper tracks the implementation of DLI, not sensemaking as a methodology. Sensemaking literature is used as a frame for discussion in order to propose how DLI can be strengthened – embracing the virtues of reflective practice (Schön, 1983). The differences between the two fields is an item for future research, with this paper focused on how to improve the practice of DLI as a starting point. The researcher will be referred to as an innovation catalyst from here on, understanding the unique combination of DLI and action research configures the researcher as a driver of change (Wrigley, 2016). The paper concludes with implications and directions for future research.

**Uncertainty**

To grasp sensemaking, first, it is important to briefly touch on the nature of uncertainty and the accompanying impact on business. Uncertainty is a state of unknowing based on the presence of ambiguous, imperfect, incomplete and/or unknown information (Geersbro & Ritter, 2010). For a business, uncertainty limits the capacity to make decisions, placing stress on management (Pahlke, Strasser & Vieider, 2015). From a poor decision the risk of an undesirable outcome can impact the very existence of an organisation (Savage, 2009). For this reason, uncertainty as a basis for risk is the enemy of business.

However, uncertainty and risk are ever present, described by van den Berg and Pietersma (2016) as the “ubiquitous and characteristic side-effect of taking action by organisations”
There are risks too that accompany strategic inaction (Porter, 2008). The premise of strategic management is to provide business with methods, tools and techniques within an overarching approach to transform uncertainty into value. However, the complexity and nature of forthcoming innovation challenges places strain on deductive and inductive management methods available (Liedtka, 2014). A building block for the design movement is set (Buchanan, 2015).

**Sensemaking**

Sensemaking is a critical activity for individuals (Dervin, 1992) within organisations (Weick, 1995) involving the creation of order from unknown. The process of sensemaking is tacit and related to cognitive and socially constructed meaning. The methodological rationale of sensemaking is best described by Dervin (1998, p.39):

> The bottom-line goal of Sense making from its inception has been to find out what users – audiences, customers, patients, clients, patrons, employees - 'really' think, feel, want, dream.

Dervin’s (1992) framework (Figure 1) provides a metaphoric framework for individual sensemaking. A situation in time will be accompanied by a lack of knowledge. This lack of knowledge is both peripheral and immediate. New knowledge is then created through action - whereby memories of the past and present are explored to consider and importantly predict future solutions. Dervin (1998) recommends time-situation specific questions like: what brought you here today? What problem would you like solved? What got in your way? What emotions or feelings did you experience? Table 1. further documents key mandates described by Dervin (1998) to scaffold user interactions. While these questions are retrospective, the outcome of knowing what the user 'really' needs, wants or dreams can contribute to a platform for prediction. The situation (now at a new present time) can be addressed through appropriate decisions – leading to an outcome. Additionally, a prediction can lead to good decision making under the pressure of uncertainty – and conceivably enable foresight. This is the relevance of sensemaking to design. The methodology supports an interface between researcher and user that while retrospective, can align to and potentially enrich the future orientated rationale of design.
Figure 1  Sensemaking framework – Adapted from Dervin (1992)
<table>
<thead>
<tr>
<th>Mandate</th>
<th>Description</th>
<th>Example (Possible method/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify and address assumptions</td>
<td>The process of knowing and unknowing. Our assumptions are what we know, however we must unlearn them in order to grow</td>
<td>A sense maker questions their own perceived bias of a phenomena by reading opposing theories and argumentation (Database search; observation; literature review)</td>
</tr>
<tr>
<td>Manage fluidity</td>
<td>People and environments may be different from the previous day. Therefore, the sense maker must be willing and equipped to know why change occurs</td>
<td>The sense maker collects information that shows a user’s appreciation of a system has changed over time. The sense maker must then identify what caused that change in order truly know the user (Survey; reflective writing; guided discovery; task analysis)</td>
</tr>
<tr>
<td>Attend to emotions and feelings of the user</td>
<td>Emotion and feelings becomes the frame through which knowing takes place.</td>
<td>A user is asked to rank their emotions during and after using a system (Quiz; questionnaire; interview; reflective writing; task analysis)</td>
</tr>
<tr>
<td>Manage power structures</td>
<td>The sense maker must be aware of and manage drivers (implicit and explicit) that challenge both users and people within an organisation</td>
<td>A proudly united community is asked about disagreement. Pockets of discord are revealed that challenge the sense makers ability manage how the project will proceed. The sense maker must become sensitive to the communication of knowledge (Interview; focus group discussion; reflective writing)</td>
</tr>
</tbody>
</table>

Managing power structures is described more definitively in organisational sensemaking. Organisational sensemaking considers how the workplace environmental contributes a unique set of drivers and normalities that effect the individual sense maker (Weick, 1995). As organisations are complex and multileveled systems involving people from many different backgrounds, creating order becomes a unique social process that emerges from complexity (Maitlis, 2005). In addition to internal interpersonal dynamics, an organisation's collective openness to the environment will determine how much information is collected – with more information challenging an organisation to negotiate greater uncertainty and process more knowledge. However, the sensemaking activity remains bound by the unit of the individual. As Dervin explains; between self-relating to self; self-relating to another; self-relating to a collective and so forth (1998). Therefore, this paper will focus on how the innovation catalyst implemented DLI within the organisational context of the AAC.
**Framework: Design-Led Innovation**

The purpose of the DLI framework is to assist organisations to develop design capabilities by supporting how design is applied. The DLI framework is comprised of the ‘external’ and ‘internal’ spaces of organisation, intersected by ‘operational’ and ‘strategic’ activities (Figure 3). The innovation catalyst, described by Wrigley (2016), becomes vital to guiding an organisation’s progression through the framework. The framework has been studied from multiple perspectives involving the innovation catalyst, with empirical evidence demonstrating a positive impact on company innovation performance (Wrigley, 2016). With stakeholder engagement and visibility to DLI comes increasing awareness of design, leading to design capability. According to Bucolo, Wrigley and Matthews (2012), moving through the framework involves three key phases, further identified in Figure 2. These phases are:

1. Gathering customer insights from customers and stakeholder that reveal deeper latent needs;
2. Proposing future orientated solutions that capture value from these customer and stakeholder insights, and;
3. Shaping strategy that leverages the value unlocked by future orientated propositions - these propositions being grounded by customer and stakeholder insight.

*Figure 2  Design-led innovation framework*

DLI uses methods central to the discipline of design to create product and service solutions that are integrated, anticipate future user needs, build future proposals and encourage feedback (Bucolo et al., 2012). To achieve these solutions, methods of design are applied to make deeply understand the customer's pains and gains as opportunities. Here lies conceptual similarities between the application of design methods and various mandates of sensemaking (earlier presented in Table 1). This paper sets out to make explicit these similarities by tracking the implementation of DLI through an action research methodology.
Research Design and Methodology

An action research methodology was applied over a period of eight months to explore the DLI within a high reliability organisation (Chivers, 2014). Action research is defined as the study of a social situation with a view to changing the action within it (Elliot, 1991). The methodology comprises of cycles of planning and action. These activities are linked through reflection and observation (Zuber-Skerritt, 2012). This methodology involved a cycle of action and research that aligned to one industry project. This project is loosely termed “digital innovation” as the nature of the project sought to make sense of current passenger experience in order to predict future opportunities in a digital space. Details on this project are tabulated in Table 2.

**Table 2. Project details**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Action Research Cycle Duration</th>
<th>Project Aim and Outcome</th>
<th>Methods Applied</th>
<th>Stakeholders Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital innovation</td>
<td>14 months</td>
<td>The aim of this project was to enrich passenger experience through digital channels</td>
<td>Reframing Persona design</td>
<td>9/9 internal AAC departments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The outcome of the project was the launch of two new mobile applications, a digital</td>
<td>Narratives</td>
<td>Innovation catalyst</td>
</tr>
<tr>
<td></td>
<td></td>
<td>departure card and the implementation of an organisation wide digital strategy</td>
<td>Three horizons model</td>
<td>Digital consultant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Persona design</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>SWOT analysis</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Touch-point timeline</td>
<td></td>
</tr>
</tbody>
</table>

**Industry Context**

The AAC provides a novel and worthy context for the exploration of DLI, as the operational challenges it faces provide immense threats and opportunities given the Airport’s high-reliability status within society. The oncoming opportunities and consequent challenges associated with digital diversification (Taneja, 2011), globalisation and capacity demands (Goedeking, 2010), and a progressive shift toward an aerotropolis business model (Frank, 2011; Kasarda, 2008) is testing current methodologies within the AAC. Airports also operate in a vast networks, placing pressure on governance structures to decide courses of action (Donnet, Keast & Walker, 2011).

The AAC undertakes new product and service development through a typical stage gate process. Participants within the AAC also described the approach to innovation as one of “smartly following” industry leaders (Damanpour & Wischnevsky, 2006). This approach, while beneficial, meant that the AAC relied heavily on partners and outsourcing for
creativity and design capability. This was the context and rationale for implementing DLI within the AAC.

Data Collection
Qualitative data describe situations and are typically non-numerical, which supports the exploration of DLI as a concept where prior theory is undeveloped. This study collected qualitative data through four research methods: semi-structured interviews; focus group discussion; field notes; and; reflective journal. The reflective journal and field notes entries were recorded by the innovation catalyst. Table 3 contains data collection particulars. Participants were sampled from across the organisations structural to represent both horizontal and vertical levels of the business. The four data collection methods were triangulated, adding integrity to the research design.

Table 3  Data collection

<table>
<thead>
<tr>
<th>Method</th>
<th>Quantity</th>
<th>Time</th>
<th>Foci</th>
<th>Authorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-structure interview</td>
<td>15</td>
<td>1-1.5 hours</td>
<td>Gather data regarding outcomes and opportunities of visualisations as part of DLI. Understand how uncertainty is currently made sense of.</td>
<td>Agostinone-Wilson, 2012</td>
</tr>
<tr>
<td>Focus group discussion</td>
<td>1</td>
<td>1.5 hours</td>
<td>Understand the impact of visual methods on AAC innovation process and sensemaking as part of DLI</td>
<td>Basch, 1987</td>
</tr>
<tr>
<td>Field notes by innovation catalyst</td>
<td>90 x A5 journal pages</td>
<td>NA</td>
<td>Internal dynamics and reception of DLI framework during projects. Reception of visualisation as part of DLI. Elements of sensemaking that occurred.</td>
<td>Zieman, 2012</td>
</tr>
<tr>
<td>Reflective journal by innovation catalyst</td>
<td>Approx. 2500 words</td>
<td>NA</td>
<td>Organisation of thoughts during reflection. Creating greater awareness of experiences and the relationship between ideas, relating to framework of DLI and the practice of design</td>
<td>Parker &amp; Goodwin, 1987</td>
</tr>
</tbody>
</table>

Data Analysis
At the completion of all cycles, a thematic analysis approach described by Ezzy (2002), was applied. This overarching analytical approach involved in the following order; open coding; axial coding; selective coding; and; write up. A separate coding scheme was applied to the
analysis of each cycle as each cycle involved unique planning, action, observation and reflection phases. Analyses were completed using NVivo software to aid the storage, management and security of the data.

Findings
The findings are segmented into situations related to moments where uncertainty was encountered by the innovation catalyst. These situations involved how the innovation catalyst interfaced with individual customers and stakeholders, the collective AAC as an organisation and external stakeholders. These situations are: bridging gaps in customer insight, gaining approvals and the need for consensus.

Situation 1: Bridging gaps in customer insight
The first situation concerned the lack of customer insight during the project. Available resources within organisation of innovation catalyst came from market research and was quantitative in form. It was noted that this information, while valuable as it represented a large volume of customers, provided little novel insight in why passengers behaved and made certain decisions. The innovation catalyst then went about implementing DLI with stakeholders to collected deeper insights.

One participant notes to the innovation catalyst of the methods applied within DLI by the catalyst, “I thought the tools were very clever in that it allowed us to approach passengers in a new way that was less direct or personally intrusive but still engage them” and of the outcome:

We were able on uncover so many issues, emotions, reasons that we will be able to tap into…it has given us so much more direct insight from our passengers that we will be able to action accordingly.

Another participant noted of how assumptions were previously the foundation for making strategic decisions. This participant noted, “We can’t sit here and assume what people want — which we still do. We need to go find out what it is — once we have all that we can go and transform [our customers’] experience to make it better”. Who these customers were was clarified and described, “It is not just [the] passenger; it’s the ‘meeter’ and greeter or somebody else”. This expanded the view of who the customer was, widened the scope of value creation beyond the obvious passenger-airport opportunity.

Additional insight from participants concerned the novelty of the DLI within the project, “It was [a] completely new concept for me, using research to build reasons and detail, not straight up solutions. It took me a little while to see that the link was the depth and amount of reasons that then framed an answer”. This element of surprise at the extent of customer insight was an important feature of DLI. These findings also provide insight into the previous innovation process of the organisation – from identified problem to solution with little exploration and reframing.
**Situation 2: Gaining approvals**  
The second situation of uncertainty encountered within the project by the innovation catalyst concerned regulatory challenges to the project. The uncertainty and gap in knowledge for the catalyst became, what will be the form/function of this solution and how will this solution pass regulatory policies. These fundamental questions had the potential to prevent the project from progressing toward a solution state. This uncertainty addressed by visualising the concept through narrative method to key stakeholders. In Figure 3, one such visual narrative method is illustrated. The realistic narrative was created with a prototype of the design concept in the form of a mobile application, combined with existing airport infrastructure and captured through photography to show context of use. The visual artefact was presented to the necessary stakeholders to gain investment within the organisation. In addition, the narrative was presented to the Australian Government in order to negotiate regulatory barriers to allow for the design concept to progress toward solution. The government granted regulatory approval under conditions, for a trial of the project.

**Figure 3  Realistic “passenger” narrative**

Reflecting on the narrative method, participants noted to the innovation catalyst, “The narratives. They are really useful. Much better than writing a detailed ten page scope. I think people understand it more, most people turn off after starting to read a report”. The notion of reading a ten-page report provided insight into the existing formal innovation processes of the organisation. This particular participant continued:

> The departure card presentation to the [government] in Canberra. Attended by seven different agencies. Yes, everyone understands the departure card and the process. It would have been okay to just show them. *The passenger narrative puts it into reality - to make sense of it.*

Feedback from participants related to the outcome of the narratives within the context of the project. One participants noted, “If you apply that narrative it becomes visual and powerful” and that, “The Senior management team were like ‘wow — that’s fantastic’”. This endorsement is evidence of the potential of the DLI to surprise and drive innovation.
in an environment where regulatory barriers are commonplace. On the lower right hand side of Figure 4, an image from the launch of the solution to market is presented providing insight into the outcome of this project. The solution was at the time, a world first solution enabling the passenger to complete their departure card digitally.

Situation 3: The need for consensus
The third moment of uncertainty facing the innovation catalyst was the lack of a digital strategy within organisation. As a result, there was little consensus across the organisation regarding the form and function for digital channels – both present and imagined. As one participant notes, “We will always have an airport with hard assets, like a runway and apron to park an aircraft... We will never have a digital airport”. In addition the another participant notes, “Digital is a big challenge for a big traditional business like ours... I guess it was one of those gaps which is an emerging opportunity”. Action was taken to address this lack of consensus given the prevalence of digital technology in everyday life.

The innovation catalyst then led the organisation through the process of defining a digital strategy. The catalyst notes within the reflective journal, “As part of the production of this strategy, the term ‘digital’ was defined through a series of meetings where the innovation catalyst observed discussion and took field notes. Based on themes within these meeting, the catalyst then developed a set of design narratives that explored themes of a possible digital strategy. Figure 4 is one such narrative that became the foundation of the current AAC digital strategy. These narratives were presented across the organisation in order to gain broader insight.

![Figure 4](image)

Figure 4  Strategy Narrative used within the digital project
This contrasted the organisation’s approach of smartly following industry examples and challenged the organisation to take leadership. The catalyst further reflects, “Creating a digital strategy was a healthy activity for the organisation and developed discourse regarding new concepts, technology and social trends” (Reflective Journal). A participant notes of the digital strategy:

*It has taken this long to cement a strategy, which shows how complex it is. I think only people really teaching it is at the forefront of what it is and how it fits into the business. But I don’t think it is as complex as much as people make out. I think is just another part or delivering on your business strategy in general. This is a tool or plank in that strategy.*

This strategy was adopted by all areas of the organisation and represents consensus, where previously there was ambiguity in the form of many discrete and isolated digital channels belonging to separate departments. At a strategic level, previous to the formation of this strategy, there was only uncertainty of ‘what to do with digital’ until a competitor or leader within the industry took visible action. As one participant describes “we like to smartly follow industry competitors”. The organisation has since received industry recognition for their initiative as a digital strategy leader in the form of:

- The mobile application created as part of the project was awarded ‘Best in Class’ at the *Global Interactive Media Awards 2015*;
- The mobile application was awarded a high score (26/30) on the *Moodie Reports APPraisal 2015*, making the project outcome one of the highest of all scorecards for any airport ever; and
- The AAC was awarded the ‘Best Airport in Australia/Pacific’ by *Skytrax, World Airports Awards*; and
- The AAC was awarded the 2015 *Brisbane City Council’s ‘Digital Strategy Innovation Award’* for its digital strategy leadership.

The digital business strategy now underpins daily value creation. In the last 18 months since the AR cycles ended, the AAC has launched multiple products and services which align to their digital business strategy – allowing the organisation to move autonomously from market leaders.

**Discussion**

As evident in the findings, the AAC is now in a position of leadership with increasing interest from within the industry for its digital strategy. From an external perspective, the AAC can be described as having foresight. What this research reveals, is that this foresight is an outcome of a design process, applied within the framework of DLI.

DLI is framework for developing design capability (Bucolo et al. 2012). Within this case study, DLI was not applied as a deliberate form of sensemaking but rather to drive radical innovation within the organisation, in doing so building design capacity. The findings reveal that the implementation of DLI shares implicit similarities to mandates of sensemaking (Table 4). These similarities provide an opportunity to learn from another field that shares user-centred ambitions and has particular emphasis on individual units of
interaction (Dervin, 1998, p. 39). This is important as the DLI framework operates at a domain level with emphasis on where design is implemented within an organisation (see Figure 3). The framework overlooks how an innovation catalyst must develop and manage knowledge at an interpersonal level. Mandates of sensemaking provide an avenue to strengthen this conceptual weak point.

Future implementers of DLI (innovation catalysts and organisations) may learn from and explicitly apply methodological mandates, methods and techniques of sensemaking to enhance interpersonal interactions within organisations. These proposed opportunities to connect sensemaking to DLI are discussed in Table 4. This discussion is a set propositions only at this time and is therefore a platform for future research.

<table>
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<th>Table 4  Discussion</th>
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<td><strong>Findings</strong></td>
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<td><strong>Bridging gaps in customer insight</strong></td>
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<td><strong>Attend to emotions and feelings of the user</strong></td>
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<td><strong>Gaining approvals</strong></td>
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| The need for consensus | Manage fluidity | Stakeholders within the AAC are influenced by the changes (and progress) in their own projects on a daily basis. These changes inform how they view the possible rationale of a digital strategy. The innovation catalyst must iterative, meeting with stakeholders in cycles to gather insight then share these insights. | People and environments may be different from the previous day. Therefore, the sense maker must be willing and equipped to know why change occurs. Iterative cycles of DLI currently serve to build insight over time (in an outcome orientated way). Here, an innovation catalyst can learn from and apply sensemaking to strengthen retrospective analysis and reflection as part of problem framing and solving |
Conclusion and Implications

DLI is future orientated with a rationale to create positive change through outcomes of the design process. Sensemaking is retrospective with a rationale to continually develop knowledge and empower people. The two are similar at conceptual and theoretical levels, but also distinct. Pairing aspects of sensemaking within the design process, completed by the designer or innovation catalyst (within DLI) is an opportunity to strengthen reflective practice during the design process. This proposition is an area for future research. It is recommended that such research is practice-led in format as sensemaking requires deeper insight into the activities of the sense maker. The similarities between sensemaking and DLI identified within this paper are recommended as a starting point for this type of research.

The following implications are articulated:

- DLI, while future orientated and effective for company innovation performance, lacks guidance for how an innovation catalyst should manage interpersonal relationships during the design process;
- Reflective practice during the design process presents an opportunity to connect with sensemaking methods and techniques, and;
- Future research is required to continue building a relationship between DLI and sensemaking.

These implications provide value to individuals and organisations seeking to build design capability or aiming to establish strategic foresight, particularly as DLI as a framework tends to focus toward a domain level. These implications are also valuable to the academic community, as a link between DLI and sensemaking provides a rich avenue for future research where sensemaking is consciously applied during the design process.

References


About the Authors

Dr Rebecca Price is a Post-Doctoral Research Fellow at Delft University of Technology, forming part of the EU funded Horizon 2020 research project, PASSME. Price’s research explores strategic design with emphasis on the challenge of digitisation.

Dr Cara Wrigley is an Associate Professor Design Innovation at the University of Sydney, residing in the Design Lab - an interdisciplinary research group within the School of Architecture, Design and Planning.

Dr Judy Matthews, Senior Lecturer in QUT Business School researches and teaches problem framing for creation action and innovation management, and is an enthusiastic advocate of human centred design, excited by new developments in the application of design-led innovation.
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Residencies by Design: a study into co-designing future programs with museums

COULSON Saskia and VALENTINE Louise*

University of Dundee, United Kingdom
* Corresponding author: S.M.Coulson@dundee.ac.uk

This paper offers an advanced conceptualization of what the future of design residencies in museums could look like. It details two co-design workshops devised to engage with people who would be most affected by a new residency model: one was held with past residents and members of staff at the Design Museum in London; the other was held as an exploratory workshop with a diverse group of designers from or based in Scotland, together with members of staff from V&A Museum of Design Dundee. For both, the overall aim is the same: that the groups use human-centred design methods to ideate collective solutions for a future residency. By combining the propositions from these co-design workshops possible solutions (i.e. concept development) are further developed and described with emphasis given to how this can have wider relevance in design management and affiliated research.

keywords: museums; residencies; co-design; concept development

Introduction

As the world changes, so do perceptions and this impacts on how individuals engage with each other, their environment and their experiences. The fast-paced changes in conceptualisations of individuality and society are slowly beginning to be reflected in the fabric of organizational systems. One need only consider the standard practices of museums to see this stasis at work. Within this sector, a reluctance to change is demonstrated in the transmission model of information, which is more commonly found than participatory engagement. As society becomes more familiar with the growing experience economy (Pine & Gilmore, 1999) and bespoke offerings pioneered by the commercial industry, so the status quo of cultural provision faces an increasing challenge.
Museums must take into consideration the value it provides to its primary stakeholders. This new position affects the way museums consider their offering to visitors and the public, and requires them to rethink their long-standing and mutually beneficial relationship with those working in the creative economy. Museums are positioning themselves as a site for research, development and production. This is exemplified by the rise of experimental spaces in internationally renowned museums, such as; New Inc at the New Museum in New York City, The Pavillon at Palais de Tokyo in Paris, and the Sackler Centre at the V&A. Museums have altered their offerings so that they are considered relevant to these new perceptions (Hooper-Greenhill, Miles & Zavala, 1994). This strategic shift has led to an accelerated development in the provision of public programmes which engage with creative professionals. Specifically, the notion and provision of residency programmes which have gained increasing attention over the past decade, as this method of involvement is perceived as critical to achieving the wider aims of the institution, while meeting government objectives of supporting the creative industries for economic growth. These demonstrations of live-action creativity further strengthen the links between the growing economy and museums’ strategies that aim at replacing products and services with engaging experiences (Bishop, 2004).

This study intends to demonstrate possible pathways towards an enriched understanding of design in this future context, illustrating how co-design may support organisational innovation and foresight in a new museum.

Foresight by Design: a museum perspective

Designers are primarily concerned with what is possible, which forever drives the field towards finding better solutions to the problems of everyday life (Buchanan, 1998). This research aims to demonstrate how design research might be employed in the concept development phase for new products and services for an emerging museum. As Manzini (2016) asserts, ‘[b]efore being a technique, design is a capacity for critical analysis and reflection, with which design experts produce knowledge, visions, and quality criteria that can be made concrete in feasible proposals’ (p. 54). This research seeks to identify the strategies involved in structuring a residency programme which supports the development of innovation in practice, both at an individual and organizational level. As an interdisciplinary project, it exploits the strength of design research: its belief that design is projective and powered by its ability to create new possible futures (Jonas, 2001; Krippendorff, 2006).

For this reason, developing a new programme has required innovation. It has been argued that design thinking is the shaping of ideas into practical propositions, leading to competitive advantage in the marketplace (Martin, 2009). Indeed, there has been a marked proliferation of the use of design thinking in a wide range of contexts beyond those considered to be traditional fields of design (Kimbell, 2011). This has filtered through to the creative economy, giving rise to a number of studies exploring design in the

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115 This research contends that ‘residency’ denotes the provision of time and resources to innovate in practice, subsequently resulting in new knowledge and/or objects, events or services from which the resident, participating individual and host organization can benefit.
creation and development of products and services (Pisaki, 2007; 2010; Pitsaki & Rieple, 2011; Rieple & Pitsaki, 2011; Mitroff Silvers, Rogers & Wilson, 2013; Mitroff Silvers, Hamley, Trinh, Lytle-Painter, Ludden & Lee, 2014). With this, there is an opportunity to use the transformation in design theory to consider the way that the residency is perceived.

The objective of this research is to further interrogate and develop the concept of a design residency by considering its key audience: the design profession itself. It is to illustrate how the knowledge gleaned thus far is embedded into the next iteration of concept development: that is to say, ‘a new model’ of residency provision. This objective is realised by facilitating two co-design workshops with two British design museums, both world leaders in the cultural field, and both seeking to engage in the creation of new future design residencies. Co-designing a new model entails testing, building and projecting the concept of a design residency. This mode of concept development demands that in order to develop a vision of what a future residency can be, those who are affected by its consequences must be brought in at the phase in which initial design ideas are created.

**Research Approach: co-design**

Co-design is used to generate ideas for a fourth model of residency provision, employed because it enables those who have the experience and knowledge on a specific subject to collectively inform, ideate, and conceptualize within the early stages of the design process (Sanders & Stappers, 2008). It attends to those who are on the receiving end of the design process to ensure their needs are met by the end product or service (Sanders & Stappers, 2012). Co-design is the approach used in the collective concept development of a future residency, and serves as the generative phase of the co-design process.

This research uses co-design to bring together professional designers with members of staff from the museums to becoming co-designers in forming the future provision of a design residency. It provides the means to collect and analyze the resulting rich and complex data. Since each industry partner approaches the notion of a future residency from a different perspective, it is necessary to design and analyze the workshops differently, and reflect the objectives of each accordingly.

**Design(ing) Residencies for the Future: Design Museum**

The Design Museum’s *Designer-in-Residence (DiR)* programme remains one of the only residencies devised for designers (specifically, recently graduated designers). In 2016, the Design Museum moved to a new home: the Commonwealth Institute in Kensington, London. For this relocation, it secured £20 million to renovate the existing building and tailor it to suit the needs of the organization. As part of the redesign of this building’s interior, senior management chose to create an on-site residency studio embedded into the museum’s permanent collection gallery. This change generated important moves, including the residency migrating from the Exhibitions Department to the Learning Department. This adjustment offered an organizational rethink of the programme. The changes, together with the shifting landscape of design, necessitated further consideration to determine how a design residency can be reframed to complement this new vista.
This workshop took place at the Design Museum Shad Thames building in November 2014. Workshop participants (n=12) included designers from previous and current years of the DiR (n=4), as well as museum staff from the Learning (n=4) and Exhibitions and Collections departments (n=4). In support of a future dialogue, the author designed a series of tools to facilitate conversation and focus [Figures 1-4].
Figure 1  Residency Proposition tool - Worksheet template. This tool enabled workshop participants to detail their needs and expectations for the new Designers in Residence programme. On the left hand-side, there are spaces to detail the drivers of change used as the initial point of concept development. Below, there are spaces to allow the groups to consider the factors that create the context for the design residency.
Figure 2  Residency Proposition tool – Roundtable Group 1
Table 2

<table>
<thead>
<tr>
<th>Features and benefits</th>
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<td><strong>Residency Proposition</strong></td>
<td><strong>Qualities</strong></td>
<td><strong>Audience</strong></td>
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<td><strong>Resident</strong></td>
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<td>Improved design skills</td>
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<td>Enhanced collaboration</td>
<td>- Enhanced collaboration</td>
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<td>Access to design network</td>
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<th><strong>What it offers</strong></th>
<th><strong>Useful to whom</strong></th>
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<td>Increased knowledge</td>
<td>- Increased knowledge</td>
<td>- Improved resilience</td>
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<td>Increased design skills</td>
<td>- Increased design skills</td>
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<td>Access to design network</td>
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**Figure 3** Residency Proposition tool – Roundtable Group 2
Design(ing) Residencies for the Future: Discussion
Discussion was highly concerned with the transformative context of design: co-designers considered the representation of design to be moving away from the object, and the implications this would have on a residency programme. It focused on learning and the
ways a new design residency could demonstrate process and engage with the museums visitors. It also examined the process, and formed a new framework for the design residency which reflects the design process: co-designers considered how this could be flexible to allow for different levels of audience engagement and various kinds of projects. However, there were three overarching themes in all groups: the role of the audience, new design disciplines and exposing the process. The following discussion examines each in more detail.

**Role of the Audience**
To meet the strategic objectives of the museum, there is a need for the public to have a more significant role in the DiR. The groups considered at which points audiences could be engaged, what an innovative course of action would look like and how the audience could have a stronger impact on the resident and residency outcomes. The preliminary residency development stage could be audience-led, it was suggested, and new stakeholders or target groups could be involved in this process. One group proposed the public be brought into the initial stages of the process, aiding development of the residency brief through open events held in the residency studio [Figure 1]. Aligning DiR closer to the existing programme, the audience could play a more significant role in the selection process. Another possibility is to have a selected community define a ‘real-world’ challenge as well as the prospective designers’ pitch, potentially resulting in a buy-in from new audiences. Audience-as-client was considered for the duration of the DiR programme. Responding to the reality that audience(s) become more involved once the designer inhabits a residency studio, the co-designers deemed the resident be open to engaging and working with members of the public [Figure 3]. This is noteworthy, as this ‘collaborative’ mind-set reflects the foregrounding of learning and engagement provision taking place as the Museum prepares to move to its new location.

**New Design Disciplines**
Here, discussed centred on complex ideas about how changes in design and shifting definitions of ‘designers’ could influence a new DiR model. Co-designers examined the traditional residency models which cater for traditional design education and traditional design, the kind of processes which exclude ‘design for the other 90%’, and discussed how, or if, future DiR programmes should work around that. An alternative view on the residency was proposed: to recruit a practitioner not trained through normal pathways of design education, but brought other professions into the equation (e.g. engineer, entrepreneur, or even a company) who use a process of design thinking in their approach [Figure 2]. This conceptual model of a collaborative residency would expose the cross-disciplinary nature of design. The designer could take on the role of the facilitator, thereby

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116 These themes were collectively arrived at during the final phase of the workshop which incorporated group presentations, further discussion and comparative analysis of the group’s discoveries through the Residency Proposition tool amongst all the participants.

117 This is a reference to the Cooper Hewitt Smithsonian National Design Museum 2010 exhibition Design for the Other 90%, which explored ‘the growing movement to design low-cost solutions for those not traditionally served by professional designers’ (source: www.nationalgeographic.com/exhibits/2010/04/28/design-other-90/).
using the residency programme to interrogate the traditional view of the designer as ‘creative genius’.

**Exposing the Process**

As the Design Museum’s DiR programme prepares to strategically move from Exhibitions to Learning, there comes an increased focus to showcase the design process. This raises questions about the future of the programme, some of which can be posed here: firstly, how does the Museum show the process of the design residency? How does it feed into the research community? How can the museum expose the complexity of the design process so that it is clear to visitors? And with emergent disciplines and more traditional processes, what really happens in a design studio, and how can this be displayed in an interesting and informative way? This provides a new perspective from which to discuss the design process, particularly of key concepts that designers must negotiate on a daily basis - for instance, responding to a brief, or working collaboratively with other designers, non-designers and clients.

The physical ramifications of a residency studio embedded in the museum is perceived to change the way design process can be communicated to visitors. There are real benefits to a studio in the heart of London, and the exposition of work to half a million people [Figure 3]. Certainly, the exposure offered to residents in the new design studio will influence the way the design process is communicated to the public, but how it attracts designers to apply, since this forward-facing role will impact the designer’s experience of the residency.

**Designers-in-Residence Concept Development**

A new approach to the structure of the DiR programme was devised based on modules which represented learning outcomes for the Design Museum, the resident and the visitors. Module One is where the brief is set: normally, this is the task of the Design Museum, but their idea for a new approach would use co-creation with the audience or specific community to develop the brief. This approach could possibly deepen these stakeholders’ engagement and offer a different perspective on public programming. Module Two is where the proposal would be submitted, and perhaps would be assessed by some of the initial external partners. Module Three would be the negotiating phase, where brief and proposal are merged and the residency is formed. Module Four is the R&D phase, where new ideas are formed and iterated through prototyping. This would be the phase where the designers’ process would be revealed through learning and engagement activities with the public. Module Five is for final stage prototyping and the production of solutions [Figure 4]. This staged development of the residency would allow the DiR to emulate the phases between R&D to production. However, it also encourages the resident and Design Museum to critique and question some of the assumptions associated with design: this would encompass important aspects of design, like the brief, and negotiating with clients, suppliers and sponsors, which often goes unquestioned by industry.

One idea was to expose the value of ‘the brief’, revealing how it is generated (perhaps using a workshop method with audience groups to unpack it as a concept while simultaneously engaging with museum audiences), or to reveal the collective side of design in a creative way, like allowing the resident(s) access to work with the curatorial team [Figure 4]. Another idea was to pair the role of a designer to the Design Museum’s
role in a cultural context, to unpack some of the larger questions for future design practice. Interestingly, this five-stage process reflects the way the design process is communicated in industry, with a strong focus on forming the problem through co-design at the initial stage of the residency, which would result in a design brief, after which the resident designer would develop the solutions at two later stages: prototyping and design development.

Having discussed the main ideas that arose during the Design Museum workshop, the next section examines the workshop conducted in partnership with V&A Dundee.

**Residency Workshop: V&A Museum of Design Dundee**

V&A Dundee aims to be an international centre for design by celebrating and displaying Scotland's past and present achievements, both in its rich design heritage and iconic contemporary design. One objective of this overarching aim is to develop a new and innovative residency model as part of its Design-Led Business Innovation programme (DLBI). It seeks to have a residency programme that will encourage creative professionals to be strategic, have a better understanding of their own skills, and work collaboratively with businesses to engage in the process of design.

![Figure 5 Discussion tool. Topics for discussion were devised in the initial phase of the workshop. The co-designers broke off and self-selected a topic to engage in further discussion. The worksheets were placed on each table to aid in documenting the discussions. After the table discussions had taken place, a full-room discussion took place in which ideas were further debated and possible solutions put forward. Badges to represent all the important elements discovered in previous research were introduced so that participants could decide where these would fit in a new model. © Colin Tennant](image-url)
This workshop took place at the Hannah Maclure Centre at the University of Abertay (Dundee) in October 2014. Workshop participants (n=11) included professional designers who lived or worked in Scotland (n=9), as well as museum staff from the Learning Department at V&A Dundee (n=2). In support of a future dialogue, the author designed a series of tools to facilitate conversation and focus [Figure 1].

**Residency Workshop (V&A Dundee): Discussion**

One question dominated the workshop, which was: “Who is the residency for?” [Figure 6].

![Finding topics for discussion. The co-designers split into groups to consider what the critical topics were for discussion. © Colin Tennant](image)

Discussions around the future residency were framed by this question [Figure 7]. There were three perspectives proposed in considering the answer: 1) the residency would add knowledge and value to the V&A Dundee organisation; 2), the wider Museum community would benefit from engaging or being inspired by the resident; and 3), the resident would benefit from the career opportunities provided by the residency.
What is the value proposition of being a V&A Dundee resident?
How will the Dundee model be different from the London model? The main comparison is V&A Dundee will not hold a permanent collection to which residents can respond. And though the models will be different, there is desire for the two institutions to collaborate. With this in mind, the relationship between the wider programme of V&A Dundee and the residency was raised as a way of combining some of the larger projects and strategic aims of the organization, including the Museum launch. It was proposed the residency could have a relationship with the wider programme of exhibitions and events, and to the DLBI programme. This implies design-related concepts (like design thinking) could be embedded into the residency, and the residency be employed as a mechanism for organisations to invest in design and designers.
Considering the residency in regards to design thinking was seen as equally beneficial to the institution. In particular, hosting a designer to work in-house and engage with visitors could differentiate V&A Dundee’s offering to visitors who wished to understand more about the design process. This type of audience engagement could be considered in marketing terms a ‘unique selling point’ (USP) for the Museum. The residency programme could be interwoven into the wider narrative of the Museum’s ‘story’ by its inclusion in the overall agenda of the organization.

Figure 9  A Business Case for the Design Residency: One group discussed how a new design residency would require a business case to be articulated in their own organizations so that directors, board members and other staff would ‘buy into’ the idea of participating in a design residency. This discussion was captured using the workshop tool and audio recording. © Colin Tennant

It was perceived as vital for designers (who run their own business) to make a good ‘business case’ for doing a residency at V&A Dundee [Figure 9]. In order to do so, importance would be placed on being able to remove oneself from the daily routine of managing a business; otherwise, the residency would not offer the same opportunity for development. A residency also offers design professionals a chance to escape the pressure of the business world and return to the creative practice of designing.

*It interests me what you were saying about a commercial sensibility and making a business case to your company, but the other side of that is [that] I always view residencies as an opportunity to step outside the commercial realm. As a creative, we have a very aggressive regime of getting up in the morning and making stuff all day, and it is a total chance to have the opportunity to reflect. What a successful residency is to me is having that opportunity to reflect on research. (VAP06)*

These core values must work with each other and become the foundation for a new residency programme with limitless potential at V&A Dundee. This idea is the rationale for
considering the democratisation of elements in the concept development, as this demonstrates there is a need to consider how the expectations and values of each stakeholder will shift and transform with each new manifestation of residency.

**Design Residency Concept Development**
A new design residency can be adapted to the needs and ambition of each specific project, and tailored to the requirements of its various stakeholders. What is crucial is V&A Dundee is open to taking risks and prototyping different models.

**A Company-in-Residence**
A Company-in-Residence programme could answer the demand for a business case for the residency. Having a full company in residence is an opportunity for all staff members to experiment collaboratively on new ideas, and innovate as a group rather than as an individual. However, this does not come without its challenges: namely, the six-month residency period (which is standard practice for the V&A), which would mean that staff would be expected, but be unable, to leave their business for the duration of the residency, since demands placed on them by the company would mean they have client projects to deliver.

*The thing about the six-month format is that if you have a handful of clients that are all expecting to be able to phone you and request work, and for six months, I wouldn’t necessarily be able to not respond. But that could maybe be part of the residency, but we couldn’t do that because we have issues with confidentiality.* (VAP05)

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118 This notion of a company-in-residence is not dissimilar to Stefan Sagmeister’s tenet of a year-long sabbatical every seven years, or as he describes ‘[s]even years of work (with plenty of living) vs. one year of living (with plenty of work)’ (SagmeisterWalsh website, www.sagmeisterwalsh.com). Sagmeister himself takes a full year out-of-office sabbatical and relocates to a studio in Bali, where he dedicates his time to the research and development of his own ideas and design passions.
Furthermore, some companies would struggle to move their practice into the museum due to confidentiality issues. However, having a company residency where the residency fee was paid to the company (rather than an individual) could allow company staff members to take turns being a resident at the Museum. 

*I've never seen a residency programme that is open to companies, at least not in this country, and I find that interesting. As long as the fee is enough to cover one person in terms of project time in running a company, I think it would be an interesting exercise in how you would share that in the team. (VAP01)*

It was determined that those who are critical to powering the company should be singled out for a residency to give them the inspiration and drive to continue to do so. V&A Dundee is potentially considering using a six-month timescale as standard. However, this period seemed to be at odds with the way design professionals work, especially those with businesses. Indeed, six months in industrial design is far too lengthy a timescale when considering the concept development of a product [Figure 10].

*We’ve never done a project that was six months: that’s a long time in industrial design and product design. If you are working with a slow company, it might take two years to get the product to the shops, but you’re working in a concept stage for a week to ten days, and that’s that. So the idea of doing one thing for six months sounds to me like a long time. I think it is an interesting prospect, but I wonder what the actual day-to-day endeavour would be. (VAP06)*
As mentioned above in the ‘Company-in-Residence’ section, a few participants also expressed concerns over how this would impact the practice of the designer or firm, as regular clients might not be able to wait for a long period for deliverables.

**Recruitment Process**

In addition to new concept models, there was discussion on the practical considerations of a design-specific residency and how it should mirror the nature of design and design practice: for instance, resident selection based on previous achievements would lay the foundation for what type of residency model is used.

The discussion also questioned whether, in order to promote the programme’s notoriety in the first instance, an internationally recognised individual should be selected for the pre-opening residency programme as a means to bring recognition to V&A Dundee as the building starts to take shape:

- *In starting up, should the first resident be invited because they are established, and could be the ambassador of the development of V&A Dundee and increase awareness of the project? (VAP01)*

Having a resident in place before the opening who is interested in social innovation and its potential impact on the Museum’s development could assist in getting the wider community involved. Engagement of this kind could raise awareness and the feeling of inclusivity for the Museum’s local communities.

- *[The aim is to] bring the city on board for the bigger journey that is ahead. Something that really engages the people of Dundee, and might help those who would otherwise be unconvinced by it, [someone who] understands what it [the project] is all about. (VAP09)*

Furthermore, the recruitment process could be more aligned to the design industry, which uses briefs, portfolios, pitching and discussions to develop projects.

**Collaboration**

Collaboration is a critical part of a design residency. The selection of a design resident is also a selection of that designer’s network. However, the residency would also broaden the resident’s network, as well as that of the organization. The notion of collaboration could play a key role, with an emphasis on securing national and international mentorship projects which would enhance the networks of both the resident and the organization. In addition, mentorship is equated with collaboration, and working with an established international creative practitioner could enhance the reputation of the resident and the development of their practice.

- *Games design is a really collaborative process. So, if it was just me in residence, you would only get a slice of what we are able to deliver. Collaboration is a really important part of our process. Something else that you would have to consider specific to games design is that we are such a young media, so I would like to have some mentorship and to connect to people within games design, and I think the V&A [Dundee] can facilitate that. (VAP08)*
In addition to one-to-one support, having mixer events where designers could meet possible collaborators and then pitch for the residency together is another possible route for collaboration. This notion stems from the current trend in similar events, such as design jams or hack-a-thons, which promote collaborative working [Figure 11].

![Figure 11 Residency workshop discussion on potential collaboration. A group discuss the potential framework for collaboration within a future design residency. © Colin Tennant](image)

For those designers working primarily in commercial businesses, the notion of public engagement is not at the forefront of their decision-making process. However, public engagement can be a core part of launching the building into the community:

> Instead of focusing on something inside the museum, perhaps you can focus on this emerging heart of the city. Which is quite an unusual position to be put into… maybe respond to that in some way, and intervene in a really big way. (VAP04)

This idea of building the Museum ethos through the residency programme resonates well with the notion of embedding the residency into the fabric of the Museum. This thought was considered further by one participant:

> It’s contributing to the fabric of the Museum, and if you are building the Museum, the opportunity for Scottish designers to contribute to that factor is an opportunity that only comes along when you build one […]. The format for that wouldn’t necessarily be under the same funding structure because you wouldn’t have the same overheads; it could be a remote process. (VAP05)

Following this analysis of both workshops, a comparative examination was conducted to analyze the ideas uncovered in each. The concepts highlighted by this comparison are discussed in the next section.
Overall Reflections

Between the two workshops, there was a noted discrepancy in the perceived need or willingness for the residency to have a strong engagement focus. The Design Museum codesigners believed that audience engagement was crucial, and considered ways in which the audience could collaborate throughout a full residency cycle. However, this emphasis could be due to the presence of a higher percentage of Museum staff (particularly from the Learning Department) participating in the Design Museum workshop. Indeed, the codesigners at the V&A Dundee workshop did not perceive audience to be a high priority: in fact, it could be concluded from some of the issues the designers raised on intellectual property that audience involvement might be unsuitable for some practices. However, this skew could equally stem from the higher number of practicing professional designers engaged in the V&A Dundee workshop, who were more aware and concerned about the notion of continuing their business while undertaking the residency.

These differing opinions are important to highlight, as it could be deduced that this strong interest in engagement and the ideas stemming from the Design Museum workshop as a whole were perhaps more representative of the anticipated value of a residency from the Museum’s perspective. On the other hand, the higher number of established professional designers from the workshop in Dundee demonstrates the opinions of designers who are contributing to the existing design industry in Scotland. It must be noted that, given the small number of participants in the Dundee workshop, it would be unwise to generalize this finding to the whole design industry in Scotland, yet these sessions do give insight into individual perceptions of what some of the designers V&A Dundee might be targeting would hope to gain from undertaking a residency. Therefore, comparing the two reveals a possible tension between what is understood as valuable by the Museum sector and what professional designers deem as such.

There were other distinctions observed between the general viewpoints of the workshops participants, and these are equally important to disclose. Most significantly, the participants of the V&A Dundee workshop were more pragmatic about what the possible solutions of a new residency could be. This is a useful aspect of the co-design process, demonstrating as it does the generation of ideas in a real-world context, even if these are being projected into a future context. The participants spoke about the recruitment process, and how this process could reflect the way design is procured in industry: through briefing, negotiation and collaborative development between the resident and the Museum.

On the other hand, the Design Museum workshop participants were keen to explore how the residency procurement process could be more aligned to what exists in industry, but believed this emulation should be used as a method to interrogate some of the elements of briefing that go unquestioned by industry. In academia, research has already begun this critical discourse by examining how the changing design landscape has resulted in a significant shift in the relationship between the ‘client’ and the designer in contemporary practice, and processes for procurement need to reflect these vital opportunities for knowledge exchange (Murphy & Press, 2007). Equally, there is growing consensus that design problems and solutions should be developed collectively and actively over the full
span of the design process (Murphy & Hands, 2012). As such, there is scope for a future design residency to question some of these challenges already facing the design industry. The notion of using the residency to question the design industry can be expanded beyond the procurement process. The residency is a platform to develop a new design concept, with the potential to effect changes in design at a broader level. If the residency is to have a focus on demonstrating process, it could be perfectly positioned to examine some of the more intangible aspects of design, such as design thinking, a shift towards a more collaborative way of working, or design ‘for the other 90%’.

Critical to all three propositions of design residency created during the Design Museum workshop is that none of these necessarily put the designer at the centre of the design process. This has implications of eligibility for the new residency, as it could incorporate individuals or a collective who use design thinking in their ventures, yet are not classified as being in traditional ‘design’ roles. In this case, as the designer is not central and is considered to be on a par with other elements in the model, this allows for an expanded interpretation of who can become a ‘design resident’, and what the role of design is within the residency. From the museum’s perspective, this expanded understanding of whom the residency is ‘for’ is precarious, as the institution will need to build a reputation around the residency programme so as to attract international recognition of its advancements as a cultural institution in the development of design. This will require an open-mindedness to the residency programme, and finding a balance between the needs of design professionals and the industry, which is currently not the case for most residency programmes. As a result, this area of inquiry - which can be posed in question form as ‘Is there a boundary for design in the residency programme?’ - will be a continuing consideration.

Closing Remarks
The co-design workshops provided the opportunity for designers and those working in design museums to discuss propositions for a new residency model. The residency programme was examined from two perspectives: one already in existence, and one in the concept phase. The first workshop was centred on the existing Design Museum, which has had a residency programme for over five years, and has developed an existing programme. The second session was focused on a new organisation, V&A Dundee, which seeks to respond to the current landscape and develop something ‘from scratch’ to provide a unique offering to the design industry, as well as create an evocative cultural programme which can question what it means to have a design residency today. The analysis of findings from these two workshops allowed for further concept development in to how to understand and develop a future residency programme. However, these possible solutions exist only as ideas, and were formulated into a theoretical framework which is embedded in the philosophy of design as part of a full PhD thesis (Coulson, 2016). More research is needed into the development and execution of both programs.

Finally, this research contributes to a growing appreciation as to how design encompasses the subject of what a museum communicates to its audiences, how it communicates that information, a way to think about the way in which exhibitions are curated. It backs a wider argument, which believes that not only is design a way to frame knowledge
relating to the development of cultural products and services, it provides an approach to the strategic management of cultural institutions.

References


About the Authors

**Saskia Coulson** researches how design can explore complex challenges in industry, culture, and environment. Postdoctoral researcher on Making Sense (H2020), previously on Design in Action (AHRC). Doctoral research was funded by ESRC and sponsored by V&A Museum of Design Dundee.

**Dr Louise Valentine** is Head of Employability, Enterprise and Entrepreneurship for School of Art and Design and, Director for the new Design for Business postgraduate programme. She is Editor of ‘Prototype’ (2013) and Associate Editor of The Design Journal.
The connective role of improvisation in dealing with uncertainty during invention and design processes

SARANTOU Melanie* and MIETTINEN Satu
University of Lapland, Finland
* Corresponding author: melaniesarantou@gmail.com

This paper explores the role of improvisation in design thinking for product design processes and design research methods. Improvisation is often at the core of practice-based and participatory design, permitting flexibility. The role of improvisation in the performing arts has received considerable academic attention, however its role in design processes has been neglected, because improvisation is often viewed as the second-best solution to design problems. This paper presents a framework for improvisation by surveying existing scholarship. Additionally, field study data collected between 2011 and 2016, primarily in Namibia and Australia, will be used to illustrate how improvisation is applied by practitioners during their art and design activities. The connective function of improvisation allows designers to negotiate, take risks, unmake and remake formations. This function enables the fluidity of design, to move from one moment in a process to the next, allowing designers to negotiate ways of work during uncertainty.

keywords: improvisation; design thinking; connective; solution

Introduction
This paper frames a concept of improvisation by surveying existing scholarship. Field study data collected between 2011 and 2016, primarily in Namibia and Australia, will be used to illustrate how improvisation is applied by practitioners during their art and design activities. In creative processes ‘improvisation is the way we work’, and improvisatory creativity of skilled practice is a foundation of design work or design thinking (Ingold 2007:...
This paper aims to illustrate the role of improvisation in moments of design thinking during invention. Improvisation also stimulates design thinking moments and their evolution, allowing practitioners to move, in multidirectional ways, from one step in a process to the next. The role of improvisation in design processes is illuminated by the stories of Namibian and South Australian improvisers. The paper draws on field research that is situated in holistic artefact making. Makers are deeply involved in their social realities and they are not distanced from their conceptual and making processes. The improvisatory practices observed in Namibian and South Australian artefact making are guided by forward-thinking experimentation on the one hand and reflections on traditions on the other (Sarantou, 2014). Improvisation is often a response to pressing demands and notions of ‘having to do what needs to be done’ (ibid). Therefore, improvisation is closely related to the way designer-makers work, instead of being only an experience of play. This paper will discuss the methodology employed in the research, followed by a framework for improvisation employing the literature and a discussion on improvisation’s role in design thinking. The four portraits of the designer-makers who participated in interviews will be used to demonstrate how the proposed framework functions in improvisation and Buchanan’s (2015:15) ‘design thinking moments’. The conclusion will indicate possibilities for further research as this paper’s focus is primarily on product design although the topic is relevant to both product and service design.

**Methodology**

Over a period of five years experienced craftspeople, designers and artists were interviewed to gain deeper insights into improvisatory practices and its role in their ways of work. Craftspeople, designers and artists were observed over a period of two months during a 2011 field study in Namibia, while the observations and interviews in South Australia occurred during an artist workshop with 42 participants. Ten individuals were interviewed in Namibia and twelve in South Australia. Six participants, of which four are represented in this paper due to word limitation, passionately narrated their improvisatory experiences. All the general findings discussed in this article derive from data collected during interviews and observations in the field.

Semi-structured questions to guide the loosely constructed conversations between the interviewee and researcher were used, allowing for richer data since the participants could sketch detailed stories that included personal aspects of their life and experiences; information that would otherwise have been lost in structured collection. Interviews lasted between 30 and 70 minutes and were conducted at a venue determined by the interviewee. The data collection methods included field notes, photographs, video recordings and their transcriptions. The identities of the participants are protected in the presentation of this research.

The paper draws on a grounded theory strategy to conduct research using methods of explication and emergence (Charmaz, 2008). Grounded theory is based on an iterative approach and emergent conceptual analysis of data captured in the field, coding supported by memo writing, and theoretical sampling (ibid.: 167). Concepts based in theory was supported by ongoing analysis of the data and adhering to a flexible approach during design research interventions. Thus, theoretical concepts are grounded in the
reality of data, giving grounded theory methodology ‘theory-observation compatibility’ (Corbin & Strauss, 1990:7).

Interviews and observations with practising designers allowed for deeper insights into the way these designer-makers worked and the role of improvisation in their making processes. Participants were not interviewed while they were making (artefacts) and thus their reflections on their improvisatory processes stem from the reconstruction of their making from memories translated via storytelling. This paper approaches the topic of improvisation by employing the selected philosophical approach, enactivism, to generate a holistic understanding of improvisory processes underpinned by cognitive science and experiential knowledge in a ‘complimentary and mutually informative way’ (Colombetti & Thompson, 2008:14). Processes are cognitive and affective structures that work together in embodied states as action, better understood as recurrent sensorimotor patterns (ibid). Improvisation is performative and subjective, ‘the lived experience of complexity’ and thus driven by emotions and personal aesthetic values (Montuori, 2003:238). Designers, as ‘makers, thinkers and doers’ (Buchanan 2015:12), use their cognitive and affective structures, thus design and making processes can be understood as interaction of mind, body and environment (Colombetti & Thompson, 2008).

However, in cognitive science the so-called ‘explanatory gap’ in understanding how to relate first person subjective experience to the third person ‘domain of brain, body and behaviour’ experience have not been adequately bridged (Lutz & Thompson, 2003:32). This presents a limitation in cognitive science research related to improvisation as these processes can only be explained and understood through memories and reinterpreted third-person reports, instead of first-person reports of experiences. The following framework of improvisation is presented by employing the literature to establish the elements that underpin this framework. However, these elements are in a complex and causal relationship with one another.

**A framework of improvisation employing the literature**

*Process, motivation and knowing in action.* In this paper improvisation will be explored as process, but also as part of design as process. Improvisatory processes are viewed through an enactive lens which means that cognition and emotion occur simultaneously and should not be separated, also not from the environment in which it occurs as improvisation responds to stimulus within an individual’s environment (Montuori, 2003; Peters, 2009). Processes emerge from repeated sensorimotor patterns that enable complex actions that are vital for improvisation such as perception, sense making and intuition. On the other hand, all processes are driven by motivation – mostly to discover something (Colombetti & Thompson, 2008; Leonard & Yorton, 2012). Cross (1982) established the difference between the ways designers work as synthesis in contrast to scientists who apply analysis in problem solving. He also explains that designers use solution oriented strategies that stem from their education and the traditions in which their practices are based, allowing them to draw on ‘designerly ways of knowing’ during action or making (Cross 1982:233). Although not opposed to experience and tacit knowledge, improvisation supports this ‘assemblage of parts and of more fluid processes of coming-into-being’ (Ingold, 2007:16).
Experience and skill. Experiences refer to activities and moments that leave lasting impressions on people while it also refers to the accumulation of knowledge and skill over time. Experience is gained from observing and analysing incidents over periods of time. Buchanan (2015:18) explains experience as ‘the accumulation of sensations and perceptions that fill our moments of engagement with products and services’. Experience, understood through the enactive approach, is set in an environment and refers to knowledge that is accumulated over time; perceived, sensed and felt. In moments of engagement experience is informed by sensations and perceptions (Buchanan 2015:18). Professional designers partially draw on their experiences and ‘specialist tacit knowing’ during design processes (Nimkulrat, Niedderer, Evans, 2015:5). Skill refers to doing something well in an expertly manner, often accomplished through the accumulation of experience and knowledge, underpinned by complex entanglements of the old and new, novelty and tradition. However, improvisors are ‘willing to break with the continuity of the old and new’ (Peters, 2009:118). Although improvisation is dependent on skill, it is often seen as something done in a ‘makeshift manner’, ‘making the best of things’ and being ‘the next best thing’, thus it is understood as a deviation from the original or best plan (Montuori, 2003:245). Importantly, improvisation draws on experience on the one hand, while practitioners gain new experiences by embarking on improvisatory processes on the other.

Intuition. Improvisors are driven by ‘quasi-spiritual’ forces and are strongly guided by imagination which is a ‘faculty of intuition’ (Peters 2009:134). Intuition is emotional experiences and automatic emotional judgements to these experiences (Dunn et al. 2010:1838). Colombetti and Thompson (2008) offer the view that intuition is emotional interpretations that allow the swift translation of cognitive translations and emotional states within seconds. Much of cognition processes happen intuitively and outside of consciousness, while knowledge and intuition involve an interplay of knowing and sensing (Sadler-Smith & Shefy, 2004). Thus, improvisation happens in moments of inspiration and realisation (Nachmanovitch, 1990; Ingold, 2007). The ‘inspirational art of interpretation’ lends to improvisation its playful dimensions which are often repetitive as paly is (Peters, 2009:156, 158).

Recognition, promisingness and learning. Interpretations, as part of improvisation, are important activities for social, product and service designers as improvisers find attractive the ‘recognition and re-appropriation of the given’ (Peters, 2009:117). Recognition is the identification of the known and research has shown that it plays a more important role in the execution of high level skill than the functioning of planning or looking-ahead-thinking (Gobet & Simon, 1996). Recognition is underpinned by social and cultural elements as recognition is a basic social need that has been denied to marginalised social groups globally (Honneth, 1996). Social and cultural recognition plays an important role in intuitive function during improvisatory processes that are essentially set in social and cultural environments. While improvisation asks for creative involvement and commitment, interpretation is the ‘recognition of opportunities that add value’ socially or for income generation purposes, Miettinen (2016:7) argues.

Improvisation is an ongoing process of learning and enquiry, ‘learning-in-organising’ that works by drawing on ‘knowledge and personal experience’ (Montuori, 2003:244). Chen et al. (2012) illustrates that promisingness can be learned when designer-makers recognise
how to identify promising ideas which is crucial for seeing through creative ideas. Designer-makers thus have learned, through experience or teaching, to recognise promisingness in environments where resources are scarce and processes are participatory. Promisingness is a crucial step in knowledge-building processes as it facilitates the identification of promising creative directions, thus avoiding the waste of time and other resources (Chen et al., 2012). Promisingness therefore is solution-oriented while the central idea of improvisation is accepting what is offered and, if anything, adding to it (Leonard & Yorton, 2012).

**Thereeness and time.** Improvisors have mastered working with what is ‘there’, the immediate resources available to them, including an important element of improvisation, which is the temporal (Peters, 2009). Thereeness refers not only to the given, immediate ‘natural’, social and cultural environments in which improvisors function, but also to skill, knowledge, processes and materials they have access to. Peters (2009) mentions that thereeness is always presented afresh in creative processes, to lose oneself in distracted actions and moments of improvisation. Improvisation is often connected to the catchphrase ‘being in the moment’ (Peters, 2009:135), but it has several temporal dimensions since it is also referred to as ‘the time of inspiration’, ‘now’ and ‘from the time’ or ‘a moment’, thus coming about in moments that appear to be ‘outside of time’ (Nachmanovitch, 2003:18). The timing to ensure the work of working requires improvisors to act and embrace states of becoming in the multidirectional to-ing and fro-ing that practical work environments often require. Improvisation asks of designers to be entangled with the beauty of intersubjective dialogue in processes where thinking is present, but often outside of itself and the moment of the work. Improvisation requires patience and the ability to judge when is the best moment to act (Peters, 2009:167).

**Change, multidirectionality and agility.** Improvisation is about embracing change and diverging pathways (Montuori, 2003). The freedom of play, to be lost in strangeness, demands of the individual to embrace rigor, exactness and accuracy during the ‘ever multiplying detours of thinking’ (Peters, 2009:161). Although experiences form and inform designers’ actions alongside the traditions they work in, it is improvisation that drives designers from one step to another to ensure fluidity, albeit in multidirectional ways. The ‘practice of improvisation itself is unable to invent a good concept of improvisation’ as it will not guarantee good improvisation to come about (Peters, 2009:147). This statement is based on the multidirectional ability of improvisation, lending the activity to be viewed as playful, spontaneous, imaginative and a second-best solution to the ordered design frameworks that exist. However, Peters (2009) explains that these elements lend improvisors the ability to think on their feet, next to flexibility and agility, navigating the unknown (Leonard & Yorton, 2015).

**Experimentalism, risk and control.** Improvisation is underpinned by experience, traditions and risk taking during experimentation (Montuori, 2003). Experimentalism refers to unfinalised and untried techniques and ideas, but also invention. Improvisors should be bold, have courage to take the next step, embrace uncertainty and believe in their skills and experiences to invest in risks (Montuori, 2003). Improvisation asks of a designer not to be ‘too attached to the outcome’ (Nachmanovitch, 1991:19), but value lies in the ability to ‘tumble into the void in the vain hope that some kind of beginning can be marked’, which Peters (2009) illustrates is the freedom improvisation offers as the ‘enactment of the
The recognition of promisingness as a crucial step in knowledge-building processes assist designer-makers to take successful risks (Chen et al. 2012). The evaluation of risk forms part of the knowledge-creation process on the one hand (ibid.), but improvisation is also perfectly suited for navigating the unknown as a bad idea can form the bridge to new and novel ideas (Leonard & Yorton, 2015). Taking risk often means having to reconsider personal, social or organisational control and overcoming personal fears of failure (ibid.).

**Judgement, failure and evaluation.** The most significant threat to creativity is the fear of failure, but failure should be accepted as playing a role in creative processes, say Leonard and Yorton (2015). The fear of failure can be eliminated if pressures of self and social judgement are minimised. Judgement is on the one hand the ability to make informed decisions, but on the other it may be associated with disapproval. During design moments judgement is a crucial step to determine desirability, feasibility and viability of an innovation (Buchanan, 2015). The final moment in design thinking of Buchanan’s model is evaluation, which is associated with the determination of value and the worth of innovation, on both ethical and political levels (Buchanan, 2015:15).

**Improvisation’s role in design thinking**

Creative processes are constituted of thinking and feeling, action and making within complex environments. Improvisation allows designers to know as they go during their ongoing paths of discovery, making and re-making (Ingold, 2007), thus enabling designer-makers to connect or disconnect steps and moments, think and feel their ways through, move on in whichever direction; backwards, forwards, up, down, inside or out.

Design thinking is an ‘art of creative enquiry’ (Buchanan, 2015:15). The following diagram illustrates how improvisation functions in ‘design thinking moments’ (ibid.). The four design thinking moments of ‘invention’, ‘judgement’, ‘connection and development’, ‘integration and evaluation’ is proposed by Buchanan (ibid.). The diagram illustrates how improvisation connects and disconnects these fluid design thinking moments irrespective of direction.

**Figure 1** This diagram is based on Buchanan’s (2015:15) ‘design moments’. Improvisation is illustrated in design thinking as a multidirectional process that
enables fluidity in design processes, whether connecting, disconnecting or reconnecting design moments

Designer-makers’ portraits
The four portraits of interviewed designer-makers illustrate how improvisation comes into play when designers think through their design processes. Conversations with Samara, Patema, Ciara and Lisa were recorded and transcribed during field studies (January-February 2011, February and October 2016). These designer-makers’ ‘worlds’ (Becker, 1976:703) were observed through their practices in their studios in Namibia, or during workshop settings in Outback South Australia.

The observations and interviews revealed that participants, who were professional or emerging designers between the ages of 30 and 65, were involved in complex, multidirectional art and design processes, especially their improvisatory practices, relating to their social and economic sustainability. This means that the participants were drawing on their design practices for the cultural and material value they gain from design processes. Being in contact with cultural elements and materials supported them socially and emotionally, while economic opportunity was an additional benefit gained from their design activities. The narrative representations of the participant interviews aim to illustrate the social, cultural and economic contexts in which the designer-makers function, while the narrative commentaries support analytical processes for gaining an understanding of improvisation. The narrative approach renders audible the voices of these improvisors, but it also illustrates the sophisticated ways in which designer-makers work despite their marginal circumstances.

Samara
During 2005, in her final year of visual art studies, Samara undertook creative research on Namibian cultural influences, thus returning to the village where she grew up. She interviewed several elders to document traditional Kavango techniques for dyeing fibres and textiles. Reconnecting with traditional Kavango artefacts such as baskets, woodcarving and pots became sources of inspiration for her textile designs. Kavango elders and their stories from her ethnic community also influenced her design processes. She explains:

‘I get [these motifs] from traditional baskets that the Ovambo and the Kavango people do and the traditional clay pots that the Kavango and Ovambo people do. They’re normally very bold and they’re very systematic next to each other, eh, in a very registered manner, but I never really try to use it in the same way. I’ll take it, but play around with the repetition just to come up with something different. So sometimes it looks very distorted, but if you look very closely to the motif and the print you will actually realise where I got the print [from].’

Invention, a phase of design thinking, is clearly illustrated in Samara’s narrative. She produces high end designer textiles from natural fibres, and she uses natural dyes and
techniques that she developed over the years, drawing on traditional textile knowledge. Symbols, patterns and materials used in crafts from the northern regions of Namibia also feature in her textile designs. Samara invents by steering away from what she already created or other established forms of textile design (Buchanan, 2015). She draws on improvisation when she feels limited in her creative approaches, or ‘stuck in a little box’.

In finding solutions to her design problems improvisation allows her moments and spaces during which she lets her creative impulses on the loose to ‘play around’ with patterns and fabric dyes. Improvisatory processes allow her to investigate new avenues for the materialities and processes she engages in and experiments with. She says:

‘You know you cannot really have an accident. You can always try to fix something and try to make it interesting. That was really fascinating for me and I enjoyed the whole process of trying to, eh, do something from nothing. And sometimes it’s a flop. It’s not how you imagined it, but then still, you work with it and come to a solution or the solution. And this is, I think, what always struck me, what made it, you know? That grip. It gave me that. It gripped me. I couldn’t let go. I really want to do more of that. Experimenting and just coming up with new ideas all the time.’

Samara acknowledged that her design and making usually include improvisatory processes and experimentation, because they allow creative expression. Her reflection on improvisation illustrates her positive attitude towards experimentation. Apart from intuition, improvisation responds to the stimulus from within her cultural and design environments (Montuori, 2003; Peters 2009). Her textiles speak of ongoing process of learning and enquiry, learning-in-organising by attempting new solutions that draw on her skills, knowledge and personal experiences (Montuori, 2003:244). In Samara’s story she reveals the ‘gripping’ moments during which she finds solutions to her design problems, which motivate her to continue these processes of learning and discovery.

Improvisation, or improvisus, refers to ‘the unforeseen, the ambiguous or the uncertain’ (Nachmanovitch, 1991:240). Samara’s views that a ‘flop’ is not possible and ‘accidents’ don’t exist are brave, because she opens herself up to stimuli in her environment, the unforeseen and ambiguous situations she experiences during making. As a result, improvisation allows her to embrace risk and so her textile design becomes ‘gripping’ and significant experiences during which she embraces uncertainty to find solutions to her design problems.

Samara’s story illustrates that ‘improvisation is spontaneous action that does not depend on a specific outcome’, thus her spontaneous processes are not strained, because she is not obsessively attached to the outcome (Peters 2009:125; Nachmanovitch, 1991:19). Although improvisation is used, in Samara’s case, as an approach to solve design problems, improvisation is often interpreted as happening on the spur of the moment. But in reality, improvisation is a sober, pragmatic activity many designer-makers draw on to overcome limitations.

Improvisation has several temporal dimensions since it is also referred to as extemporisation, meaning ‘the time of inspiration’ (Nachmanovitch, 2003:18). Samara’s narrative illuminates the role of improvisation as being unmeasurable moments in time during which individuals are motivated by immediate stimuli in their environments, such
as cultural patterns from baskets and clay pots (in her case). Other temporal dimensions Samara refers to are that improvisatory practices encourage her to experience moments of making ‘outside of time’, to ‘do more of that’, thereby sustaining her recurring and ‘gripping’ design moments and invention.

Another temporal dimension of improvisation that influences Samara’s decisions while making and designing artefacts is that improvisatory processes assist her in moments of time constraint to find ‘the’ spontaneous design solution. The temporal dimension Samara refers to is the economy of time and the pressing reality that time remains a limited resource in her life and practices. She argues: ‘So a lot of times you have to go through a process of problem solving, and I didn’t have time, so I had to improvise again. So I save time, but I had to improvise at the same time to save time’. In this statement Samara considers improvisation to be moments in time that saves her most valuable resource which is time.

In Samara’s narratives elements of Buchahan’s additional three design moments are detectable. She uses judgement to consider the feasibility of her designs by measuring her time. The design moments ‘connection and development’ are also detected as she considers the usability and desirability of her textiles as she approves the appealing distortion created using overlapping and cleverly-designed patterns in her textiles.

Patema
In reflecting on her fashion design practices, Patema explained her work approach:

‘Sometimes I create something. I see something and then it triggers something in my mind. Sometimes I will just look at a fabric and I will think: “Wow, this fabric will look nice if it is made into such and such a thing.” So the fabric itself, visually I’ve seen it, but it brings ideas into me, of what I can make. And then the idea of adding the ondelela fabric to it just came about, because I remember when I had the linen I cut it, then I looked and there was the ondelela fabric. And I took it, overlayed it and it worked. When I took this [black linen men’s shirt] and folded it, I saw the shape, so this one also came by accident. It’s not like I had intended to, but when I saw that it looks good, then I realised in the process of making that I do this. The design completely changed. So, that is what I do. I improvise by trial and error. I go forwards, backwards, forwards, backwards, like that. It’s my visual perception. If I look at something and it doesn’t please me, then I change it. I go forwards, backwards, forwards, backwards, like that.’

Patema’s story illustrates how stimuli in her environment inspire her to create ‘something’. Similar to Samara, Patema also refers to one of her design outcomes as the result of an ‘accident’. She acknowledges that her work processes are often guided by ‘trial and error’. According to Patema, improvisation is a significant ingredient of her making, yet improvisation is often seen as something done in a makeshift manner or as the second-best solution, a deviation from the original or best plan. However, Patema does not perceive working in such a fashion as makeshift or the second-best solution. This is what she does and ‘the way [she] work[s]’ (Ingold & Hallam, 2007:12). Connected to her intuition, she sees and recognises when something ‘works’, illustrated by the clever way
she added the *ondelela* (a traditional vertically striped Ovambo textile) trim on the hem of a denim skirt. When this skirt is worn the sway of the wide hem, set off with the vertical stripes of the ondelala trim, will create a dynamic and perhaps playful visual effect when it is worn.

Improvisatory processes do not follow planned and ordered routes, but are often multidirectional. Patema explains how she moves in multiple directions during her moments of practising design and design thinking (‘I go forwards, backwards, forwards, backwards’). Her story also illustrates that improvisation is often an ongoing process. The multidirectional dimensions of improvisation refer to a temporality which is not linear. As a result, improvisation cannot be planned – it happens in the moment and is realised in the present. Her working process was determined by how the moment she worked in unfolded. She works unrestricted and free from pre-set expectations, including her own. She allows herself freedom to get done what she needs to do. Improvisation is spontaneous action that does not depend on specific outcomes as both Patema and Samara’s narratives illustrate, but it embraces invention as it breaks with dichotomies of ‘old’ and ‘new’.

**Ciara**

Ciara experiments in the way she does due to the confidence she has in the design skills and experiences she has acquired during her practice. As talented designer she practices both as a fashion and graphic designer. Improvisers have to trust in their design abilities that are shaped by the traditions of rote learning and design training on the one hand, and intuition and imagination on the other, enabling them to take risks and steer into the unknown. For Ciara it is a similar situation and she explains:

> ‘A lot of the times when you do a collection the design seems to change as you work, and I find that interesting. I like how it evolves. You know, you make it better. You keep adding, and maybe you have a new idea, you don’t stick to what you originally had, but if you open yourself to change, uh, it’s how I design. [...] Sometimes you don’t have time to research, you don’t have time to think about it too much, so you’re also taking risk and you go “OK, I have to go for this”, because it has to get done. Under pressure you are a little bit more creative and productive because you take risks. Improvisation does not only have to happen only under pressure, it can also happen with time, so you can have a little bit more time to think about things.’

Elements of risk and openness to change, which is an essential ingredient for improvisation and working through design processes, was present in all the narratives of the research participants introduced in this article (Adamson 2007). All their narratives also reveal their willingness not to obsessively control the outcomes of their artefacts. They are willing to journey via multidirectional avenues to discover new outcomes, solve design problems, grow their practices and explore their identities, as Ciara illustrates. She prefers open-ended processes, creating artefacts through discovery and embracing risks. She seeks out new experiences (‘I have to go for this’) by embracing fluidity and change simultaneously through to-and-fro steps. She prefers to be able to question herself, her
aims and approaches. There is a connection between improvisation and complexities offered through new experiences due to the performative and subjective nature of improvisation. Improvisors are driven by emotions and personal aesthetic values as the stories of all the designer-makers reveal. Within improvisation’s particular temporal dimension, memories, intentions and intuition are combined when designers take on risks during invention.

Another meaning connected to improvisation is to make something up as you go along, which means that an individual’s histories and past experiences guide their intuition, which is always operating in the present to achieve an intended aim which influences or postulates future experiences. The role of experience in improvisation illustrates a positive feedback loop; improvisation draws on a practitioner’s experience, simultaneously, their use of improvisation extends a practitioner’s experience. This is illustrated in Samara and Chiara’s narratives of taking risks under pressure and venturing into new territories of experimentation.

All four designer-makers’ narrative commentaries illustrate that the prerequisites for improvisation, as highlighted by Nachmanovitch, Montuori, Ingold and Peters, are not necessarily determined by free play. For Ciara, improvisation is often part of her working under pressure because ‘it has to get done’. A sense of playfulness is not always present in the designer-makers’ improvised moments, but rather a sense of seriousness and a necessity to get things done during working processes. These pressures are often driven by the need to earn their living or time limitations resulting from artefact marketing and sales deadlines.

However, Ciara acknowledges that rare occasions do arise when improvisation comes about because she is able to allow more time ‘to think about things’, an idea that resonates with Adamson’s (2007) concept of ‘thinking through craft’. This concept is connected to the design thinking moments of Buchanan as it includes invention, judgement and development. All the designer-makers’ processes discussed in this article illustrate how they embrace improvisation to think through their design and invention (for example the use of resources such as skills and materials), while being guided by visual perceptions, critical analysis, judgement and decision making.

Lisa

Explaining the connections between her pottery practices and her design thinking, Lisa’s ideas about improvisation is critical. At the same time, being a skilled potter who humbly refers to her practices as ‘dabbling’, she strongly identifies with her creative practices while she also feels that the people who use her pots should be able to relate to them. In her design thinking Lisa employs moments of judgement, connection and development (Buchanan 2015). She thinks through her craft (Adamson 2007) and design by assessing the desirability of her outcomes, their usefulness and the emotional satisfaction gained from using them (Buchanan, 2015:15). Lisa explains:

* ‘My pots, they’re all little bits of me, so I want them to go somewhere nice. I mean they must feel good when you use them. So if you don’t get that feeling of enjoyment out of something you use, why use it? It’s nice if the shape’s good and it gives you a good feeling when you pick it up. Hopefully...*
The people who buy these things are people who can, hmm, feel a sort of familiarity with them.’

The evaluation of her design illustrates Lisa’s ability to think in designerly ways (Cross, 1982). Although she is critical of the way improvisation works, perhaps due the misconception that improvisation is a second-class design activity instead of a connective tool in design processes, Lisa admits that she uses improvisation as ‘layers of ideas’. She explains:

‘I like to build on what I did before ... it’s not sort of an isolated incident. I don’t abstractly improvise. I suppose I have these layers of ideas which I draw on and some of them are suitable for that situation and some are not. I also have these other layers of improvisation in that they’re already ideas that I have thought about that I could do if I don’t like what I’m doing. There must be some sort of layers, of a dictionary of ideas, in there somewhere to sift through and rearrange.’

Lisa argues that improvisation relates to isolated incidents, admitting that she has some ideas that she may use as an additional solution when she does not like her outcomes. She equates ‘layers of improvisation’ to a ‘dictionary of ideas’, making a connection to thinking and language. However, the use of language is action. This means that her design is action, thinking and remembering. In other words, Lisa associates improvisation with design thinking. Lisa prefers more pragmatic processes where she starts her design with a preconceived idea and her actions do not ‘go off at another tangent’ like some artists. She explains:

‘I think you get the sort of really exciting artists who are really creative and they come up with weird ideas and they really go into it and then they go off at another tangent. So, it’s like a free fling. And then we come back and carry on with the serious work. So, as I work I have an idea and I start. If you don’t have an idea when you start, you’re lost. If you don’t have a preconceived idea about where you’re going and what you’re doing, then you end up not making anything.’

Lisa asserts that some ‘exciting’ artists ‘really go into it’, recognising the ‘being in the moment’ element of improvisation (Peters, 2009:134). Lisa prefers to start with an idea instead of being lost; and then to revert to the next best plan if she does not like her outcomes. She also considers improvisatory processes outside of ‘serious work’, but acknowledges that she draws on the language of improvisation that she collected over many years of design practice to connect at least some of her design thinking processes to Buchanan’s invention, judgement, connection, development and evaluation phases.
### Table 1  Table illustrating which elements of the improvisation framework applies to the interviewees

<table>
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<tr>
<th>Elements of the improvisation framework</th>
<th>Samara</th>
<th>Patema</th>
<th>Ciara</th>
<th>Lisa</th>
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<td>Process, motivation and knowing in action</td>
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<td>Experience and skill</td>
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<td>Intuition</td>
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<td>Recognition, promisingness and learning</td>
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<tr>
<td>Thereness and time</td>
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<tr>
<td>Change, multidirectionality and agility</td>
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<tr>
<td>Experimentalism, risk and control</td>
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<tr>
<td>Judgement, failure and evaluation</td>
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It is difficult to identify the work of intuition in the interviewees’ processes, but all four draw on the first two elements including process, motivation and knowing in action, experience and skill. Not all the interviewees refer to time, but all rely on the elements of recognition and an understanding of promisingness. Lisa, as the oldest of the four interviewees in her mid-sixties, shows little evidence of an open attitude to experimentalism and risk taking, while she prefers her processes to be well-defined and ordered before she starts.

### Conclusion

This paper aims to address the often-ad hoc approaches designers employ in participatory and development contexts. They cope with often scarce resources, embracing the realities and practicalities in their field of work. Improvisation should be embraced as a design thinking activity that enables invention, but also connects the various design thinking phases into cohesive and fluid processes of all designers. The way designers work, illustrated by Ingold (2007) and Montuori (2003), is possible by moving from one step, scenario or moment to the next. Designers have access to multiple frameworks and resources for design solutions in their various fields, but little or no attention has been given to the elements that make these processes possible in practice. It is here that improvisation should be considered a valuable and viable solution instead of a second-best outcome to design problems.

Problem solving that draws on personal design experiences in the field, with backward-looking traditions of practice and memories on the one hand and the forward-looking leaping into the unknown, risk taking, and drawing on imagination and intuition on the other, all belong to the concept of improvisation. Whether organisational environments in need of product-service design, or development contexts in need of social design, improvisation remains solution orientated, an ingredient for ‘designerly ways of thinking’ (Cross 1982), and the connective, but underestimated, tool for cohesiveness in design processes. The potent element of improvisation, agility, does not mean organisational anarchy (Peters 2009), but it should be embraced in all areas of design, including organisational contexts that in essence consists of environments that are driven by participatory processes in need of the optimisation of resources.
Improvisation supports the understanding and management of uncertainty in design thinking and invention. The theorisation of improvisation presents new knowledge about the subject in the field of design. It is essential that improvisatory methods and processes are extended to the field of service design through further research, as well as design research through the development and testing of approaches. The knowledge about improvisation creates a familiarity with the concept, minimising the ‘moments of dread’ that are associated with facing the unfamiliar (Peters 2009:125).

References

About the Authors

Melanie Sarantou is a post-doctorate researcher at the University of Lapland, investigating how arts and narrative practices impact on marginalised women in communities in Namibia, Lapland, Russia and Australia. Her PhD holistically mapped Namibian craft and design.

Satu Miettinen is Professor in Service Design with research interests spanning the themes of design methods in engaging with the Arctic region, service design methods for inclusion, the participatory development of services, socially responsible art and design methods.
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Rethinking the prototyping process for applying design thinking to business model innovation

AMANO Tsuyoshi\textsuperscript{a}; BRASSETT Jamie\textsuperscript{a} and GREEN Lawrence\textsuperscript{b} and HESTAD Monika\textsuperscript{c}* \\
\textsuperscript{a}Central Saint Martins, United Kingdom \\
\textsuperscript{b}Birmingham City University, United Kingdom \\
\textsuperscript{c}Brand Valley, Norway \\
* Corresponding author: syntropylab@gmail.com \\

This research proposes a prototyping perspective in design for business model innovation to facilitate disruption. The value of design-led approach for managing innovation has been recognised under the concept of ‘design thinking’. In the research on innovation, the concept of business model innovation has been discussed as business models started to be acknowledged as a key aspect of managing innovation. Although experimentation for business model innovation is argued to be of importance, how to apply prototyping of design thinking to business model innovation has been limitedly theorised. This research is based on a literature review to articulate theoretically the concept of prototyping in business model innovation. Through the literature review, this research identifies four key dimensions of prototyping in business model innovation: purpose, process, context and engagement. This paper focuses on the Process dimension to interrogate the existing argument.

keywords: design thinking; prototyping; business model innovation; design process

Introduction

Over the past decade, business model innovation has been acknowledged as an emerging subject and a new approach for innovation management in particular (Chesbrough, 2007; Baden-Fuller et al., 2010; Schneider & Spieth, 2013) and more broadly for management of organisations as a whole (Pohle & Chapman, 2006; Chesbrough, 2007; Amit & Zott, 2010; Teece, 2010). The connection with disruptive innovation with business model innovation is widely acknowledged (e.g., Markides, 2006; Chesbrough, 2010; Koen, 2015)
Part of the reason why the interest in business model innovation is growing is that the domain of innovation studies itself has extended from a subject focusing on technology policy to an interdisciplinary subject. As the dynamics and complexity surrounding our society are increasing (Wallner, 1999; DG MediaMind Research, 2013; Hausman et al., 2014), organisations come under further pressure of finding a way of managing innovation to survive (Dervitsiotis, 2012). As approaches to tackle the issue, business model innovation and design thinking are emerging subjects in various research fields such as management (e.g., Boland & Collopy, 2004; Martin, 2009; Lockwood, 2010), innovation studies (e.g., Martin, 2012; Fagerberg et al., 2013) and design methodology research.

As for business models, despite the growing interest, there is still little agreement on what business models are (Teece, 2010; Spieth et al., 2014; Wirtz et al., 2016). Reflecting the diversity of the argument, researchers on business models, Lorenzo Massa and Christopher Tucci (2013) suggest a broad definition of the concept: “the [business model] may be conceptualized as depicting the rationale of how an organization [...] creates, delivers, and captures value [...] in relationship with a network of exchange partners” (p.423; see Afuah & Tucci, 2003; Osterwalder et al., 2005; Zott et al., 2011).

In the research on business model innovation, some researchers attempt to apply experimental approaches (e.g., Sosna et al., 2010; Hawryszkiewycz, 2014), but there is still little research on prototyping and exploration of new opportunities in designing business models (Osterwalder & Pigneur, 2013). Furthermore, the approaches are mainly labelled as ‘experimentation’ (Bucolo & Wrigley, 2012), and the terms, ‘business model experimentation’ and ‘business model prototyping’ are often interchangeably used (e.g., Girotra & Netessine, 2013), or prototyping is argued without the articulation of the meanings (e.g., Chesbrough, 2010; McGrath, 2010). According to design methodology research, however, the application of the scientific approach to complex problems has been problematic (Rittel, 1972b; Schön, 1983; Buchanan, 1992; Cross, 2011). Thus, developing the theory of business model prototyping will potentially enable researchers and practitioners to understand the process of business model innovation further.

**Prototyping in design and design thinking**

The lack of the general definition is pointed out not only about business models but also about design thinking (Liedtka, 2015). Thus, there are several strands in the discussion (Kimbell, 2011; Johansson-Sköldberg et al., 2013), and it is difficult concisely to show the characteristics of design thing. However, former President of the Design Management Institute, Thomas Lockwood, offers a definition of design thinking as “a human centered innovation process that emphasizes observation, collaboration, fast learning, visualization of ideas, rapid concept prototyping, and concurrent business analysis” (2010b, p.xi). This definition encompasses the key features of design thinking that are also argued as applicable to managing the complexity of innovation (e.g., Neumeier, 2008b; Brown, 2009; Martin, 2009).

Although design thinking is a newly argued concept, the complexity of design problems has been argued as ‘wicked’ problems at least since 1970s in design methodology research (e.g., Rittel, 1972a; Buchanan, 1992). The differences in ways of thinking among science, humanity and design also support the argument that design as a methodology is also distinctive from science’s and humanity’s methodology as a discipline (Cross, 2001). It is
argued that design has a different way of thinking for tackling complex problems, and design methodology research turns to develop design as a discipline (Cross, 2007b) or a liberal art (Buchanan, 1992) inherently different from science and humanity. From this perspective, design is not a subject in science or humanity, but a discipline with value for everyone to learn (Archer, 1979; Cross, 1982). The difference influences not only a way of thinking but also the terminology used in design, and the argument of design started to use their own terminology. For instance, in the current argument of design thinking, instead of using a terminology of science such as experimentation, the concept of ‘prototyping’ is often used to represent a feature of the design methodology for managing the complexity of design problems (e.g., Brown, 2009; Lockwood, 2010b; Liedtka, 2015).

Design thinking can contribute to business model innovation as there are some key points in common, and the commonality suggests that the application of the design methodology can be effective also for business model innovation. Prototyping is regarded as an important aspect in the design methodology and process (e.g., Thomke, 1998; Buchenau & Suri, 2000; Terwiesch & Loch, 2004; Hartmann, 2009) as well as a key element of innovation processes in management (Leonard & Rayport, 1997; Mascitelli, 2000; Schrage, 2000; Thomke, 2008). This section reviews the role of prototyping in design and design thinking.

Sanders (2013) asserts that as fields that design contributes to expand, the role of prototyping also changes. The focus of using prototyping was “to help us see what it could be” (p.63), but in the expanded design fields, the focus also expands “to help us […] to make sense of the future” (p.64). For this type of prototyping, prototypes are not simply representations of objects but need to be tools for collectively exploring, expressing and testing hypotheses about future ways of living in the world” (p.64).

As prototyping in this thesis is for business model innovation, which is a new area for the design methodology, the argument in this thesis follows the distinction between prototyping and prototypes and the definitions of the concepts above. Distinctions of prototypes from other concepts are argued in some literature. For instance, interaction design scholar, Lars Erik Holmquist (2005) distinguishes prototypes from mock-ups and representations. In his theoretical framework, prototypes embody functionality, mock-ups show appearances and representations have both of the attributes. In this thesis, prototypes are not strictly limited as the embodiment of functions for two reasons. One is to avoid turning the terminology to be too complex. The other is that this research rather regards prototypes as “learning tools” (Coughlan et al., 2007, p.124).

As for piloting, in the context of design thinking, the main objective of prototyping is to get feedback and learn from building and implementing a product or service (Brown, 2008; Lockwood, 2010). This point is sometimes argued as a distinctive difference between prototyping and piloting, which aims at evaluating the feasibility of the product or service (NESTA, 2011).

Therefore, as long as mock-ups and representations are used for learning, they are perceived as ‘prototypes’ in this research. Further detail will be argued in the following subsections.
A theoretical framework of business model prototyping

This section reviews five conceptual frameworks of prototyping in existing literature to enable this research to theoretically argue about prototyping (McCurdy et al., 2006; Beaudouin-Lafon & Mackay, 2007; Lim et al., 2008; Blomkvist & Holmlid, 2011; Jensen et al., 2015). As various frameworks coexist, there are also various ways to selecting and synthesising the key dimensions of prototyping. However, the main objective of making a conceptual framework in this section is not to precisely represent what prototyping is but to provide a conceptual foundation for the argument of business model prototyping. Thus, the selection and synthesis of the key dimensions are based on the assumption that prototyping is applicable to something intangible and complex problems as various arguments on design thinking do (e.g., Brown, 2009; Lockwood, 2010b; Jobst & Meinel, 2014; Almahmoud et al., 2016). This focus influences the choice of terminology and priorities for each dimension, and also pays more attention to simplicity than precision of the framework. The selected literature spans from Human Computer Interaction, Engineering design, Interactive design and service design (see Table 1).

Human-computer interaction (HCI) researchers, McCurdy et al. (2006) assert that measuring prototypes only by whether they are low fidelity or high fidelity is too simple, and propose five dimensions of prototypes: the level of visual refinement, the breadth of functionality, the depth of functionality, the richness of interactivity and the richness of data models. As their main concern is interaction between computer and the users, the dimensions are set up for how prototypes can be interactive.

Also, in the argument of prototyping in interactive systems, computer scientists, Michel Beaudouin-Lafon and Wendy Mackay (2007) propose a set of key elements of prototyping for interactive design (p.1018):

- representation – the type of the prototype and how it is represented
- precision – how much detail is represented in the prototype
- interactivity - the degree of the capacity for users to interact with the prototype
- evolution – the role of the prototype in the whole expected life cycle

While Beaudouin-Lafon and Mackey see HCI as an interdisciplinary subject among science, engineering, and design, they claim that “prototyping is primarily a design activity” (2007, p.1018).

Other researchers in HCI, Youn-Kyung Lim, Erik Stolterman and Josh Tenenberg (2008) propose a theoretical framework of prototyping consisting of dimensions of ‘filters’ and ‘manifestations of idea’ as parts of prototyping. Filtering dimensions are the focus of design ideas that designers choose to prototype, and manifestation dimensions are how to represent the ideas. In the framework, both filters and manifestations have sub-attributes. The former’s sub-attributes are:

- Appearance
- Data
- Functionality
- Interactivity
- Spatial structure
The latter’s three sub attributes are defined as (p. 11):

- Material - Medium (either visible or invisible) used to form a prototype
- Resolution - Level of detail or sophistication of what is manifested (corresponding to fidelity)
- Scope - Range of what is covered to be manifested

In this framework, what to prototype and how to prototype are considered as two key metrics of arguing types of prototyping.

From a service design perspective, Blomkvist and Homlid (2011) formulate a framework of service prototyping based on expert interviews and literature review. Dimensions in the framework contain purpose, position in process, author, audience, validity, technique, fidelity and representation. While the frameworks from HCI and interactive design tend to focus on how prototypes are developed, this framework pays more attention to the context surrounding prototyping processes.

More recently, engineering design academics, Matilde Jensen, Stephanie Balters and Martin Steinert (2015) reviewed the literature of theoretical prototyping frameworks to formulate a general model of prototyping. Through a statistic analysis of the literature, they identify important themes of prototyping: material, interactivity, visual detail, purpose, surroundings and technology. Although the authors aim to contribute to engineering design, their review includes Blomkvist and Homlid’s work above and the framework also acknowledges the importance of context in prototyping.

Through the review and comparison of the frameworks, this research develops a theoretical framework of prototyping consisting of key four dimensions: purpose, process, context and engagement.

‘Purpose’ is what prototyping is done for, ‘process’ is how prototyping is conducted. ‘Context’ is in what circumstance prototyping is carried out and ‘engagement’ is how prototyping encourages the participants to engage. Context includes participants, environment and culture as the sub-dimensions. Although ‘engagement’ is usually argued as representation, interactivity or fidelity of prototypes, the selection of those attributes depends on how to make the participants engage with prototypes and prototyping processes. Thus, this research uses the term, engagement as a dimension relevant to representation, interactivity and fidelity of prototypes.
The process of business model prototyping
This chapter argues the process of business model prototyping as a key dimension. As we will see, the process of prototyping, as well as the design process, is argued in various ways. While normative process models of both design and business model innovation suggest that prototyping is located in a late stage of the process, the importance of conducting prototyping as early as possible is also acknowledged.

This section discusses the position of prototyping in a design process. Initially, it clarifies a normative model of the design process and business model innovation through literature as a theoretical foundation for identifying where prototyping is located in the processes. These models suggest that prototyping is in the late stage of the process. However, it is also assert that prototyping should be done as soon as possible. The following sections reviews the arguments with the consideration of the relationships with purposes and fidelity.

Prototyping in a late stage
By integrating seminal frameworks of the process of design thinking (IDEO, Continuum, Stanford Design School, Rotman Business School, Darden Business School), Liedtka (2015) proposes three sequential stages in the design process: exploring stage, idea generation stage and testing stage. Prototyping is included in the testing stage. She also mentions the similarity of the steps to the key methods of design thinking proposed by Seidel & Fixton (2013): need finding, brainstorming and prototyping. Glen et al. (2015) argue the applicability of design thinking to the curriculum of business schools, and propose brief steps of design thinking. In their steps, prototyping and testing is the fifth step in six steps. These models commonly locate prototyping in a late stage of the process (see Table 2).

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<td>The depth of functionality</td>
<td>The richness of interactivity</td>
<td>The richness of data model</td>
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<td>• Position in the entire Process</td>
<td>• Author</td>
<td>• Audience</td>
<td>• Validity</td>
</tr>
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In some frameworks of prototyping for business model innovation, the idea generation phase is set before the prototyping phase. For example, Seidenstricker et al. (2014) suggest a systematic idea generation and selection phases for business model prototyping should be conducted before prototypes are actually developed. This point is in line with the process models of design thinking (see Liedtka, 2015).

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<td>Discovery and interpretation</td>
<td>Discovery and interpretation</td>
<td>Discover deep insights</td>
<td>Emphasise and define</td>
<td>Empathy</td>
<td>What is?</td>
<td>Brainstorming</td>
<td>(1) problem finding, (2) observation</td>
</tr>
<tr>
<td>Create</td>
<td>Ideation</td>
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<td>Ideation</td>
<td>Ideation</td>
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<td>Prototyping and experimentation</td>
<td>Prototyping</td>
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<td>What if?</td>
<td>What works?</td>
<td>What works?</td>
<td>Brainstorming</td>
<td>Prototyping</td>
<td>Prototyping</td>
<td>Prototyping and testing</td>
<td>(3) visualisation and sense-making, (4) ideation</td>
</tr>
<tr>
<td>Experimentation and evolution</td>
<td>Ideation and ideation</td>
<td>Prototype and test</td>
<td>Create</td>
<td>Prototyping and experimentation</td>
<td>Prototyping and testing</td>
<td>Prototyping</td>
<td>Prototyping</td>
</tr>
<tr>
<td>Make it real: prototype, test, and deploy</td>
<td>Prototype and test</td>
<td>Create</td>
<td>Ideation</td>
<td>Ideation</td>
<td>Ideation</td>
<td>Prototyping and testing</td>
<td>Prototyping</td>
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</table>

Researchers of business model innovation struggles with finding a process model of business model innovation in management. Thus, they borrow the structure from design (e.g., Zott & Amit, 2015). Although the importance of business model innovation has been recognised, there exists little academic research on the process of business model design, let alone business model innovation (Bucherer et al., 2012; Zott & Amit, 2015). Due to difficulty in finding normative process models for business model innovation from literature in management, Zott and Amit (2015) explore process models in the design literature (e.g., Beckman & Barry, 2007; Bhavani & Sosa, 2008; Brown, 2008) and propose a five step process model for business model innovation: observe, synthesise, generate, refine and implement. Following a notion of Owen (1993), they assert that the first two steps are in the analytical stage, and the last three steps are in the synthetic stage. From the study of entrepreneurship, Osterwalder and Pigneur (2010) also propose a five step model of business model design: mobilise, understand, design, implement and manage. One of the characteristics of this model is that it starts from mobilise, which other models do not often include. Combining the five steps by Osterwalder and Pigneur
with knowledge from their own experience, Bucherer et al. (2012) offer a similar process model: analysis, design, implementation and control. In the study of product development, Frankenberger et al. (2013) propose four phases of business model innovation based on innovation management literature and their case studies: initiation, ideation, integration and implementation. The first three phases are for designing business models, and the last one is for realising it.

By synthesising the models in literature, this research theorises the process of business model innovation with the stages of mobilise, understand, innovate, develop and implement (see Table 3). As it suggests, prototyping is located in a late stage of the process, the implement phase in particular, also in the process models of business model innovation.

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<tr>
<th>Author</th>
<th>Discipline</th>
<th>Mobilise</th>
<th>Understand</th>
<th>Ideate</th>
<th>Develop</th>
<th>Implement</th>
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<tbody>
<tr>
<td>Bucherer et al. (2012)</td>
<td>Product development</td>
<td>Design (an iterative process)</td>
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<tr>
<td>Frankenberger et al. (2013)</td>
<td>Product development</td>
<td></td>
<td></td>
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<td>Implement, Control</td>
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</table>

**Prototyping in an early stage**

Although the process models of design and business model innovation shown in the previous subsection locate prototyping in a late stage, it is also claimed that prototyping in design thinking should be conducted in an early stage (Jobst & Meinel, 2014). In engineering design, Yang claims a “prototype is an early embodiment of a design concept” (2005, p.650). Also, in the argument of social service development, NESTA (2011) defines “Prototyping is an approach to developing and testing ideas at an early stage before large-
scale resources are committed to implementation” (p. 6). It is believed that benefits of prototyping in an early stage are saving costs and time of product and service development (Houde & Hill, 1997; McCurdy et al., 2006; Coughlan et al., 2007). These arguments suggest that while prototyping is located in a late stage of design process in normative frameworks of design and business model innovation processes, some literature recognises the importance of embodying ideas in ‘an early stage’ of the process. Although how early it should be does not clear in most of the arguments, the claims conflict with most of the normative models leaving prototyping to a late stage of a design process.

To understand the conflict between the two notions, the relationship of the design process with the purpose of prototyping should be considered. It is argued that the position of prototyping in the design process is connected with the purpose of prototyping (Voss & Zomerdijk, 2007; Blomkvist & Holmlid, 2011; Sanders, 2013). From this perspective, prototyping for exploration tends to be located in an early stage of the design process. As prototyping for evaluation needs to have more specified ideas, it needs to be located in a later stage than exploration (Blomkvist & Holmlid, 2011). Also, prototyping for persuasion is generally located later than evaluation (Voss & Zomerdijk, 2007; Blomkvist & Holmlid, 2011) or at the end of the process (Sanders, 2013).

Process and fidelity of prototyping

Another pattern of the process models of design is that high-fidelity prototypes are used in a late stage, while low-fidelity prototypes are used in early stages. For instance, based on the argument of Skogstad (2009), Vetterli et al. (2012) propose four milestones of prototyping processes following the requirements of prototypes: Critical Function Prototype, Dark Horse Prototype, Functional Prototype and Final Prototype. In this model, prototyping moves from conceptual prototypes to more concrete prototypes. Similarly, Ullman (2009) proposes four classes of prototypes based on the difference of the purposes: proof-of-concept prototypes, proof-of-product prototypes, proof-of-process prototypes and proof-of-production prototypes. In this process model, prototypes in later stages need to prove a more specific issues by higher-fidelity prototypes. Both models indicate the increase of fidelity during the iterative prototyping process. Also, it is argued that “the level of precision usually increases as successive prototypes are developed and more and more details are set” (Beaudouin-Lafon & Mackay, 2007, p.1019). Referring to Sommerville (1995) 2010), Yang (2005) suggests that there are three stages of prototyping in software engineering: throwaway, evolutionary and incremental. In this process, prototypes in an early stage should be designed to be thrown away, and changes in a late stage are supposed not to be radical but only incremental.

In these process models, the purpose and the stage of prototypes are connected through fidelity of prototypes, and the categorisation of prototypes is based on the level of embodiment of ideas. The process models are based on the assumption that ideas represented in prototypes are gradually verified through iteration. This assumption could be controversial when design problems are seen as wicked problems, as the concept of wicked problems assert that verifying the viability of solutions through trials and errors is questionable because of the complexity in the context surrounding problems (see Rittel &
Webber, 1973). Also, the process model with increasing fidelity does not well explain radical changes of the direction in new business (see Ries, 2011; Blank & Dorf, 2012).

The relationship between the purpose and position of prototyping can be also seen in the argument on the relationship between prototyping and piloting. In the context of social service development, NESTA (2011) describes the difference between prototyping and piloting based on the purpose and the position in the design process. Prototyping is in an earlier phase than piloting and the main purpose is to develop services. On the other hand, piloting is located in a later stage of the design process than prototyping for exploration, and the purpose is the refinement of well-verified services essentially for rolling out and scaling the service. Additionally, service designer working with NESTA, Aviv Katz (2011) asserts that the difference between prototyping and piloting as, “there are two main types of prototyping: exploratory (done in early stages of insight and idea generation) and developmental (done after the service has been specified and you know what you’re designing). The former is quick and cheap; the latter requires more planning”. Here, also, the purpose and position of prototyping are interconnected, and even fidelity of prototyping is influenced by the factors. From this point of view, prototyping can be both in an early stage and also a late stage, but the purpose of prototyping needs to shift from exploration to evaluation to persuasion.

**Agility in prototyping**

While design processes based on phases are identified as we have seen above, learning through iterative processes is frequently mentioned as a characteristics of prototyping (e.g., Hartmann et al., 2006; Brown, 2008; Leifer & Meinel, 2011). This iterative aspect is also characterised as ‘agility’ (e.g., Neumeier, 2008b; Mootee, 2013). Agility is a widely used concept as a key element of design thinking for managing uncertainty in facilitating disruptive types of innovation (e.g., Brown, 2008; Neumeier, 2008a; Lockwood, 2010b). Agility is also recognised as an effective element for managing innovation as well as business processes, as it is in effect to manage uncertainty surrounding innovation (e.g., Thomke & Reinertsen, 1998; Bessant et al., 2005). In terms of uncertainty in managing innovation, Christensen (2003) claims that a new market cannot be analysed even by market experts. To tackle the uncertainty, designers build a product or service to learn, not to complete it. Production processes should be flawless, but when you regard production processes as part of learning activities, even failure can be used as a learning opportunity (see Rodriguez & Jacoby, 2007).

Despite the growing awareness on the importance of agility, the meaning of agility in design is not clearly articulated (see Lindberg et al., 2011). Iterative processes are in common with other practices dealing with uncertainty such as agile development in IT development and the Lean Startup methodology in entrepreneurship. Indeed, it is asserted that the concept of agility was originally formulated in the study of software development (Abbas et al., 2008). Larman and Basili (2003) also claim that, through the historical review of iterative and incremental development (IID), using iteration for managing uncertainty is not a new approach for software development. Moreover, not only in IT development and design, there is a methodology of developing business models to a viable business through iteration called ‘Lean Startup’ methodology in entrepreneurship (Blank, 2005; Ries, 2011; Blank & Dorf, 2012; Maurya, 2012). The
methodology encourages entrepreneurs to expect business development is not a linear but iterative process (Ries, 2011).

In the Lean Startup methodology, there are two key concepts, pivot and Minimum Viable Product (MVP), that characterise the methodology. Similar to prototyping in design, the lean startup methodology usually goes through an iterative process. The methodology relies on a launch of a product that is minimally developed to gain feedback from the market, which is conceptualised Minimum Viable Product. After each iteration, the user of the approach needs to interpret the feedback from the market and decide whether to keep improving the current product (persevere) or change the direction of the business (pivot). Pivot is defined as “structured course correction designed to test a new fundamental hypothesis about the product, strategy, and engine of growth” (Ries, 2011, p.149).

Despite the similarity to other approaches for tackling uncertainty, researchers of design thinking, Tilmann Lindberg, Christoph Meinel and Ralf Wagner (2011) argue that, although a core feature of design thinking is described as “iterative learning and development processes” (p.11), agility in design thinking is different from agile development in IT development at some points. First, agile development tends to reduce options, but the iterative process in design thinking is for diversifying ideas. Secondly, agile development in IT development is less collaborative than that in design thinking. From this understanding, iteration in the design approach is not only for mitigating risks but exploring potential opportunities and supporting collaboration with and involvement of stakeholders. When prototyping is regarded as an exploration, iteration or agility is not only for incremental improvement but can be a source of discontinuous changes.

**Prototyping as philosophy and culture**

The previous subsections show the discussions to locate prototyping in a certain phase of a design process. In addition, prototyping is also discussed as a culture and philosophy of design approaches as well as the agile aspect of design. Rather, this research faces difficulty in clearly identifying in which phase prototyping should be. In this regard, this research supports the arguments asserting prototyping as a culture and philosophy of design, and the notion can be applied for business model innovation. From business model’s point view, final solutions can be a prototype in a long term. Also, prototyping is identified as the core of implementation in social innovation (Brown & Wyatt, 2010). In this process, business models can be seen as fundamental tools for supporting the development of a new business. Therefore, the difference between the development and implementation phases rather derive from the level of exposure of prototypes to external stakeholders such as customers and clients. Feedback gained from the exposure can be a key source of learning for developing business models. Thus, implementation can be seen part of business model development. This point is rather close to the concept of ‘effectuation’, which is an attitude of learning through doing rather than planning (Sarasvathy, 2001).

Moreover, for business model prototyping, prototyping for evaluation or persuasion can provide also learning opportunities for exploration due to the complexity of business model development. Thus, it is difficult to identify where the position of business model prototyping should be in the entire process of business model development in advance.
Rather, learning opportunities seem to exist at any point of business model development processes. Although this argument undermines the value of normative process models, such models are useful for convincing stakeholders unfamiliar with the process. For the purpose, the process of design and business model innovation is simplified to clarify the benefits of applying a design approach to complex problems by people outside of the design discipline. This simplification and formalisation, however, also causes confusion of the position of prototyping in the process. Thus, articulating the position of prototyping in the design process as a phase-based model may not be suitable to represent the dynamics in the process.

By contrast to the arguments supporting formal models, some researchers point out that prototyping is part of the philosophy and culture of design (Kauber, 1985; Schrage, 1993; Schrage, 1996; Thomke & Nimgade, 2000; Pering, 2002; Brown, 2005), which also suggests that prototyping is part of the design process from the beginning to the end. This resonates with the space model of the design thinking process proposed by Brown (2008). The space model suggests the interconnections among inspiration, ideation and implementation phases. In this model, prototyping can be conducted throughout the design process.

Overall, while various process models indicate that prototyping is an activity in a late stage of the whole process, some theories suggest that prototyping can be effective in an early stage if the position of prototyping is correctly aligned with the purpose of prototyping and the fidelity of prototypes. Furthermore, prototyping can work as a philosophy and culture of the design process. The process of business model prototyping can be also considered as not only iterative but also overlapped over the entire design process. This understanding of prototyping in design is in line with the notion that design is an agile approach (e.g., Neumeier, 2008; Lindberg et al., 2011; Leifer & Meinel, 2011; Mootee, 2013). While agility is argued as a characteristic of processes, it is also considered as an organisational property or “competence” (e.g., Neumeier, 2008a). When prototyping is regarded as philosophy or culture of design, agility can be regarded as part of the philosophy or culture. Although agility is characterised with the iterative process, it does not explain well about the discontinuity in the prototyping process. The following sections will argue it with the concept of evolution and emergence.

Discontinuity in the process
While iteration is an important characteristic of the innovation process, it is reported by practitioners that most of new businesses go through a major change of direction during the iterative business development process (e.g., Blank, 2005; Ries, 2011). Likewise, it is also asserted that while iteration is useful for incremental innovation, ‘windows of opportunity’ to change get narrowed in quick iterations unless there are interruptions such as unexpected events or new discoveries (Tyre & Orlikowski, 1994). This point suggests that an iterative approach is effective to manage uncertainty, but at the same time how to manage discontinuity in the process has to be considered to successfully exploit the value of the prototyping process as exploration. In practice, difficulty is in making a decision in the conflict between improving the current solution and exploring new possibilities. It is asserted that “there is a tension between evolving toward the final
solution and exploring an unexpected design direction, which may be adopted or thrown away completely” (Beaudouin-Lafon & Mackay, 2007, p.1020).

Regarding design problems as complex problems, each iteration in the prototyping process should include the reconfiguration of prototypes as the business situation dynamically changes and each iteration affects the next iteration (Rittel & Webber, 1973). In other words, each iteration is not the same as it affects the mindset and knowledge of project members is accumulated through the iteration. Thus, the analogy of tornado or a representation of the process in a spring shape is more suitable than a horizontally-recurred circle. Similarly, Lim et al. (2008) assert that the process of prototyping is organic and evolitional.

Although the differences among iteration, increment and evolution are not often argued, software developer, Allan Kelly (2011) divides agile development into three types, which are iterative, incremental and evolutionary development. Iterative development turns large requirements to be small sized requirements that can be managed by short term iterations. In iterative development, predetermined tasks and goals are assumed to be well defined and correct. Thus, even though it uses an iterative approach, all the effort is made for a big product launch and changing requirements is perceived negatively. Incremental development is similar to and based on incremental development, but the product release cycle is shorter than iterative development to gain users’ feedback. Therefore, changes are a positive move and reducing tasks is regarded as saving, although it still starts with predetermined requirements. By contrast, evolutionary development starts with a loose set of requirements, as the approach is based on the assumption that it is hardly possible to identify all the requirements in advance. Not only in software development, specifying required features before prototyping is also questioned in product development (e.g., Boehm et al., 1984; Rudd et al., 1996; Thomke & Bell, 2001).

The process is goal-oriented, and through the process, new requirements and opportunities are emerged and identified. The development has to be measured by how much progress is achieved towards the goal rather than by how many pre-set tasks are done. An important point for this paper is that evolutionary development is a parallel process of creating solutions and discovering new requirements and opportunities. From this perspective, the findings of this research suggest the term, evolution should be intentionally chosen to describe the process of business model prototyping. It is also argued that business models are a subject to evolve rather than something staying in the same state (Chesbrough & Rosenbloom, 2002; Mitchell & Coles, 2003; Gerasymenko et al., 2015). Thus, at least in the context of business model prototyping, the process can be seen as an evolutionary process as the development of prototypes works as an exploratory process for new opportunities.

Following the argument of the evolutionary process, another question is raised; how the emergence of new requirements and opportunities occurs. Some arguments suggest that iterations gradually improve a solution. For instance, Fixton and Rao (2014) claim that “emergent strategy is an iterative process, one experiment leads to another, and to another, in each case closing in on a workable solution” (p.49). As they apparently regard the iterations as experiments, this might not be exactly the case of prototyping, but an issue in emergent processes is that it is uncertain about whether the direction is right or
wrong, and the accumulation of knowledge through iteration is more likely to lead to a fairly radical change of direction (Tyre & Orlikowski, 1994; Ries, 2011; Bogers & Horst, 2014).

Emergence requires deep understanding of the context of innovation opportunities. Peschl and Fundeider (2015, p.142) introduce the concept of emergent innovation, and suggest that the realisation of potential opportunities requires an exploration for a profound understanding on the key contexts. The aim of business model prototyping can be to gain this level of understanding of a new business, and it is expected to lead the emergence of innovation through new business models.

The advantage of the iteration may be to generate the dynamics in the power structure for decision making to widen a window of opportunity to change (see Tyre & Orlikowski, 1994). In other words, iteration is not for gradually validating the parts of business models, but deconstructing and rebuilding the organisational situation for identifying new opportunities for business model innovation. In addition, as the importance of principles and cultures is asserted, simply following the process may not result in intended outcomes.

Conclusion
This paper reviews the arguments about process models of prototyping for managing innovation. While some normative process models are developed in the existing literature, this research identifies the nature of prototyping as a philosophy or culture embedded in the entire innovation process. As there is difficulty in finding the existing literature about the process model of business model innovation (Zott & Amit, 2015), this research contribute to the literature by providing a prototyping perspective to the discussion on business model innovation. This research mainly relies on literature, and further research based on empirical data will strengthen the prototyping perspective for managing business model innovation.

References


About the Authors

**Tsuyoshi Amano** has been interested in how to apply design thinking to business model innovation through prototyping. He contributed to DMI Conference 2014 and Business Model Conference in 2017.

**Dr Jamie Brassett** is Reader in Philosophy, Design and Innovation at Central Saint Martins, and Subject Leader and MA Course Director of Innovation Management.

**Dr Lawrence Green** is Director of Research: Art & Design at Birmingham City University. He worked at Oxford University, Manchester University, Manchester Metropolitan University and Central St Martins. Much of his research activity focuses on innovation and design-related issues.

**Dr Monika Hestad** is founder of the strategic consultancy Brand Valley and an associate lecturer at Central Saint Martins. She holds a PhD in industrial design and brand building. Her research interest is design thinking, branding and innovation.
Introduction: Contemporary Brand Design: Designing meaningful brand experiences

RANCHHOD Ashoka\textsuperscript{a}; NAGASAWA Shin’ya\textsuperscript{b}; GURAU Calin\textsuperscript{c}; SUGIMOTO Kanad and ENSOR John\textsuperscript{e}

\textsuperscript{a} University of Southampton, United Kingdom
\textsuperscript{b} Waseda University, Japan
\textsuperscript{c} Montpellier Business School, France
\textsuperscript{d} Mentor Inc., Japan
\textsuperscript{e} Edinburgh Napier University, United Kingdom

Brands represent inert information unless they are perceived and experienced by vendors and consumers. A brand is not "just a logo or a package. It is a complex set of visual, verbal, and experiential cues supported by media messages" (Landa, 2006, p. X). The classic brand design literature presents and illustrates best practices in developing the physical, graphical and semiotic aspects of a brand. However, both practitioners and academics outline that brand design is only the starting point of the brand strategy, which has to be completed and complemented by designing and effectively managing meaningful brand experiences (Norton, 2003). The success of the brand depends on a value co-creation process in which the intentions and offerings of producers and vendors encounter, and interact with, the customer experiences of the brand and of the associated product (Ambler et al., 2002; Owren, 2013). A brand experience designed for the customer can therefore be multi-dimensional and not just product led.

Brakus, Schmitt and Zarantonello, (2009, p. 53) conceptualize brand experience as "subjective, internal consumer responses (sensations, feelings, and cognitions) and behavioral responses evoked by brand-related stimuli that are part of a brand's design and identity, packaging, communications, and environments". We also posit that brand experiences are directly and significantly influenced by the associated product experience, as the reputation and positioning of the brand depends on customers' interaction with the product through usage and/or consumption. On the other hand, direct and indirect will shape customers' perception, attitude and behavior (i.e. loyalty, avoidance or neglect) regarding the brand and the associated products/services (Brakus et al., 2009).
The aim of this track is to shed some light on the contemporary challenges in designing brand experiences and how these can be understood through case studies, games, logos and future trends.

In *How is brand Experience designed in practice?* Silja Bakker-wu, Giulia Calabretta and Erik Jan Hultink explore the idea of the creation of meaningful experiences through the design of various touchpoints that are in line with brand values. The authors sample three companies as relevant case studies and consider the three stages of brand experience, convergence, transition and divergence. The interviews conducted bring to light the thinking and practical approaches that the companies take at each stage of the process. Their conclusion centre around considering the development of Leading Principles (LP) as an essential step in the design process (Dorst, 2011).

Calin Gurau in his paper *Enhancing Brand Experience through Advergames: A Design Approach*, proposes several models explaining the advantages and challenges of using advergames for promoting corporate, product or service brands. In the paper the author illustrates the way in which players engage with advergames and attempts to understand how games design affects their perceptions and attitudes. The game chosen was Magnum Pleasure Hunt, with three different editions of the game. The findings indicate that the three advergames are perceived differently on various evaluation criteria, an important element being not only the influence of games’ characteristics on player, but also the signals sent by players’ memory – as an advergame is often compared with previous similar experiences. The main gamers design evaluation criteria centred around, audio-visual style, narration, complexity of controls, game goals, character and object structure, balance of user input/programmed rules and spatial properties.

*Franck Celhay in Logo’s textual and visual content: a double anchorage effect,* fills a gap in the literature by investigating how the interactions between a logo’s graphic design and textual content determine the messages that are communicated to the brand audience and modify brand perception. A review of the literature on semiotics, visual art and marketing provides the theoretical framework for this work. Two logos presenting the same textual content but different graphic designs are analyzed from a semiotic perspective and then tested with two groups of respondents. The framework was determined through a review of the literature on semiotics, visual art and marketing. The anchorage effect of logo design is explored. The author provides empirical evidence that the semiotic approach helps marketing managers to anticipate the associations of ideas generated by a graphic design in the minds of consumers. It thus demonstrates that semiotics offers a methodological approach that marketing managers can use to optimize their communication media.

In the paper by Vanissa Wanick, Ashok Ranchhod and Calin Gurau a conceptual approach to understanding brand experiences, now and in the near future is considered in the paper: *Digital Interactions and brand experience Design: A future Perspective*. This paper introduces an overview and positioning of the contemporary brand experience in the digital context. With technological advances in games, gamification and emerging technologies, such as Virtual Reality (VR) and Artificial Intelligence (AI), it is possible that brand experiences are getting more pervasive and seamless. In this paper, the current theories around multi-sensory brand experience and the role of new technologies in the
whole consumer journey, including pre-purchase, purchase and post-purchase stages is explored. Following this, a conceptual framework that promotes a continuous loop of consumer experience and engagement from different and new touch points, which could be augmented by games, gamification and emerging technologies is introduced. A multifaceted approach to brand experience is considered, explored through a brand touch point wheel. This is then analysed further in the light of the new and emerging technologies by attempting to understand how the touch points will evolve and encompass the customer. Finally, the authors make a series of propositions that could be explored empirically in the future.

References
About the Track Facilitators

**Ashok Ranchod** is an Emeritus Professor and currently a Principal Teaching Fellow at the Winchester School of Art. His research interests are in Branding and Games Design. He has published widely in many top journals and has supervised over 25 PhD students.

**Kana Sugimoto** is the president of Mentor Inc., Japan, a part-time lecturer at Waseda University, Tokyo, Japan, and also is a researcher in the area of Design and Brand Innovation Management at Graduate School of Commerce and Graduate School of Business and Finance, Waseda University.

**Dr. Călin Gurău**, Professor of Marketing at Montpellier Business School. He has two PhDs and an extensive set of publications in top journals on strategic marketing and entrepreneurship. He holds various visiting Professorships, including one at Duke University.

**John Ensor** is a Professor in the Marketing, Tourism and Languages subject group within The Business School, Edinburgh Napier University. John is also a Visiting Professor, of the Mudra Institute of Communications, Ahmedabad, India and Member of IPAG Business School, Paris.

**Professor Shinya Nagasawa** is the leading expert in Japan on Design and Brand Innovation Management. He has served on many national government committees, won numerous academic awards, and travelled and lectured extensively throughout Japan, Asia and Europe.
How is brand experience designed in practice? 
Results of a multiple-case study

BAKKER-WU Sijia*; CALABRETTA Giulia and HULTINK Erik Jan 
Delft University of Technology, Netherlands
* Corresponding author: s.bakker-wu@tudelft.nl
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Brand experience is an important concept in marketing because it can affect brand loyalty, brand recall, and brand attitude. Brand experience design is therefore an important practice for companies to create favourable and meaningful experiences, through the design of various touchpoints that are in line with the brand values. This paper presents a multiple-case study of brand experience design in practice. Our results suggest similarities and differences between product design and brand experience design processes. Furthermore, we suggest that reciprocal influences may exist between the brand and touchpoint design. We also provide insights for managers and designers to not only use logical reasoning but also other capabilities to design for brand experiences. Finally, we identified the limitations of our study and interesting areas for future research.

Keywords: brand experience design; touch point design

Introduction

Brand experience (BE) is an important concept in marketing because it can affect brand loyalty (Brakus, Schmitt, & Zarantonello, 2009; Iglesias, Singh, & Batista-Foguet, 2011; Shim, Forsythe, & Kwon, 2015), brand recall (Baumann, Hamin, & Chong, 2015), and brand attitude (Chang & Chieng, 2006). Design serves as an important practice for creating intense, integrated brand experiences (Kent, 2003). This paper presents a multiple-case study of BE design in practice which sheds light on some unique aspects of BE design comparing to common product design process, in particular how the brand interacts with design.

The power of a brand lies in what consumers have “learned, felt, seen, and heard about the brand as a result of their experiences over time” (Keller, 2013, p. 69). For example, the
Lego Group does not only engage with consumers through the brand name Lego, their physical product Lego bricks, but also uses the Legoland parks, The Lego Movie and the First Lego League event to build the brand. Consumers experience all these stimuli as a holistic whole and form their attitude toward the Lego brand. Brakus et al. (2009) conceptualised Brand Experience (BE) as “subjective, internal consumer responses (sensations, feelings, and cognitions) and behavioural responses evoked by brand-related stimuli that are part of a brand’s design and identity, packaging, communications, and environments.” Similar to brand stimuli, a Touch Point (TP) is defined by Neumeier (2005, p. 178) as “any place where people come in contact with a brand, including product use, packaging, advertising, editorial, movies, store environments, company employees, and casual conversation”. Thus, BE is formed by consumers over time through interaction with TPs that are related to a brand.

TPs can be tangible or intangible. Some of them can be designed by the company (logo, brochures); some of them can be co-created with consumers (an event); some of them can only be created by consumers (casual conversation among consumers about a certain brand). This paper defines BE design as the design of various TPs that can be created or co-created by the company with the aim of building a brand.

The existing literature tends to address the challenges of BE design from a single aspect, such as product design, service design or brand design management. While consumers experience various types of TPs as a holistic whole, little guidance can be found about how to coordinate and design these TPs to provide customers with meaningful BEs and to help companies to build a favourable brand attitude. Therefore, the main objective of the study is to explore how to design for BE in practice. In particular, we investigated 1) how does the process look like; 2) how does brand influence TP design, and 3) what are the skills and competences used in BE design.

To answer these research questions, we studied three BE design projects in three different companies. First, our results suggest that BE design seems to follow a three-stage approach that is similar to a common design process but with some differences. Secondly, in addition to the existing literature, we suggest that reciprocal influences may exist between the brand and TP design. Finally, our results also provide insights for managers and designers on the importance of deviating from logical reasoning and complementing it with other cognitive mechanisms when designing for BE.

The rest of this paper is organised into four sections. Section 2 provides a literature review. Section 3 describes the research method. Section 4 presents the research results. Finally, Section 5 addresses discussion, limitation, contribution and suggestions for future research.

**Literature review BE design**

We performed a literature review to retrieve existing research on how design is used in the creation of BE and its TPs (i.e., products, services, brand elements). Therefore, the relevant research fields are: product experience design, service design, and brand design and management.

In design research, scholars have developed many experiential concepts to help designers understand and better design for the product experience (Desmet & Hekkert, 2007).
provide clarity, these authors have introduced the framework of product experience consisting of three levels of internal consumer responses that could be triggered through design: aesthetic pleasure (sensations), attribution of meaning (cognitions), and emotional response (feelings). In addition to these internal consumer responses (sensation, cognitions and feelings), in the management research literature, Brakus et al. (2009) have pointed out the importance of evoking behavioural responses when designing for the desired BE. BE can be evoked by the product but also by other brand related TPs, such as service. Many scholars have addressed the importance of developing specific practices for designing targeted customer experience for service companies (Berry, 2000; Pine & Gilmore, 1999; Zomerdijk & Voss, 2010).

To reach its full potential for BE, design needs to be integrated in a number of company processes, such as the brand management process (Beverland, 2005; Stumpff, 2003), the new product development (NPD) process (Montaña, Guzmán, & Moll, 2007), and the general business process (Newbery & Farnham, 2013). Conversely, the brand also needs to be integrated in the design process. Montaña, Guzmán and Moll (2007, p.829) stated that “if design is guided by the brand, it can serve as the cohesive factor for all that configure a brand experience”. Service design literature has paid more attention to this aspect and offers insights on how to integrate the brand in the new service development (NSD) process (Berry, Carbone, & Haeckel, 2002; Clatworthy, 2012; Owren, 2013). For instance, the three stage Brand Megaphone model developed by Clatworthy (Clatworthy, 2012) shows how a company’s brand and customer experience development can be aligned through the creation of a service personality and the combination of analytical work and experience prototyping.

Literature suggests several approaches that can facilitate the design of various TPs in the context of BE design. Some focus on the semantic transformation –i.e., the embodiment of qualitative brand characteristics in various physical design features of a product, such as the educational approach to design physical products for visual brand recognition (Karjalainen, 2007) and the three-stage Brand Megaphone model for NSD (Clatworthy, 2012). Some emphasize more the integration of the brand in the design process, such as the Brand Value Pillars Framework (Newbery & Farnham, 2013) and Brand Experience Manual (da Motta Filho, 2012). Furthermore, the literature offers different approaches to transforming a brand into a product or service design. Montaña, Guzmán and Moll (2007) proposed that NPD design process should start with the development of a “potential offering” using “internal and external information and stimuli” and use brand building strategy as a guide. Karjalainen (2007) uses the “brand characteristics” from the “language domain” to create design cues of physical domain, explicitly or implicitly. Clatworthy (2012) has adapted Karjalainen’s approach for service design and introduced “service personality” as an equivalent concept for brand characteristics capturing desired strategic associations. Finally, the Brand Value Pillars Framework (Newbery & Farnham, 2013) is the only and the most elaborate approach concerning both product and service design in the context of BE design. This framework introduces the Brand Concept supported by high level value propositions as a new starting point of the design process. Then it uses Brand Attributes, that specify differentiating qualities, to develop various TPs. In this approach, the Brand Attributes are similar to “service personality” or “brand characteristics”.

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Although several models are tested with students (Karjalainen’s design for visual brand recognition) or with companies (the Brand Megaphone) and the Brand Value Pillars Framework is developed based on many years of design consultancy experience, empirical evidence about how designers or brand managers actually work on BE design and how the brand influences TP design is missing. In this study, we aim at providing insight into the BE design practice.

Method

A multiple-case study design is chosen since the intention of this research is to understand the phenomenon of BE design while retaining a holistic and “real-world” perspective (Yin, 2013). The sampling strategy is based on the logic of replication (Yin, 2013). Our literature review indicated that large organizations (LOs) have different approaches to brand management than small and medium-sized enterprises (SME) (Berthon, Ewing, & Napoli, 2008; Krake, 2005). For example, due to organizational structure differences, directors of SME brands may take more decisions on brand management and design than those of LO brands (Krake, 2005). Abecassis-Moedas and Benghoz (2012) found that when design capability is internal, designers seem to be more familiar with the brand values and “provide shorter lead times and reduced development costs, ... design becomes ... more a productive activity that sits at the junction of manufacturing and marketing”. When design capability is external, designers will take extra time to familiarize themselves with the brand; while the advantage can be fresh new ideas. With the aim to find contrasting results for anticipatable reasons (theoretical replication) (Yin, 2013), the companies were selected based on their size (LO versus SME) and the source of design capability (internal versus external). Table 1 provides an overview of our cases.

Table 1  Case information

<table>
<thead>
<tr>
<th>Case</th>
<th>Firm size</th>
<th>Source of design capability</th>
<th>TP design project</th>
<th>Interviewee</th>
<th>Number of interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>SME</td>
<td>internal</td>
<td>In store display</td>
<td>Company founder S (R) Junior designer (F)</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>SME</td>
<td>external</td>
<td>Website</td>
<td>Company creative director R (G) Creative director of design agency F (M)</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>LO</td>
<td>external</td>
<td>Website</td>
<td>Senior brand communication manager (E) CEO of design agency D (T) Senior designer of design agency D (E) Creative director of design agency M (H)</td>
<td>3</td>
</tr>
</tbody>
</table>
The cases are recently finished design projects of specific TPs. These are used as the starting point that enable us to investigate the relationships between the specific TP and the brand in the context of BE design. We selected the projects and identified the interviewees together with our key informants from the chosen companies. Two of the cases are about the redesigns of websites and one case is about a redesign of an in-store display. By choosing different types of TPs, we hope to find either similar or contrasting results between the cases. To obtain a good understanding of the interplay between brand and design, both brand managers and designers who worked on the same project were interviewed.

We used semi-structured interviews to collect data. The interview guide included four topics: the description of a specific TP design project; the actual design activities; the influence of the brand on the project and the evaluation of the outcome. The interview guide was tested and optimized using a pilot interview. As preparation, information was collected about the specific TP design and company through desk research. Data were collected with interviewees in their daily work environment between October 2015 and June 2016. All interviews were taped, transcribed and checked.

We adopted the process of building theory from case study research (Eisenhardt, 1989). The first cycle coding of within-case analysis resulted in 1127 codes using a mix of methods, such as initial, in vivo and simultaneous coding (Miles, Huberman, & Saldaña, 2013; Saldaña, 2015). These codes were then clustered into themes for each case. At the moment of writing, the themes were compared across the cases as a transitional step to the second cycle coding. The next section presents these preliminary findings.

Findings
This chapter presents the preliminary findings of our study. Section 4.1 addresses the process of BE design. Then section 4.2 illustrates the influences between a brand and its TPs. Finally, section 4.3 discusses the skills and competences of designers in this context.

Convergent and divergent process
Our results suggest that the BE design process may include three stages: convergence, transition and divergence, as illustrated in Figure 1. BE design starts with a convergent stage where broad information is collected and analysed with the aim to formulate a “Leading Principle” (LP). The LP is the transition between the convergent and divergent stage. In the divergent stage, the LP is used to design various TPs for BE.
4.1.a: The convergent stage: from broad input to a Leading Principle.

Our results suggest that the BE project may start with the collection of a broad set of information from internal and external sources. This information addressed the past, current and desired future situation of the brand and the company.

In our cases, external sources included shop visits, interviews with consumers and examples from successful brand TP designs. Internal sources were used to gather strategic and organizational information about the brand, existing TPs’ designs, design guidelines, target customers, strategies and organisations. Information about the brand included brand values, brand identity or brand DNA, brand perception, and brand image. Existing designs included the product, packaging, displays, website design, magazines, and catalogues. Two interviewees called them “brand manifestations”. Brand design guidelines included the look and feel of the brands, font, material, form, photography and requirements. In case B, the Creative director of design agency F described strategic and organisational information as follows:

*It is about the positioning in the market, and how they perform against competitors and how differentiating you are in the category, where you can excel or where you can differentiate.*

Our interviewees used different terminologies, such as “brand DNA”, “brand pillar” or “brand identity”, to refer to the brand characteristics that needed to be translated into a TP design. For example, the Creative director of design agency M explained “brand identity” as follows:

*Brand identity is more (about) how the brand behaves, what the brand is and why. That is, of course, very clear in (relation to) competition, target market and what is the identity of the organization.*
All this information was provided in a large variety of forms and purposes (e.g. textual, verbal, visual information, descriptive or inspirational) and transferred to designers through different channels (e.g. a written document or interaction between the client and the designers). In case B, the client conveyed brand values to the designers through workshops. In case C, even “a whole cross-section of the organization” was interviewed to “read the organisation” or to gain input for the BE design, CEO of design agency D recalled:

*(The designers) can “breath in” what they think of the project and the client. That’s not the same as the written briefings, but (information) comes in in another way.*

The designers used both their analytical skills and intuition to create a LP based on the analyses of information. In case C, the LP is used to explain “how” to translate strategy or brand characteristics into a design. The Creative director of design agency M (case C) explained:

> *In between, (there) is a kind of transition... Those (LPs) are kind of design principles that tell the design team how we translate the highest level (strategy), to (a) tangible design, so that the design will actually support (the strategy). ... From this (strategy) level to the lowest (design) level is very difficult, so we always prepare the design principles.*

In case C, the CEO of design agency D, responsible for brand design, explained the LP as “everything that is strategically important, is packaged in a tiny expression”. Meanwhile, the “LP is also found in everything, it is also a design principle which sits in all facets of design” (Creative director of design agency M, responsible for website redesign). Therefore, defining a LP seems to be the transition stage between the convergent and divergent stage.

One challenge in defining LP was the conflicting requirements or paradox that were found in all cases. In case C, the LP was defined based on the paradox of using one service to attract two different target groups (low budget vs. business customers). The senior designer of design agency D illustrated the paradox as follows:

> *A very important input has been that it should be both low-cost but also for business customers. That is a very strange paradox. Because on the one hand, you want to attract business customers, but on the other hand, low-cost, (it is also) for normal people.*

Although our data do not provide sufficient clarity on how the LP is created, we found preliminary evidence for the fact that LP seems to be related to the emotional elements of brand positioning and brand personality. For instance, the CEO of design agency D highlighted the emotional element in this process:

> *We try to touch a nerve by appointing what is actually the personality of the brand? What is the emotional side of the brand? I think that always sounds a bit heavy, but we actually always try to merge content and emotion or rationale and emotion.*
Compressing a large variety of information, sometimes even paradoxical requirements, into a short LP can be challenging. As the LP will be reflected through “all facets of design”, defining it seems to be an essential step in BE design. Using the emotional element of a brand in this particular step seems to be a helpful practice in BE design.

4.1.b: The divergent stage: bringing BE to life through various TPs

Our results suggest that in the divergent stage, the LP may be used to direct various TP designs with the aim to bring BE to life in a consistent way. For instance, the senior brand communication manager from case C explained:

(In this case,) you give the service employees the opportunity to take that responsibility, and take that space themselves to radiate (the) “Leading Principle”. So provide tools to show that we are who we say we are. I think that is really the brand experience that is brought to life.

As TPs can take various forms, the characteristics of the brand are then expressed in visual design, 3D design, content, storytelling and interaction with customers. These various forms of TPs can be related to different dimensions such as time, space, and verbal. In case C, the Creative director of design agency M illustrated:

That the brand is not only the logo, but is in many aspects of manifestation...and then you get to sound. This is a very important carrier of the brand. So that’s the very typical (way) of how M deals with the brand experience, thus it is translated into all kinds, in many dimensions.

The complexity in TP design may vary depending on the strategic importance of a TP. For example, designing company notepapers can be straightforward, while designing a website can be complicated. Despite the different levels of complexity and various forms, consistency across TPs is needed to ensure that the brand will be experienced unambiguously. In case C, the CEO of design agency D explained consistency as follows:

Then, it is not that (the TPs) should all be identical, because consistency is often confused with things have to be identical, ... but that’s just boring. You have to bring the specific (value) to life. So machine looks like this, product, packaging, online, then all (TPs) have to exhale the same spirit.

Our results suggest that BE is brought to life through the use of a LP that ensures consistency across the design of various TPs in multiple dimensions.

Reciprocal influences in BE design

During the BE design process as described in section 4.1, the brand and TPs may have reciprocal influences and the design of one TP may influence the design of another, Figure 2 illustrates two types of influences, which will be discussed next.
4.2.a: Influences between the brand and TPs (type 1)

Our results suggest that reciprocal influences between the brand and TP design may exist in practice.

First, brands can direct TP design. In case B, the design agency F successfully redesigned the website using brand related input. In case C, the CEO of design agency D believed that TPs could not be designed before the brand was defined, and “... you should be working from the principle”. However, the other two interviews revealed that the need to redesign the brand had emerged during the website redesign project. Two design agencies have consulted each other to design the brand and the website in parallel. The Creative director of design agency M recalled:

This was the first collaboration with design agency D. We had to get used to each other yet. We are two DNAs. It took a few weeks, but it went actually quite fast. It actually became a very good cooperation.

In case A, the youngest brand in the sample, we found that TP design helped to define the brand, the Company founder S explained the process as follows:

And whatever you notice with brand definitions, as long as it is abstract and only in words, it is difficult. At a time when you are going to translate it into a product, such as display, brochure or a website then it becomes concrete, you can easily say this material or that material, this shape (fits well) and that shape does not. You get a kind of reversed engineering, ok this is our brand, this is our identity.

An explanation may be that when designing a new TP, especially for a young brand, designers need to make design decisions related to a specific new dimension. For example, the first website design will require designers to think about how to interact with consumers through the interface according to the brand characteristics. By making
these decisions, designers create new facets of the brand, which can influence or add new characteristics to the existing brand.

**Influences among the TPs (type 2)**

Our results suggest that in the BE design practice there may be interdependences in the design of the different TPs. First, it seems that BE design may follow a sequence in the design of the different TPs, where the starting point is represented by the TP with a more prominent role in terms of generating business value and/or determining the customer journey. In cases B and C, the website was an important sales channel and played an essential role in the customer journey. In case C, the Creative director of design agency M suggested that “the digital TPs are leading now. Starting from there, you go to the offline TPs.”

Instead of online TPs leading offline ones, a reversed sequence is found in case A where the product was considered to be the most significant TP. The sequence of TP optimization was: product, packaging, display and website. An explanation of this sequence may be that there is a learning effect in TP design according to the Company founder S:

> Yes, for website you learn from your brochure and your display, (also) for your website, you learn from your product sell, and everything is interconnected.

TPs can be designed in sequence but also in parallel. In case B, online (website) and offline (shop in shop) purchase environments were closely related. The Company creative director R recalled:

> I have done two projects together, both shop-in-shop (and website) ...
> Because what I believe is that these two things, must be connected to each other.

Based on these results, we suggest that brand managers or designers should be aware of and analyse the interrelationship between the TPs, the importance of one TP in relation to the others and if possible make use of the learning effect.

**Designers’ skills and competences**

Our results suggest that designers may need to have the skills to use a broad range of generic design tools in BE design. In case B, the Creative director of design agency F recalled some of these tools as follows:

> SWOT analysis, we make sometimes. We often do interviews, ... persona is actually another way, cultural probe, customer journey... in which we actually look at in what context is the customer... what questions, places, circumstances, references, feelings and concerns (he has), what is the need.

Next to these tools, designers also need to have expertise in different knowledge areas, such as “knowledge of ergonomics, marketing knowledge, knowledge of sales, knowledge of design, knowledge of construction” (case A Company founder S).
Furthermore, BE design requires designers with different background or disciplines to work together. For instance, in case C, functional and visual designers worked together on the redesign of the website.

The involvement of various people, the input from different knowledge areas, and the diversity of TPs can make BE design a complex process for designers. In order to make sense from the complexity and be able to distil a LP, designers may need to empathise with various people who can give input for the design process. In case C, the CEO of design agency D pointed out: “You must have empathy. If you do not have empathy, then it will not work.” In particular, empathic design helped designers to understand their client. The senior designer of design agency D explained:

\begin{quote}
Look, it is also a feeling and the ability to listen. But a customer can say this is good that is not good, but can we tweak that 'not good' slightly based on our intuition? Then it can be good again. That depends very much on what the customer says and how we look at it in a professional way.
\end{quote}

Furthermore, designers also used their feelings in design and decision making. It can also be a challenge for them to communicate their feelings, as Junior designer in case A mentioned:

\begin{quote}
Sometimes I actually had a feeling about something is wrong or right, I just can’t express myself well enough. … I still find it quite difficult to put it in words.
\end{quote}

As feelings are subjective and personal, designers can be uncertain about whether the feeling evoked by a certain design is in line with the brand. In case A, the Junior designer explained how he worked with this uncertainty:

\begin{quote}
And what evokes a certain feeling by one person can evoke another feeling by someone else. So you can never have the full 100% ...so then you need to decide if we are satisfied with 80 - 90%. Yes, this is tough, but also very nice.
\end{quote}

To conclude, our results suggest that BE design may require the use of a broad range generic design tools, expertise in different knowledge areas, empathic design, and ability to work with feelings.

**Discussion and implications**

This paper addresses the gap between research and design practice by providing insight into the BE design practice. Similar to the literature, we found all three stages (convergent, divergent and transition) of a product design process (Hsiao & Chou, 2004; Jones, 1992). However, our results suggest that BE design may start with a convergent stage, rather than with a divergent stage as it generally occurs in the design process of products. We contribute to the design methodology literature by providing initial evidence that BE design may have a reversed process compared to product design.

Secondly, we contribute to the BE design literature by suggesting that defining a LP may be an essential step in the design process. In this particular step, we suggest that using paradoxical input may be a necessary challenge that has not yet been applied to BE design.
before. In line with the design research literature, the paradoxes in our cases represented “a complex statement that consists of two or more conflicting statements- true or valid in their own right, but they cannot be combined.” (Dorst, 2011 p.527). Our results also suggest that the usage of an emotional element may be helpful in defining a LP. Furthermore, our results show that designers have engaged with empathic design to reveal client’s “unarticulated user needs” (Leonard & Rayport, 1997). We provide insights for managers and designers to use not only logical reasoning but also emotions, feelings and empathy in the context of BE design.

Lastly, in the existing brand management and service design literature, brands serve as the starting point of the design process (e.g., Clatworthy, 2012; Montaña, Guzmán, & Moll, 2007). We contribute to the literature by providing initial evidence of a reverse logic, where a company used the design of TPs to iteratively define their brand.

This multiple-case study has several limitations. First, the sample size is limited, and we need to study more cases to achieve “data condensation” (Miles et al., 2013). Secondly, the analysis of data needs to be validated by asking a colleague to recluster the codes and discover potential new themes. Finally, a more extensive literature review is necessary to better relate findings to the existent literature and shed light on how to apply the existing knowledge of product and service design to BE design. Interesting directions for future research can be how to apply paradoxical thinking in defining a LP and how to use feelings and empathy in the BE design process.

References


About the Authors

**Sijia Bakker-Wu** is a lecturer on product innovation management. Her research interests are branding, FMCG, packaging design, supply chain, marketing, project management.

**Dr. Giulia Calabretta** is assistant professor in product innovation management. Her field of research is design management. She is interested in understanding how design skills and methods can be effectively integrated in the strategy and processes of companies.

**Dr. Erik Jan Hultink** is professor of new product marketing, Head of Product Innovation Management Department. His research interests include launch strategies and new product performance, time to market strategies, IT usage and new product effectiveness.
Advergames represent an increasingly popular advertising channel, but the way in which their design influences players’ attitudes and behaviour is still debated. This study proposes several models explaining the advantages and challenges of using advergames for promoting corporate, product or service brands. To explore the design elements that influence the perceptions and attitudes of players, we apply a testing procedure, asking ten subjects to play a series of three games released by Unilever, on the theme of Magnum Pleasure Hunt, and then to evaluate the effectiveness of games’ design using two sets of criteria. The results indicate that the design elements of these games are well realized, but the interaction between these elements and game players is often unsatisfactory. Our findings identify also an interdependence effect, as successive game versions are compared and judged in relation to previous versions, leading to customer bias towards the games’ attractiveness and novelty.

*keywords: advergames; brand experience; state of flow; interactive elements*

**Introduction**

In traditional marketing, brands are designed as an optimized solution to several problems: to distinguish an organization and its offer from competition, as well as to provide a representational platform for customers in order to identify, perceive, recognize, memorize, and act upon this organization and its offer. These processes attempt to transmit and reinforce in customers’ mind a certain meaning, but the large possibility to interpret a sign raises important challenges for both marketers and designers:

*Both interaction designers and information architects want to design objects with a singular meaning – a noble, albeit impossible goal. The best*
we can hope for is to create more consistently meaningful experiences. To do that, designers must better understand the interplay between designer intention and user interpretation: the ways that we can influence – but not dictate – user interpretation (Wendt, 2013).

The way in which an experience is perceived and interpreted in real life is hard to control, for several different reasons: first, external circumstances – such as the context, can influence the perception, experience and interpretation of a situation or artefact; second, customers’ state of mind and their memory dynamics can associate the experience with a wide range of emotions; finally, the interaction between the design object and customer can vary depending on customers’ experience, skills, abilities and/or intuition. The possibility to control at least a part of these influencing elements is provided by immersive virtual environments. In advergames, the designer builds around brand signs and symbols a dynamic universe that uses interaction and automation to tailor the online experience in relation to various users. Despite the enhanced possibilities offered by virtual reality, designing the online interaction to achieve a specific type of experience depends on several elements that are still not fully understood: users’ propensity to play the game, reaching and maintaining a state of flow, and the effect of playing the game on consumers’ behaviour in real-life circumstances. In this paper we identify and address an important knowledge gap, exploring the place of advergames in modern marketing, defining the elements that enhance consumers’ experience, and the way in which they are creatively applied in three advergames, used as illustrations to the theoretical elements discussed in the first three sections of our study.

The paper is structured as follows: First, we discuss the present situation of advergames as an increasingly popular medium of marketing communications, and we distil, from previous studies, the characteristics of a well-designed advergame. Second, we present the psychological mechanisms that influence users’ experience of an advergame, and how this experience can eventually impact customers’ intentions to buy and experience the product. To better understand the relation between various decision-making processes involved in playing, buying and consuming, we combine in this section three theoretical models that are relevant regarding consumers’ behaviour: the state of flow model, the theory of reasoned action, and the AIDA model, concerning the effect of marketing communication of consumer’s intention regarding a product or service. Third, we outline the methods applied to collect and analyse secondary and primary data. Fourth, we present the results of our analysis, which, fifth, are then discussed and interpreted. Sixth, we conclude the paper with a summary of the main findings and limitations, as well as with propositions for future research.

**Advergames: Popularity and applications**

Advergames have been defined as online games that incorporate marketing content (Dobrow, 2004; Thomases, 2001). They are interactive games that are developed around a brand, a product, or a character associated with a brand or a product. Branding and products are incorporated into the game itself through either associative or demonstrative methods – meaning that a game can be used to demonstrate the use of a product or to associate the product with an activity or a lifestyle.
The need to develop new Internet advertising tools arose from the rapid decline in the effectiveness of rich media advertising in the late 1990s (Chen & Ringel, 2001; Yuan, Caulkins & Roehrig, 1998). The interest in advergames has substantially increased in the last 15 years, because of their perceived advantages (FreshGames, 2002; WebResource 2004):

- low-cost marketing in comparison with the traditional advertising channels, such as TV and radio;
- a captured audience that can transmit valuable personal information about their demographic profile, behaviour, needs, attitudes and preferences;
- customer retention: the average time spent in an advergame is 7 to 30 minutes, which cannot be reached in the case of a classical TV advertisement;
- viral marketing – 81% of the players will email their friends to try a good game.

All these data demonstrate the huge potential of advergames (Rodgers, 2004; Sennott, 2004). It is predicted that advergaming will become a standard part of interactive advertising, as consumers become more annoyed with traditional ads. A study investigating the effect of advergames in comparison with classical 30 seconds TV adverts, found that both methods can lead to telepresence and a positive reinforcement of brand perception and attitudes, however, advergames led to a significantly better recall of the brand (Bellman, Kemp, Haddad & Varan, 2014).

The existing studies have identified three main categories of online gamers (Fattah & Paul, 2002; Santos, Gonzalo & Gisbert, 2007):

- children and teenagers;
- adult males; and
- adult females.

Advergame.com portal, a site dedicated to licensing advergames, is already using this market segmentation, proposing specific advergames for various categories of online players.

Children and teenagers represent the traditional market segment for games. The increased possibility of children and teenagers to get online (Santos et al., 2007) has created new opportunities for the advergaming industry. A study conducted in the US by eMarketer provides relevant information about the importance of gaming and online surfing for children and teenagers (Macklin, 2006). The research revealed that 39.4% of children between 8 and 11 years old and 73.4% of teenagers aged 12 to 17 are regular Internet users. Some of the most popular activities of children and teenagers are playing games (81% of children between 8 and 12 years old, 78% of teenagers between 13 and 15 years old, and 72% of teenagers between 16 and 18 years old), and surfing the web (46% of children between 8 and 12 years old, 76% of teenagers between 13 and 15 years old, and 87% of teenagers between 16 and 18 years old).

Surveys conducted in the United States indicate that there are more than 150 million casual games users. Contrary to most expectations, the majority of these players are not teenagers and male. Quite the opposite: according to the Popcap survey, over 70% of this group are female, and 89% are over 30 years’ old. This correlates with the Nielsen’s findings that 64% of all online gamers are female. Casual games represents a favourite
leisure pastime, which is ranked above watching television and listening to music (GamesIndustry International, 2006).

Another study conducted during December 2003 – January 2004 in the US, has identified the women over 40 years old as a major segment interested in online gaming (Arkadium, 2004). These female game-players spend 9.1 hours per week playing games (or 41% of their online time in comparison with only 26% of the online time for men). This trend seems also to be present in other parts of the world, with the exception of Asia (Wi-Fi Technology News, 2005). A global survey conducted by Global Digital Living indicated that in North America’s households, 52% of women play online games each month compared with only 39% of men. Similar gaps regarding online gaming exist among Internet-connected households in Europe (i.e., 39% of women and 28% of men), and in Australia (i.e., 53% of women and 27% of men). Only in Asia these gaming activities are almost equally distributed between women and men, at percentages of 49% and 50%, respectively.

The reasons for playing online games vary depending on gender. The main reason given by women players is to relieve or eliminate stress, while men are attracted by the competitive factor of Internet gaming. Women prefer word and puzzle games, while men are more interested in sport, combat or casino games (Arkadium, 2004; Fattah & Paul, 2002).

The geographical location of players also seems to make a difference in terms of the type of game preferred and the reasons for playing (Arkadium, 2004). In Atlanta, the main reason identified is the elimination of stress, in Dallas people play to alleviate boredom, in San Francisco the players are enjoying the competition, and in Washington DC they play online to get trained for real casino gambling. These findings raise the problem of online games’ adaptation to the specific characteristics and preferences of a clearly-defined population.

Fattah and Paul (2002) indicate four possible ways to target a specific category of users:

- the advergame content is tailored to suit the targeted customer – for example, games of strategy are directed towards upscale, more educated users, while action games are appealing more to younger players;
- adapting the channel used to promote the advergame (e.g., using email marketing campaigns or web sites);
- expressing the contest structure of the game in relation to a specific target audience (e.g., how players win the game);
- considering the geographical location of players: using demographic information to facilitate the access of gamers to the promotions launched by local dealers or retailers.

Although the profile and the evolution of the main demographic categories are not yet clearly defined, the existing results are very encouraging for the advergames industry. The number of people accessing online games is large and growing every day, these players representing excellent prospects for advergaming marketing campaigns. However, more market research is necessary to identify the number and the profile of online game players in different parts of the world. Until now, the majority of such studies were conducted in
the US, the figures describing the population of online players in other countries being vague and controversial.

Despite the large number of academic and professional publications targeting advergames and their effects on players, the creation of an efficient advergame is still considered predominantly as an artistic work that is difficult to describe in a formal, precise manner (Smith, 2007). However, it is possible to distil from the extant professional literature the main characteristics of an efficient advergame (3RD Sense, 2006; D5 Games, 2004a and 2004b; Skyworks, 2007; Zodal, 2007):

- Careful selection of the game genre to appeal to the targeted demographics.
- The game relates closely to the core brand messages to be communicated.
- The brand message is fully-integrated into the game, enhancing both the effect of the game and of the brand.
- Carefully managed progression from simpler to more complex game levels, compelling the player to improve his/her performance and to stay in touch with the game for extended and repeated brand exposure.
- Registration system for players inviting them to input personal data in order to post scores or enter competitions.
- Communication tools that encourage the player to share the experience with friends or relatives – the viral marketing aspect.
- Competitions with prizes encouraging players to register and to keep returning to the site.
- Visible score tables that encourage players to improve their performance, to compete against each other, and to invite other people to join the competition.

**The advergames’ influence on consumer perception and behavior**

The placement of products or brand names in movies or TV shows is a relatively old technique, but studies regarding their influence on consumer perceptions and behavior are inconclusive (Gould, Pola & Grabner-Krauter, 2000; Russell, 2002). The advergames present a few distinct characteristics that can eventually enhance their marketing effect:

- the advergames are selected by the player himself/herself, and are not forced upon an unwilling viewer;
- the player interacts with advergames adopting an active stance, in comparison with the passive attitude of the TV audience;
- advergames incite players to share the gaming experience with their friends or family.

From a marketing point of view, the advergames attempt to capture the attention of players, and then to transmit to them, in an indirect way, suggestions that aim to modify their perceptions regarding an enterprise, brand, or product. The psychological fundament of this process is the inducement of the ‘state of flow’. This concept is used by psychologists to describe a mental state in which attention is highly-concentrated on a specific process and the environmental information is screened out, the person experiencing a harmonious flow of dynamic perceptions (Csikszentmihalyi, 1991). The state of flow is known to create a state of wellbeing, as well as increased perception and learning capacity.
The interaction with Internet applications can induce the state of flow in specific circumstances (King, 2003). Mihaly Csikszentmihalyi, professor at the University of Chicago, and world specialist in the state of flow, outlines that the most successful websites are the ones that offer interactive experiences, and not simply content. The state of flow can be created online if the following essential conditions are combined: user motivation, user telepresence, and interactivity of the Internet application. The motivation of the online player is usually a complex construct, determined and shaped by a combination of various needs: relaxation, competition, social interaction, etc., which are satisfied through the interaction with the online advergame. The primary motivation of the online player will determine his/her choice of the advergame, this variable representing an important segmentation criteria. On the other hand, the maintenance of the state of flow is a dynamic process that depends on the relation between the player’s capabilities and the level of difficulty proposed by the game. Figure 1 demonstrates the three possible scenarios of the interaction between an Internet user and an advergame.

![Figure 1](image_url)

**Figure 1** The inducement of the online state of flow in gaming

When the capability of the player is lower than the level of difficulty of the advergame, the player will experience frustration and will abandon the game with a negative feeling. If the capability of the player is higher than the level of difficulty proposed by the game, a feeling of boredom is likely to result, having as a direct effect the exit of the player from the advergame environment. Finally, if the capability of the player matches the difficulty of the advergame, the state of flow results and reinforces the motivation of the Internet user to revisit the site and to replay the game. This model contradicts the statement of Chen and Ringel (2001) that games should be kept simple as complex games may deter continued interaction.

Once induced, the maintenance of the state of flow requires a constantly evolving challenge, because the player’s level of capability is likely to improve after playing the game a few times. This raises the problem of including in the advergame a difficulty progression that represents a dynamic challenge for players.
In terms of consumer behavior, one of the most popular models in explaining the effect of marketing communication messages on the prospective customer – the AIDA model - can be used to investigate the possible effects of advergames. Considering the effects of an advergame on the perceptions and behavior of a player/consumer, we can define for every stage of the model a specific influence (see Figure 2).

**Figure 2**  The possible influence of the advergame on the perceptions and behavior of players, explained through the four phases of the AIDA model

Considered in connection with the state of flow, the first stage of the AIDA diagram includes two distinct phases:

- in the first phase, the online advergame should attract the attention of the potential player, either through classical online promotions and/or adverts, or through messages sent by other players as an effect of the viral marketing campaign. The online user will then decide to play or not the game, depending on his/her level of motivation and on the personal circumstances surrounding the online activity;
- the direct interaction with the game will determine either the voluntary exit of the player (because of boredom or frustration), or the experience of the state of flow, when the gaming activity captures the attention of the player, increasing his/her wellbeing, as well as his/her receptivity to the promotional messages embedded in the game.

The stimuli received during the interaction with the online advergame will then arouse the Interest of the player, both in the game itself, and indirectly, in the product/brand associated with the advergame.

A major problem may appear during the transition between the second (Interest) and the third stage (Desire). Some players may completely ignore the marketing dimension of the advergame and, although they continue to play, their behavior does not evolve towards an action of purchasing the advertised product. Ideally, the desire to play the game should
influence in an indirect way the consumer’s perceptions, creating the desire to experience the advertised product that can eventually lead to a purchase action.

The application of the AIDA model to advergames has a number of important limitations. First of all, the presented situation corresponds well to a singular company-customer interaction. Nowadays, the development of a long-term relationship between the firm and its customers (3RD Sense, 2006) has become essential for increasing and stabilizing the profitability of the company, which transforms the use of advergames in a dynamic, iterative activity (see Figure 3).

On the other hand, the viral marketing dimension is not represented in the above model. Viral marketing describes any strategy that encourages individuals to pass on a marketing message to others, creating the potential for an exponential growth in the message's exposure and influence (Wilson, 2000). The use of advergames corresponds well to a strategy of viral marketing, which incorporates the following principles (Wilson, 2000):

- give away products or services;
- provide for effortless transfer to others of these products/services;
- scale easily from a small to a very large audience;
- exploit common customer motivations and behaviors;
- utilize existing communication networks to transfer the products/services, or messages about them;
- take advantage of others’ resources (existing users/customers).

Figure 3  The iterative application of the AIDA model for advergames in the context of relationship marketing
Therefore, from the perspective of a viral marketing strategy, the application of the AIDA model to advergames becomes even more complex (see Figure 4).

Figure 4  The iterative application of the AIDA model for advergames in the context of relationship marketing, using the framework of a viral marketing strategy

Considering the specific influence of the advergame on the player during the four stages of the AIDA model, it is possible to identify the characteristics of an effective advergame. As any other marketing communication tools, the advergame will have to correspond to: (1) the personality of the advertised brand, (2) the profile of the targeted audience, (3) the characteristics of the channel – in this case the Internet, and (4) the strategic objectives of the communication campaign.

Considering the interaction of the player with the online advergame, the creation and maintenance of the state of flow are facilitated by adapting the design of the game to the primary motivation and to the capability of the player. Once the state of flow is reached, the game should aim to maintain this state, progressively increasing the difficulty of the game, and to transmit brand and product information, providing specific communication channels for viral marketing.

To understand how the advergame’s features and induced experience may influence the intention of players to buy and consume a product or service, we consider now the theory of reasoned action, developed and validated by Ajzen (1991). This theory states that (1) intentions represent the main antecedent of behavior, and that (2) attitudes, social norms and perceived behavioral control over ones’ actions will determine intentions. There is
also a link between the perceived behavioral control and behavior, because in a situation in which the person is not capable to effectuate his/her intentions, the passage to act is not realized (see Figure 5).

Figure 5  The theory of planned behavior (Ajzen, 1991)

If we consider various variables included in this model, probably the two main objectives of the advergame’s experience are (1) changing the attitudes regarding the advertised product or service, and (2) modifying the level of the perceived behavioral control. Generally, attitudes change by associating positive emotions with the product or service experienced during the state of flow created by a finely-tuned advergame. On the other hand, the perceived behavioral control over buying and consuming the product can be induced by the capacity of the player to fully-control the game and to win the advergame competition. However, this is not the same with the behavioral control over purchasing or consuming a real-life product – even if a surfer in a virtual reality advergame has a sense of complete behavioral control over the surfing board, this may not be the case with a real surfing board battled by real winds and waves.

Methodology
In the last 15 years, several different approaches have been proposed to analyse advergames’ structure and content. Among these, Malliet’s (2007) developed an analytical toolkit and used it to analyse the presence of violence in games. Later, the same toolkit containing 2 elements for representation analysis (audio-visual style and narration) and 5 for the simulation analysis (complexity of controls, game goals, character and object structure, balance between user input and pre-programmed rules, and spatial properties of the game) was applied to examine the appearance of a brand in a game (Theodorou & Sirmakessis, 2009). Another perspective is to evaluate the mechanisms that facilitate the players’ interaction with the game, as well as the tools that enhance customer relationship management:
• accessibility: facility to identify the hyperlink between the firm/product site and the game, free access or required registration, specialized software required, downloading time;
• facility of understanding: existence of explicit instructions/rules, and the facility of understanding these rules;
• competitive level: number of players, the display of score lists, multiple level of difficulty;
• relevance for the firm, brand or product: type of product advertised, type of game, advertising elements associated with the game;
• capacity to induce and maintain the state of flow: multiple levels of difficulty, the possibility offered to players to choose a specific level of difficulty;
• viral marketing: communication with friends and family members is encouraged.

In this paper we apply a combination of these approaches, considering first the elements that can attract the player to the game, then the elements that are embedded in the game to induce and maintain the state of flow, and finally, the elements that may encourage the player to purchase and consume the product.

To apply this research methodology we selected three advergames that were created by the same company – Unilever, in order to advertise the Magnum Ice Cream: Magnum Pleasure Hunt 1, 2 and 3. The advergame is developed as a series of three games, introduced successively on the Internet. Each game is fully independent and does not require knowledge of the previous games in order to be played and enjoyed. However, there are a few common elements that create the perception of a series of episodes: the main character is the same – a young lady who in real life is a French ballet dancer; the central narrative of the three advergames consists in a quest, although each advergame proposes a different type of quest, and finally, each game require the collection of as many as possible Magnum bonbons, which are transformed in points won.

To eliminate the bias of a single player, we proceeded into three stages: first, we realised the analysis ourselves, filling in the matrixes that evaluate the main characteristics and features of the three advergames; second, we invited ten French master students (five males and five females, average age 23.5 years old) to play the game, and then to describe their on-game experience; third, we asked to the same ten students to play the games again, but this time to pay attention to the various design elements that shape and enhance their experience, and fourth, we asked these students to fill in the same matrixes and declare if their intention to buy Magnum Ice Cream is lower, higher, or about the same with their purchasing intentions before playing the game.

Each dimension in the matrix was evaluated with notes from one to ten, where one represented a poor note, and ten, an excellent note. For example, regarding the complexity of controls, a score of ten was indicating a low complexity – and therefore a high facility to manipulate the character(s), while a score of one was indicating high controls complexity. However, for the intentions to buy Magnum Ice Cream, the scores were distributed as follows: 1 to 3 - lower intentions, 4 to 7 - same intentions, and 8 to 10 - higher intentions than before playing the game. The scores were then averaged to understand the general effect of the three games on the testing group. The evaluations are presented in the next section.
Results

The three games analysed in this paper are quite different despite their resemblance in terms of product and style of narrative.

Game 1

Magnum Pleasure Hunt, launched in 2011, was the name of a worldwide online campaign realized by Unilever to promote its Magnum Ice Cream by using advergames. The first game was highly successful in terms of reach – with more than 7,000,000 players and an average engagement per user of approximately 5 minutes. The campaign was propagated using viral marketing methods and several social networking sites. As a result of its popularity, Unilever decided to introduce two more sequels, using the same character and style of narrative.

The first game described the quest of the main character – a young lady – to collect as many Magnum bonbons as possible, in an online race that crosses over several real and imaginary websites that promote and sell luxury products and services. The race continues no matter if the lady collects or not points, while the game set changes continuously. The producers of the game make a very original and creative use of the selected websites, using their features to stage specific experiences that the lady character goes through in her race for the Magnum Ice Cream that waits for her at the end of the game – no matter how many points she has collected. From this perspective, the competitive nature of the game is ingeniously divided into two elements: first, it is the race itself, the quest through a large diversity of websites, but which share the same style and level of quality; second, it is the (quite limited) manipulation of the character by the player, which moves her up, down, left and right in order to collect as many Magnum bonbons as possible. At the end, a score is displayed, representing the amount of points gained by the player, however, the lady from the game does not seem concerned by this score, as she always gets to the end of the game, and receives as price the Magnum Ice Cream.

Personally, I consider that the design of the gaming experience is surprising, being enhanced by the race of the main character, who crosses so many different websites keeping an alert rhythm, and constantly changing the scenery. However, towards the end of the game, during the interaction with a couple of websites, I cannot stop asking myself how long is this still going to continue, as I started to have a déjà vu experience.

The students were impressed with the design execution, as, at least in the first half of the game, the glide from one site to another is effortless and full of creativity. On the other hand, eight out of ten students confirmed the impression that the last few scenes were more static and less interesting than the ones presented in the first part. The boys were mostly attracted by the action and skills required to collect the points, while the girls focused more on the experiences lived by the main character. All ten students said that they would like to play again the game, inviting friends and family to try as well. However, only three girls and one boy declared that playing the game enticed them to try to advertised product. Although they understood the association between the other luxury products/services and the Magnum Ice Cream, they perceived a dichotomy between the advertised product – whose consumption or qualities are not presented or experienced during the game, and the race that represents the main narrative of the game.
Game 2
Magnum Pleasure Hunt 2 was launched in April 2012, in order to capitalize on, and continue, the success of the first game. The success was quick, as after a little more than a month, more than one million people worldwide had already played the game.

In this sequel, the same character – a young lady, is launched in a race to collect as many points as possible (Magnum bonbons again) running through the street of New York, surfing in Rio de Janeiro, or flying in Paris. The scenes are highly realistic, as each location was photographed and then reconstructed in the studio with all the existing details. For this new project, the producers created promotion partnerships with Bulgari, KLM, Quicksilver, Hotel Fasano and Bing – the search engine – all these brands being displayed in the game.

Despite the new trick of running through the streets of three of the most beautiful and famous cities of the world – a truly global exploit, I perceived the new game as too similar with the first one. The principle of points’ collection was the same: the lady raced in her own rhythm from one scene to another, while the player tried to control some of her movements in order to collect maximum points. Finally, reaching the destination, the lady received again the Magnum Ice Cream, irrespective of the number of points scored.

The realism of locations added more charm to the race, allowing players to eventually recognize places they already visited themselves, however, the overall impression of that of repetition – not enough creativity and originality was injected into the second game to make it interesting and different from the first one.

The students invited to play were fascinated during the first run of the game, but many of them protested that ‘it is all the same’; the race ‘reason’ was not good enough to keep them interested, and after the first experience, they quickly became disenchanted and started to criticize various design elements. This time only seven people out of ten declared that they will talk about the game with friends or relatives, inviting them to play; and only two said that they will play the game again in the future. Amongst the main criticism was the limited number of cities, the fact that some of the best places, shops or monuments from these cities were not displayed or included into the game; and finally, the limited control of the player over the motions of the main character.

Game 3
Considering the success of the first two instalments – with 23 million people playing the games, Unilever launched in 2014 the third game from the Pleasure Hunt series, this time introducing a much more complex plot: the main character – the same lady from the first two games – attempts now to save a man kidnapped by a team of Bad Girls. In her endeavour, she has to play five different games, obtaining at the end of the race five different Magnum kisses: ‘Crème brulée’, ‘Meringue aux fruit rouges’, ‘Tiramisu’, ‘Gateau au chocolat’ and ‘Tarte tatin’. The actions taken by the main character are more complex, having to collect Magnum bonbons while running on top of Paris metro cars, throwing back the bombs launched by the Bad Girls, or fencing in a desperate fight.

The students were first happy that the narrative has finally changed and became more complex. However, the game did not fully attract their attention, maybe because they already knew the main character. After playing once, the majority (eight students)
declared that the design is new in comparison with the two previous instalments, but has a rather low interest to them to find out what are the ingredients of Magnum Ice Cream Kisses. Only one declared that it will talk about the game with friends and relatives, and none said that he is willing to play again the game.

![Table 1 Evaluation matrix of the three games in terms of game design](image)

When interrogated regarding the comparative evaluation of the three games, the students indicated that the first one was the best, as it contained the surprise element, and the idea of travelling through cyberspace, by entering and crossing various websites.

![Table 2 Evaluation matrix of the three games in terms of game-player interaction](image)
Discussion

Considering the definition of design that we retain for this study (Khandani, 2005) - developing an optimum solution for a specific problem, we need first to identify what are the problems that designers attempt to solve through advergames. Considering the rich academic and professional literature on advergaming, we can identify at least five such problems that are inter-related:

1. to raise the interest of the potential player to interact with the advergame;
2. to induce and maintain the state of flow;
3. to create positive impressions/feelings regarding the advertised brand, product or service, during the state of flow;
4. to incite the player to talk favourably about the advergame, acting as a viral agent;
5. to determine the player to purchase and consume the advertised product or service.

From this perspective, we start to understand that probably only the best games are capable to achieve simultaneously all these objectives, by using an appropriate design. The answers of the students invited to play the three Pleasure Hunt Magnum games clearly indicate which problems have been solved by the innovative design of these three advergames, and which elements have failed. Regarding the design elements of the three advergames, both male and female respondents indicated particular problems with the game goals: “too trivial”; the balance between user input and pre-programmed rules: “no matter what you do, you are forced to follow the same tract, with the speed decided by the programme”; and spatial properties: “screen sometimes too crowded to be capable to register and understand the layout”. Among the positive points we can list the audio-visual style and the complexity of controls. Narration is generally receiving high scores, with the exception of the second game, from the male respondents who give an average note of only 7.8.

On the other hand, from the point of view of the interaction elements, the evaluations are poor for the relevance of associations: “too many products, brands and locations that have no clear relevance of Magnum Ice Cream”; the existence of viral marketing tools: “you can’t play simultaneously in competition with another person”; capacity to improve attitude towards products/services: “product associations seem sometimes arbitrary and confusing”; and the capacity to induce the desire to buy the product: “at the end of the game, you don’t know exactly what you’ll like to buy – as the Ice Cream is not really presented in a purchasing or consumption context.”

On the other hand, the games are not exceptional regarding their capacity to induce and maintain the state of flow. It is interesting to note that to both these dimensions, the best notes were given to the first game. The respondents justified this by the surprise element, and by the ‘cool’ idea that the main character is racing through various websites:

*Version two and three of the game were quite predictable, once you played the first version. Although they changed the layout, the narrative and the*
goals were mostly similar. They made a special effort with the third version, but then you have five different games, some better than others.

Overall, although the traditional design elements scored quite well, the elements that facilitate the interaction with customers and that should determine a change in attitude and purchasing behaviour, are poorly designed. However, this dichotomy between design and interactive elements is artificial because the design elements should ultimately incorporate the entire experience of the player. Future studies should thus attempt to unify these two evaluation scales, or develop a new scales that takes into account both the structural and the functional elements of advergames.

In addition to all the elements taken into account in this paper, it is important to understand that the perception and evaluation of an advergame is never done in complete isolation from past experiences and memories. In other words, an advergame that applies a successful, well known narrative, but fails to deliver in terms of interactivity and attractiveness in comparison with other videogames, will not be analysed in itself, but rather in relation to other previously-experienced games. These complex associations introduce another layer of influences, which makes extremely difficult to predict the degree of success of a new advergame.

This effect is easy to identify when analysing, as in our case, a series of advergames with the same main character. Although the setup of each successive game changes substantially in comparison to the previous version(s), all three advergames use the central motive of the quest, which is transformed into a dynamic race through different settings. The competitive goal of the game is trivial – collect as many bonbons as possible, which on the one hand succeeds to induce rather easily the state of flow, but cannot maintain it for long. However, the hidden goal of the game is just to experience different brands which participate to the same universe of consumptions as the Magnum Ice Cream. This creates diversity and change, but on the other hand may confuse the player, failing to sufficiently reinforce the positive attitudes towards the Magnum product, and to transform the player into a potential customer. The students that played the game indicated that they felt attracted towards a lifestyle of leisure, diversity and modernity, represented in the game by a whole series of actions, products, locations and brands. The Magnum Ice cream certainly is a part of this lifestyle, but only minor one:

I do not understand why I have to run around three cities, located in different continents, to get at the end a Magnum Ice Cream. The game is interesting, but the connection with the core product is far too weak.

Concluding remarks
The design approach is used more and more in organizational and business studies to provide optimum solutions to dynamic problems, involving repeated interactions of a person (either employee, stakeholder or customer), with the product, brand, or specific processes within the value-added chain of the corporation.

As with any problem-solving technique, to achieve a good result in terms of design, it is necessary to define clearly the problem to be solved, as well as the specific characteristics and constraints of the environment. Nowadays, the accent of design research and activity shifts from the development and combination of static elements in specific artifacts, to
dynamic interactions, to influence customer’s experiences that contribute to the established goal(s) of the project.

In this study, we identified the main goals that should be fulfilled by a well-designed advergame, and we explored the main requirements and challenges encountered in the process of fulfilling these goals. To illustrate the complexity of this approach, we also analysed three advergames created by Unilever as a promotional series, centered on the theme of Magnum Ice Cream Pleasure Hunt. The findings indicate that the three advergames are perceived differently on various evaluation criteria, an important element being not only the influence of games’ characteristics on player, but also the signals sent by players’ memory – as an advergame is often compared with previous similar experiences.

The main limitations of this study stem from its methodological approach. The sample of players that tried and evaluated the three games is rather limited, the reason being the exploratory nature of this research. Based on our findings, future studies should attempt to increase the size of the sample, and/or to develop and validate a unified evaluation scale that addresses both the structural and the functional elements of an advergame.

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About the Author

Dr. Calin Gurau is Professor of Marketing at Montpellier Business School, France. His present research interests are focused on Marketing Strategies for High-Technology Firms, Internet, and Sustainable Development. He has published more than 70 papers in internationally refereed journals.
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Logos' textual and visual content: the double anchorage effect

CELHAY Franck
Montpellier Business School, France
f.celhay@montpellier-bs.com
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The logo is a key part of a brand’s visual identity. Logos appear on letterhead, business cards, annual reports, package and product designs, print and TV advertisements, websites and smartphone applications. As a result, logos have become an important way to capture awareness and build brand image. This study investigates how logo design impacts brand perception. More specifically, we explore how a logo’s textual content interacts with its graphic design to deliver a specific message. Semiotic theory provides the framework to study this question. Two logos with the same textual content but different designs are analyzed, first through a semiotic study and then with an experiment involving 903 survey respondents. The results confirm that the textual content of the logos interacts with the visual aspect in what we have termed the double anchorage effect.

keywords: graphic design; typography; semiotics; marketing

Introduction
The logo is part of a brand’s visual expression. It communicates messages to the brand’s audience through its textual content (i.e., the brand name it displays) and visual aspect (i.e., its graphic design).

Many academic studies have highlighted the importance of logos in brand communication, showing that logo designs have a powerful impact on brand image and that a change in the design will change the brand perception (Henderson & Cote, 1998; Henderson et al., 2003; Hagtvedt, 2011; Cian et al., 2014). Through the graphic and stylistic choices that have been made, logos communicate different brand identities and positionings.
Several studies have sought to understand how this occurs in order to build a theoretical framework and principles to guide managers in defining the optimal visual aspect of their logo based on the message they want to communicate. More specifically, these studies have tried to identify the logo variables that can be manipulated to communicate specific messages to consumers. Some have adopted an analytical approach, examining how “low order” variables like color or typeface independently impact brand perception. Others have taken a holistic approach, exploring how “high order” variables like the overall complexity of the design impact brand perception. (Orth & Malkewitz, 2008).

The two approaches are complementary and have significantly contributed to a better understanding of the question. However, most of these studies have tended to focus strictly on the visual aspect of the logos without considering the interaction with the textual content. Yet, brands commonly choose highly evocative names. These names may suggest the brand’s sector of activity (e.g., Easyjet), its alleged country of origin (e.g., Desperados) or the functional (e.g., Everlast), emotional (e.g., Innocent) or symbolic (e.g., Desigual) benefits the brand promises its consumers. Once the name is chosen, a logo’s design will then make sense by echoing the brand name. Moreover, the meaning of a logo’s visual attribute can change according to its textual content. For instance, the meaning of green in a logo is not likely to be same if the brand’s name is “Poison” (like the Christian Dior perfume) as opposed to “Greenpeace” (like the NGO).

This article aims to fill a gap in the literature by investigating how the interactions between a logo’s graphic design and textual content determine the messages that are communicated to the brand audience and modify brand perception. A review of the literature on semiotics, visual art and marketing provides the theoretical framework for this work, and a proposition is formulated. Then, two logos presenting the same textual content but different graphic designs are analyzed from a semiotic perspective and then tested in two groups of respondents (N=903). The research objective is twofold: to verify the proposition issued from the literature and to determine whether semiotic tools can predict how the two logo designs are likely to generate specific associations of ideas and thereby impact brand perception.

**Conceptual and theoretical background**

*A semiotic approach to logos*

Logos are visual signs and semiotics can be quickly defined as “the science of signs” or “the theory and study that describe signs and the mechanisms by means of which a sign system produces meaning” (Kehret-Ward, 1988; Ares et al., 2011). It therefore appears logical to consider the semiotics literature to understand how logos produce meanings about the brands they represent.

The field of semiotics grew out of the pioneering work of the Swiss linguist Ferdinand de Saussure and the American philosopher Charles Sanders Peirce (Glen Mick, 1986; Crow, 2010).

Saussure argues that signs can be divided into two facets: the “signifier” and the “signified” (Saussure, 1916). The “signifier” is usually defined as the physical manifestation of the sign. It is something we perceive through our senses – that is, something which can be seen, heard, touched, smelled or tasted. It can be a sound (for a verbal sign) or an
image (for a visual sign). The “signified” is defined as the meaning that is attached to the signifier (Chandler, 2007). Signifiers form the “expression plan” of signs while signifieds form the “content plan” (Barthes, 1964a).

Peirce introduced the concept of “semiosis.” Semiosis can be defined as “the relationship associating a signifier with a signified” (Chandler, 2007). The concept of semiosis allowed Peirce to distinguish different types of signs called “symbols,” “index” and “icons. These types of signs differ according to the “mode of relationship” between the signifier and the signified. Building on Peirce’s typology of semioses (Peirce, 1931-1958) and on Barthes’s (1964b) research on visual rhetoric, Cavassilas (2007) proposed that four kinds of semioses can be used to describe how packages or logo graphic design communicate meanings to consumers:

- Symbolic semiosis refers to the situation in which the signifier is arbitrarily connected to the signified. The association is purely conventional and culturally dependent. In other words, there is no objective characteristic of the signifier that allows an outsider to understand why, within a given society, it has been associated with a specific signified. Verbal signs (i.e., words) are usually cases of symbols as they need to be learned to be understood.

- Indexical semiosis refers to the situation in which the signifier is connected to the signified by a link of continuity or causality. For example, the use of green in the Greenpeace logo is a case of indexical semiosis because green is a common color for vegetals and nature. It’s therefore logical to use it as a signifier to suggest an organization that seeks to protect the environment.

- Iconic semiosis refers to the situation in which the signifier is connected to the signified by resemblance. For example, the use of a basketball player’s silhouette in the NBA logo is a case of iconic semiosis because the signifier “basketball player’s silhouette” looks like the object that it is supposed to mean (i.e., a real player).

- Finally, metaphoric semiosis refers to the situation in which the signifier is not to be interpreted “literally” but is used to refer to one of its qualities/properties. For example, the drawing of a massive red bull in the Chicago Bulls logo is a case of metaphoric semiosis. Of course, the drawing doesn’t mean “literally” that the players are bulls but that they are as combative or powerful as bulls.

These concepts have been widely used to analyze how companies communicate explicit and implicit messages to their consumers through their different communications materials (Floch, 2003, 2010; Cavassilas, 2007; Ares et al., 2011; Gollety & Guichard, 2011; Piqueras-Fiszman et al., 2011; see also Hetzel & Marion, 1993, or Mick et al., 2004, for extensive literature reviews on the topic). They provide a relevant framework for analyzing how logos produce meanings. Thus, from a semiotic perspective, it can be said that a logo is part of a brand’s expression plan. It is a combination of several signifiers (e.g., its textual content, colors, typography, imagery, and overall form) that communicate specific signifieds (i.e., meanings) to the brand’s audience through different types of semiosis. These signifieds are part of the brand’s content plan and are usually relative to the brand’s identity – that is, its values, promise, and points of difference.
From this perspective, typography is thus one of the visual signifiers that logos employ to communicate messages to their consumers. However, typography is different from other visual signifiers (colors, imagery, etc.) as typography is “the visual transcription of verbal signs” (i.e., words) (Drucker, 1994). Therefore, typography is a signifier that is simultaneously word and image and carries textual as well as visual content.

Based on this observation and Barthes’s works (1964a, 1964b), typographer Blanchard (1980, 1998) suggests that typography communicates two levels of meaning. The first level is the literal and explicit meaning of the word that is written. The second level is the meaning induced by the visual aspect of this word (i.e., its typography). Thus, the same word, depending on whether it is written in Times or Mistral, bold or thin, and italic or roman letters, will produce the same meanings according to its textual content but different meanings according to its typography (cf. Figure 1). This assumption has been empirically verified by several marketing studies that have demonstrated that the visual aspect of typography has an impact on consumer perception of brands and products (Childers & Jass, 2002; Doyle & Bottomley, 2004, 2006; Hagtvedt, 2011; Henderson et al., 2004; Van Rompay & Pruyn, 2011; Velasco et al., 2014).

If we apply this idea to logos, it can be argued that logos are visual signifiers that carry two levels of meanings as well. The first level of meaning is produced by the logo textual content, which most of the time is the brand’s name. The second level of meaning is produced by the logo visual aspect – its typography as well as its colors or other visual attributes.

A double anchorage effect

The distinction between these two levels of meaning (the meaning produced by the textual content and the meaning produced by the visual aspect) helps to explain how communications materials combining text and image generate meanings.

In Rhetoric of the Image (1964b), Roland Barthes observes that print advertising is almost always composed of an image accompanied by text. According to Barthes the image carries an “iconic message” while the text carries a “linguistic message.” This latter serves to “anchor” the iconic message (the image) because, still according to Barthes, all images are polysemous and open to subjective interpretation. Barthes points out that the addition of a linguistic message guides the interpretation of the image in the direction intended by the advertiser and therefore fulfills a function of “anchorage”:

The text directs the reader through the signifieds of the image, causing him to avoid some and receive others; by means of an often subtle dispatching,
it remote-controls him towards a meaning chosen in advance (Barthes, 1964b).

This idea applies quite clearly to logos: a logo’s first level of meaning, which is produced by its textual content, is what Barthes calls a “linguistic message.” The second level of meaning, which is produced by its visual aspect, is similar to what Barthes calls the “iconic message.” As for print advertisement, the textual content of logos can be used to guide the interpretation of their visual aspect (i.e., their graphic design). Figure 2 illustrate this idea. The typeface presented is an exotype called “Kremlin Premier.” Its design is supposed to suggest the Cyrillic alphabet and the Russian culture. When the textual content is neutral (example on the left) the meaning of the typeface design is uncertain and only a few connoisseurs in typography may understand it. However, when the textual content fulfills a function of anchorage (example on the right) the meaning produced by the visual aspect of the typeface is more likely to be understood by a large audience (Celhay et al., 2015). Therefore, it can be argued that for logos as well as for print advertisement the textual content fulfills a function of anchorage regarding the meaning of the logo’s visual aspect.

Figure 2  The textual content “anchors” the meaning of the logo design.

Yet these observations merit further development because, just as an image is polysemous, a word can have several meanings. This is notably so when it appears in isolation from all other textual content, as is often the case with logos. Another example is when the meaning of the brand name is implicit (e.g., Innocent, Bonne Maman) and not explicit (e.g., Easyjet, Duracell). In such cases, it seems that the visual aspect of the logo, especially the typography, can activate one meaning rather than another. We therefore hypothesize an effect of “double anchorage”: the meaning of the logo’s visual aspect is anchored by the meaning of its textual content AND the meaning of the logo’s textual content is anchored by the meaning of its visual aspect. To illustrate this, let us take the word “care.” On its own, this word has many meanings. It can signal an alert, a concern, or the act of a looking after someone. In this situation, the typographic choices (font, boldness, uppercase letters) will activate one meaning over others. For example, when “care” is in uppercase letters with a bold stencil typeface, it is more likely to activate the meaning of an alert (see Figure 3, left). Yet when the same word appears in lowercase lettering with a delicate formal script, it will probably activate a gentler meaning like the fact of caring for someone (Figure 3, right).

Figure 3  The logo design “anchors” the meaning of the textual content.
Therefore, we propose that the anchorage effect first described by Barthes is not unilateral but bilateral. Especially in the case of logos, it is likely that the visual aspect guides the interpretation of the textual content, just as much as the meaning of the textual content guides the interpretation of the visual aspect. In the following sections, we test this proposition by studying two logos presenting the same textual content but two different visual aspects.

**Methods**

To test our proposal, we studied the perceptions of the old and new logos of the Cooperative for Assistance and Relief Everywhere, a nonprofit, nongovernmental organization (NGO), long known simply as CARE (Figure 4).

![Figure 4](image.png) The logos analyzed and tested in the study.

We performed a semiotic analysis of the two logos and then conducted an experiment with 903 survey respondents to determine their perceptions. In the following sections, we explain our choice of stimuli and then present our methodology for the semiotic analysis and the experiment.

**Choice of the stimuli**

CARE is one of the oldest nonprofit NGOs dedicated to providing disaster relief and fighting poverty worldwide. According to Kasturi Rangan and Lee (2012), CARE employed more than 12,000 people in 2007, was present in 71 countries, and had a budget of 545 million dollars for its various programs. Despite its importance, the American NGO has a relatively weak brand awareness (Rieunier, 2008), which is one of the main reasons for choosing these logos for our study: It was relatively easy to find “naïve” respondents – that is, without prior knowledge of CARE, its positioning and its activities.

Also, CARE underwent a reorientation in 2007. The brand’s positioning was redefined and a new logo was adopted to signal this change (Kasturi Rangan & Lee, 2012). The new logo has the same textual content as the original (i.e., the word CARE) but a different visual aspect (Figure 4). This case study thus gave us two realistic stimuli (being real) and was nicely adapted for an experiment to study how a logo’s graphic design impacts the perception of a brand.
These two logos had one further advantage with regard to our objective. Each proposes a different visual retranscription of the polysemous word “care.” The choice of these two logos thus allowed us to study our proposition regarding the existence of a double anchorage effect. Our idea was to investigate the extent to which the meanings expressed by the visual aspect of each logo would activate one of the meanings of the word “care” rather than the others.

Semiotic analysis of the two logos
In this first step, we conducted a semiotic study of the two logos. We expected this first study to provide insights into the probable interactions between the textual content and visual aspect of each logo.

We used a text-interpretive approach in the Saussurean/structuralist tradition of semiotics (Chandler, 2007). More specifically, we adopted the methodological approach proposed by Cavassilas (2007), which consists of decomposing the logo expression plan into its various signifiers and then studying how each of them individually and synergistically contributes to create specific meanings (i.e., signifieds) about the brand. The value of this approach is that each interpretation is based on the above-presented typology of semioses, as well as on an extensive review of the literature in the visual arts, art history and graphic design. As each interpretation is qualified according to the kinds of semiosis, the transparency of the analysis is ensured and readers are able to grasp the relevance of the interpretation. By basing the interpretations on the visual arts literature, Cavassilas further ensures that the interpretation is not subjective but is instead in line with the conventions and well-known rules that artists and graphic designers use to express themselves in a visual way. This is an important point because, as Chandler (2007) reminds us, “social conventions ensure that signs cannot mean whatever an individual wants them to mean” and prevent the reader (and the analyst) from what Eco (1965) calls “aberrant decodings.”

Regarding this issue, it should be noted that even though we have qualified our methodology as “text interpretive,” there is little room for subjectivity. Indeed, semioticians such as Hall (1973) remind us that media texts vary in the extent to which they are open to interpretation and that some codes are more widespread and accessible than others. This observation led Fiske (1982) and Bernstein (1971) to make a distinction between “broadcast and restricted codes,” which are shared by the members of a mass audience and are structurally simpler and more repetitive, and “narrowcast and elaborated codes,” which are aimed at a more limited audience and are more complex and less redundant. Eco (1981) considers mass media texts as belonging to the first category and describes them as “closed texts” – that is, texts that are not open to subjective interpretation. Logos fall into this category as they occur in a commercial context and are used by brands as mass media. This means that it is not difficult to analyze their meanings compared with the meanings of other visual artifacts such as artistic ones. Brands conceive their logos to be understood by the greatest number.

After this decoding, another methodological precaution was to triangulate the data to check whether our interpretation of the two logos was congruent with the intended communication from CARE and its change in positioning as presented in the case study of Kasturi Rangan and Lee (2012).
Analysis of the perceptions of the two logos

In the second step, we conducted an inter-subject experiment to study the perception of the two logos. Each respondent was randomly shown one of the logos. Data were collected via an online questionnaire using the Qualtrics platform. Filter questions at the beginning of the questionnaire allowed us to exclude respondents who had a previous knowledge of CARE or who had already seen the logo they were presented with. Our final sample was composed of 903 respondents (48.7% male; Mage = 27 years), 486 who were shown logo 1 and 417 who were shown logo 2.

To evaluate the perceptions of the two logos and their impact on the CARE image, we used a free word association task (Ares et al., 2011) and the nonprofit brand image scale developed by Michel and Rieunier (2013) for humanitarian organizations. The responses to the word association task underwent lexical content analysis using Sphinx Quali software. Last, the scores for each logo on the brand image scale were compared by ANOVA.

Results

Semiotic analysis

Logo 1 used the signifier “care” presented in uppercase letters with a stencil typeface. The font is thick and rectangular. The colors are green and white, and the green shade is a cold one. There are no illustrations except for two very thick and rectangular horizontal lines framing the word “care.” These two lines reinforce the rectangular aspect of the logo. The contours of the different parts of the logo are regular and there is no texture effect.

Logo 2 uses the same signifier “care” but the word is in lowercase letters and the typeface is non-script sans serif. The font differs from the font of the first logo because it is rounded. The colors are orange, yellow and white: all warm colors. An illustration completes the text: handprints in different colors forming a circle. The contours of the illustration are irregular and give the impression of texture.

We will now look at the signifieds that might have been produced by these two logos as suggested by the literatures in semiotics, graphic design and art history.

In logo 1, the signifier green is today strongly associated with signifieds of nature, ecology and the environment (Cavassilas, 2007; Pastoureau, 2013). When associated with the word “care,” this color may activate a signified of protecting the environment. In addition, the association of green and white suggests pharmacies and, by extension, healthcare (Pastoureau, 2013). Thus, when these two colors are associated with the word “care,” they might activate a signified of medical care or health protection. We should also note that the uppercase letters in thick boldface, when associated with the word “care,” can be signifiers that activate the signified of alarm or urgency (Garfield, 2010). Depending on what the colors activate in the receivers – a signified of the environment or of health – the logo can signify an urgent need to defend the environment or to provide healthcare. As we have seen, the font is part of the stencil family (Alessandrini, 1979, 1980). Traditionally, these fonts were part of a marking system used in the military to label ammunition and food crates (Blackwell, 2004), and they remain typical of the military sector to this day. The stencil fonts are also used to mark the jute sacks for transporting coffee beans, for example, and they therefore also evoke the transportation of raw
materials (Heller & Vienne, 2012). The fonts of the stencil family usually look rustic and masculine, and in the case of logo 1, masculinity is reinforced by the thick boldface and overall rectangular shape. It should also be noted that the rectangular appearance, the use of cold colors and the absence of any illustration communicate seriousness. This impression is further strengthened by the regular contours of the logo. In terms of the double anchorage effect, it is likely that in logo 1 the word “care” evokes signifieds like “an emergency to protect the environment” or as “an emergency to protect the health of people.” Table 1 summarizes the semiotic analysis of logo 1.

Table 1  Semiotic analysis of logo 1.

<table>
<thead>
<tr>
<th>Signifiers</th>
<th>Signifieds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Colors</strong></td>
<td>Green and white</td>
</tr>
<tr>
<td></td>
<td>Cool colors</td>
</tr>
<tr>
<td></td>
<td>Green: ecology</td>
</tr>
<tr>
<td></td>
<td>Green and white: pharmacy, health</td>
</tr>
<tr>
<td></td>
<td>Seriousness</td>
</tr>
<tr>
<td><strong>Typography</strong></td>
<td>Stencil typeface</td>
</tr>
<tr>
<td></td>
<td>Uppercase letters</td>
</tr>
<tr>
<td></td>
<td>Army, transportation, raw materials, rusticity, masculinity</td>
</tr>
<tr>
<td></td>
<td>Alert, emergency</td>
</tr>
<tr>
<td><strong>Illustration</strong></td>
<td>No illustration apart from two rectangular bars framing the logo</td>
</tr>
<tr>
<td></td>
<td>Seriousness</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td>No texture, regular contours</td>
</tr>
<tr>
<td></td>
<td>Mechanical &gt;&gt; rigor, seriousness</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Rectangular</td>
</tr>
<tr>
<td></td>
<td>Rigor, seriousness, masculinity</td>
</tr>
</tbody>
</table>

In logo 2, the warm colors, yellow and orange, may communicate signifieds of warmth and friendliness. These colors may also signify countries of the southern hemisphere, especially African countries (Cavassilas, 2007). The use of two colors in association with handprints suggests the idea of diversity and social mixing. Lowercase letters should imply the signified of CARE’s proximity to its target public (Blanchard, 1980, 1998). Thus, the combination of lowercase letters, rounded shapes and warm colors should reinforce the signified of friendliness and communicate a warm and accessible brand image. The illustration suggests many possible signifieds, in fact. The hands forming a circle convey a signified of solidarity and mutual aid (international or inter-ethnic). The handprints suggest childhood and play. The circle may refer to the earth and thus to the organization’s international dimension. This shape, associated with the hands of children, also suggests maternity (Cavassilas, 2007). The irregular contours and the impression of texture produced by the handprints further reinforce the impression of friendliness and warmth through the illusion of a handmade visual, in opposition logo 1, which has a far more mechanical appearance. The combination of colors, typography and illustration in logo 2 seems designed to activate a signified of the word “care” that is gentler and warmer and certainly less alarmist than in logo 1. In terms of the double anchorage effect, it is likely that in logo 2 the word “care” evokes a signified of “caring for the people from...
the southern hemisphere” or “caring for children all over the world.” Table 2 summarizes the semiotic analysis of logo 2.
Table 2  Semiotic analysis of logo 2.

<table>
<thead>
<tr>
<th>Signifiers</th>
<th>Signifieds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colors</td>
<td>Friendlyness, human warmth, diversity, southern countries, Africa</td>
</tr>
<tr>
<td>Orange, yellow and white</td>
<td></td>
</tr>
<tr>
<td>Warm colors</td>
<td></td>
</tr>
<tr>
<td>Typography</td>
<td>Proximity, friendliness, sympathy</td>
</tr>
<tr>
<td>Non-script, sans serif, rounded</td>
<td></td>
</tr>
<tr>
<td>Lowercase letters</td>
<td></td>
</tr>
<tr>
<td>Illustration</td>
<td>Solidarity, mutual help, social diversity, childhood, play, maternity, earth &gt;&gt; international solidarity</td>
</tr>
<tr>
<td>Different colored handprints</td>
<td></td>
</tr>
<tr>
<td>forming a circle</td>
<td></td>
</tr>
<tr>
<td>Texture</td>
<td>handmade &gt;&gt; warm</td>
</tr>
<tr>
<td>Textured, irregular contours</td>
<td></td>
</tr>
<tr>
<td>(hands)</td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td>Friendlyness, sympathy, femininity</td>
</tr>
<tr>
<td>Rounded</td>
<td></td>
</tr>
</tbody>
</table>

Results of the study of perceptions of the two logos
In the second step of this research, we compared the findings from the semiotic study with the results of an experiment to determine the perceptions of the logos. In this second study, the findings of the semiotic analysis were very much confirmed (Table 3 and Figure 5). The lexical analysis of the responses on the free word association task showed that our respondents for the most part associated logo 1 with protection of the environment or healthcare. Logo 2 evoked ideas of solidarity, diversity, humanitarian action and childhood. Also, the study of the textual content of logos 1 and 2 seemed to support the notion of a double anchorage effect. Although the textual content was the same, in logo 1 the word “care” evoked sharper and more alarmist meanings, with a higher frequency for the word groups “protection, defense, preservation”; “attention”; and “safety, danger, prevention, emergency.” Logo 1 had a “serious” image – “strict” and even “cold” – and evoked a more masculine universe than logo 2 (”transportation, logistics”; “industry, works, construction”; and “army, military, soldier”).
<table>
<thead>
<tr>
<th>Groups</th>
<th>Logo 1</th>
<th>Groups</th>
<th>Logo 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecology, nature, environment</td>
<td>50.0%</td>
<td>Aid, solidarity, assistance</td>
<td>64.0%</td>
</tr>
<tr>
<td>Health, medicine, pharmacy</td>
<td>28.2%</td>
<td>Diversity</td>
<td>28.3%</td>
</tr>
<tr>
<td>Care</td>
<td>18.5%</td>
<td>Humanitarian action, charity</td>
<td>26.4%</td>
</tr>
<tr>
<td>Protection, defense</td>
<td>13.4%</td>
<td>Union, together, team</td>
<td>24.5%</td>
</tr>
<tr>
<td>Aid, solidarity, assistance</td>
<td>6.4%</td>
<td>Sharing</td>
<td>20.4%</td>
</tr>
<tr>
<td>Seriousness, strictness, rigor</td>
<td>6.0%</td>
<td>World, planet, earth</td>
<td>17.0%</td>
</tr>
<tr>
<td>Attention</td>
<td>5.1%</td>
<td>Africa</td>
<td>13.7%</td>
</tr>
<tr>
<td>Humanitarian action, charity</td>
<td>4.7%</td>
<td>Children</td>
<td>12.2%</td>
</tr>
<tr>
<td>Danger, emergency</td>
<td>4.5%</td>
<td>Care</td>
<td>7.7%</td>
</tr>
<tr>
<td>Transport, logistics, stamp</td>
<td>4.3%</td>
<td>Warmth</td>
<td>5.8%</td>
</tr>
<tr>
<td>Development</td>
<td>3.7%</td>
<td>Protection, defense</td>
<td>5.3%</td>
</tr>
<tr>
<td>Sustainable</td>
<td>3.5%</td>
<td>Health, medicine, pharmacy</td>
<td>4.6%</td>
</tr>
<tr>
<td>Industry, works, construction</td>
<td>3.5%</td>
<td>Fraternal</td>
<td>4.3%</td>
</tr>
<tr>
<td>Simple, sober, basic</td>
<td>2.9%</td>
<td>Sun</td>
<td>3.6%</td>
</tr>
<tr>
<td>Car</td>
<td>2.7%</td>
<td>Friendship</td>
<td>2.9%</td>
</tr>
<tr>
<td>World, planet, earth</td>
<td>2.3%</td>
<td>Equality</td>
<td>2.9%</td>
</tr>
<tr>
<td>Cold</td>
<td>2.1%</td>
<td>People</td>
<td>2.6%</td>
</tr>
<tr>
<td>Hope</td>
<td>1.9%</td>
<td>Social</td>
<td>2.4%</td>
</tr>
<tr>
<td>Army, military, soldier</td>
<td>1.6%</td>
<td>Poor, disadvantaged</td>
<td>2.4%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1.4%</td>
<td>Attention</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

The results of the nonprofit brand image scale from Michel and Rieunier (2013) also supported the conclusions of the semiotic study (Figure 5). Logo 1 scored high on the item related to the impression of seriousness but also suggested an organization perceived as not very sympathetic, generous or warm. In contrast, logo 2 scored high on items related to sympathy, generosity and friendliness. Yet this perception was not incompatible with an image of seriousness, as logo 2 scored close to logo 1 on this item.
Discussion and conclusion

This research enriches theory about graphic design and brand communication in several ways.

First, it proposes a conceptual and theoretical framework derived from semiotics that should lead to deeper insights into brand communication. This framework enables the simultaneous study of textual and visual content and takes into account the possible interactions between these different types of “signifiers.” By doing so, this framework provides a truly holistic approach (Henderson & Cote, 1998; Henderson et al., 2003; Orth & Malkewitz, 2008) and can be used by other researchers to analyze and test other logos or other kinds of visual materials used by brands to communicate their identity.

Second, it provides empirical evidence that the semiotic approach helps marketing managers to anticipate the associations of ideas generated by a graphic design in the minds of consumers. It thus demonstrates that semiotics offers a methodological approach that marketing managers can use to optimize their communication media. In this respect, it responds to a direction of research identified by Mick et al. (2004). It also offers an interesting alternative to the holistic but purely empirical approach proposed by Henderson et al. (1998, 2003, 2004) and replicated by Orth and Malkewitz (2008), and to the analytical approaches wherein some design elements (like colors or typefaces) are manipulated independently during experiments. As it includes an experiment on a less often studied communication medium (the logo and not packaging), it also reinforces the external validity of the conclusions drawn by Ares et al. (2011) and Piqueras-Fiszman et al. (2011).

Third, this research also extends semiotic theory by describing and confirming the phenomenon of double anchorage: we show that the interaction of a logo’s textual content and visual aspect is likely to modify the meaning of the transcribed text. This in
turn supports the notion that the two levels of meaning in typography are not independent but interact. This finding should be of strong managerial interest as it highlights the importance of taking into account the denoted and connoted meanings of a brand’s name when designing a logo. As it is still frequent to observe logos whose graphic design is not relevant to the brand identity – especially among small businesses or start-ups – this article should interest entrepreneurs as much as marketing managers. It highlights the variables that should be taken into account when designing a logo, proposes a methodology for analyzing the meanings that a logo is likely to generate, and demonstrates that this methodology is efficient.

Last, this text presents the “stencils,” a typeface family from the typographer Jean Alessandrini’s (1979, 1980) classification. To our knowledge, this family has never been presented in the marketing literature. It is missing from the classification proposed by McCarthy and Motherbaugh (2002) and the work of Hagtvedt (2011) on “incomplete” typefaces. This illustrates that marketing researchers would gain much from greater familiarity with the literature on graphic design. For example, familiarity with the history of stencil fonts helps to understand why using an “incomplete” typeface does not necessarily convey an image of modernity or innovativeness (Alessandrini, 1979, 1980; Blackwell, 2004; Heller and Vienne, 2012).

This study also presents some limitations. Choosing real logos instead of stimuli specifically designed for the experiment increased the external validity of the research but decreased its internal validity. Notably, the fact that logo 1 did not present any figurative imagery compared with logo 2 made it impossible to determine whether the associations of ideas observed for the two logos were produced by changes in typography, colors or imagery. Therefore, a direction for future research would be to replicate this study using ad hoc stimuli in which variables other than typography are controlled (i.e., two black and white versions of a logo differing only by their typography, as in Figure 3).

References


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**About the Author**

**Dr Franck Celhay** is Associate Professor at Montpellier Business School. He graduated in Marketing and Graphic Design. Major topics of research are graphic design, semiotics and marketing. He also works as a consultant in marketing and graphic design.
This paper introduces an overview and positioning of the contemporary brand experience in the digital context. With technological advances in games, gamification and emerging technologies, such as Virtual Reality (VR) and Artificial Intelligence (AI), it is possible that brand experiences are getting more pervasive and seamless. In this paper, we review the current theories around multi-sensory brand experience and the role of new technologies in the whole consumer journey, including pre-purchase, purchase and post-purchase stages. After this analysis, we introduce a conceptual framework that promotes a continuous loop of consumer experience and engagement from different and new touch points, which could be augmented by games, gamification and emerging technologies. Based on the framework, we conclude this paper with propositions, examples and recommendations for future research in contemporary brand management, which could help brand managers and designers to deal with technological challenges posed by the contemporary society.

**Introduction**

People are changing the way they interact with brands, products and services. Consumers are more connected through digital devices, such as laptops, smartphones, tablets, smart watches, fitness wristbands and video game consoles. This high adoption of digital technology has impacted consumer behaviour considerably. With this, the consumer experience has also changed. As mentioned in a report published by Deloitte (2016), this change in consumer behaviour has brought new ways to do business, including the
embracing of cognitive technologies (e.g. speech recognition systems, artificial intelligence, machine learning), virtual reality development (e.g. Google cardboard goggles and Oculus Rift utilised to promote immersive environments), high Internet connection around the world (e.g. broadband access and live streaming), touch technologies in m-commerce (e.g. consumers can pay through their mobile phones), cross-channel integration (e.g. consumers who interact in mobile phones also use their PC desktop) and strong social media participation (e.g. commerce is becoming more “social”). However, to what extent do digital technologies influence people’s experiences with a brand? The report, trendwatching.com (2017) indicates that people give value to brand experiences that are often virtual experiences that become part of one’s identity. Often, therefore, virtual experiences have the same level of importance as real experiences. In this context, even Google built an interactive and immersive shopping experience during Christmas holidays called Window Wonderland\(^1\), in which consumers could window shop from their home, but also have an immersive experience very close to reality. This is the result of the experience economy or, in other words, an economy and consumer society that see value in experiences people have with brands, usually supported by engaging activities (Pine and Gilmore 1998). This suggests that getting the attention from the consumer is not enough. It is necessary to focus on consumer engagement, evoking consumer participation and collaboration (Mcgonigal 2008). Hence, experience becomes a commodity; brands would have to compete in order to promote the best experience for the consumer.

A brand is a multifaceted approach to imprinting and distinguishing a particular product or service in the mind of the consumer. Over the years it has progressed from simple branding stamps to sophisticated logo design and different communication strategies. Since the 1990s there has been an acceleration of the ways in which brand identity can created and disseminated to the audience. The subtle changes have also meant that brand communications have moved from being pushed to the audience to becoming more interactive with the audience. These changes mirror the rise of the digital communication technologies beginning with the Internet and computers to more recently, the advent of social media platforms and mobile devices with Apps being linked to specific brands. People are now experiencing brands through digital platforms, clever algorithms and sometimes coming across new brand quite by chance. Brand experience design seeks to satisfy customers and through series of steps ensures that they get the maximum value from the brand concerned. Many companies will go above and beyond the normal steps and even delight the customer, so that they become more loyal to the brand. In this paper we wish to explore the steps that take place before a person actually purchases or experiences an item, through digital brand design experiences. We argue that these experiences can also be enhanced in the post-purchase stage through digitally based feedback and interactions. Considering those aspects, we ask:

- How are consumers likely to interact digitally with brands in the future?
- How does technology contribute to a virtual brand design?

In order to address those questions, we start by reviewing the current literature in brand experience and brand design, with the aim to identify the main elements from a holistic

\(^{1}\) https://windowwonderland.withgoogle.com/
brand experience that could be augmented by emerging technologies. As a result of this review, we present a framework for brand experience design in the context of technological changes. We conclude our paper by posing four future propositions based on this framework and examples in order to promote a holistic brand experience in a changing world.

Background
This paper aims to encompass the various stages of the customer brand experience and to understand how this changes with new digital experiences and developments that are taking place globally. We live in an age where the consumer is connected every day and every hour through various channels, including mobile or computer based. The variety of devices is continuously expanding and now we have intelligent watches that can not only geolocate but also feedback important health and fitness data. It is also apparent that brand managers are evolving different methods of interaction with the consumer, not only gauging their needs and wants in a more intelligent manner, but also offering relationships based on datasets that they hold and can analyse. In an age where we have smart connected products, the customer modes of interaction change from being passive to being active and engaged. Many products are connected to the Internet and are also part of a 'cloud' system, where they have access to data and remote software. Examples of this are smart cars such as Tesla, intelligent electric bicycles (Pedelec, Van Moof and others) using systems such as SEMS\(^2\) and fitness trackers such as Apple Watch, Garmin fitness trackers and FitBit to name a few. In addition we also have many devices such as household appliances linked to the cloud as well as home control devices such as Nest for tracking energy usage. According to Porter and Heppelmann (2015) these smart devices not only create value but are also changing the competitive landscape by offering new capabilities. This means that a brand has to be able to incorporate a myriad of pre-purchase, purchase and post purchase experiences into its design.

Brand design
When people engage with a product or service a whole spectrum of experiences come into play, from the encounter with the brand, through magazines or digitally to actual purchase, use and after use service care. The way in which these interactions take place and the way in which either positive or negative experiences occur will determine the total brand experience of the consumer. This experience and the carefully orchestrated design of this experience will affect the value, validity, integrity and strength of the brand.

According to Newbery and Farnham (2013) a brand is connected in a business through four areas as depicted in Figure 1. These are presented by as:

- **Strategy**: the core corporate strategy, encompassing the mission, vision and core meaning for the brand and its positioning, together with functional components such as technology strategy, product/service strategy and market strategy.
- **Expression**: How is the company identity portrayed and articulated? What communication strategies in marketing and advertising as well as company presentation through graphics and trade press increase recognition for the company.
- **Value**: The actual products/brands, services and solutions that a company may place into the marketplace, including the tangible, intangible and aspirational values.
- **Engagement**: How people outside the company (press, partners, most importantly customers) interact with and interpret what the business is doing (the manifestation of strategy, expression and value). This includes the basic journey from awareness to consideration, purchase, and use of the brand, as well as cycles of relationship with the business over time. Experiences are delivered through a range of touch points and mechanisms, some owned and controlled internally by the brand and some outside it.

In other words, a brand is composed of many aspects, particularly external and internal, involving complex and subjective variables such as emotions, experiences and beliefs that are interrelated and integrated with the brand’s mission, value and strategy. However, how can designers make sure that all touch points are integrated in order to give the best experience to the consumer?

A common approach utilised by brand managers and designers to build a strong and powerful brand is the model of Customer-Based Brand Equity (Keller 2001). As shown in Figure 2, brand equity has six components that form a pyramid in terms of levels of engagement with the brand. For example, resonance is the top level of brand equity,
reflecting the intensity of the relationship between consumers and the brand. At this level, the brand becomes more subjective but also more human, as it involves relationships, connectivity and conversations. Thus, if considering Farnham and Newbery’s (2013) four points of value, engagement, expression and strategy, there is a connection between each of these points and the levels of brand equity. For example, brand resonance could involve all four points, but particularly engagement, as resonance reflects an action, instead of just attitudes. That is, brand equity moves from attitudes to behavioural actions. With this in mind, it is possible that each experience with the brand has different levels of interaction. For example, it is possible that consumers might start through brand awareness, moving towards attitudes and finally to engagement. This suggests that the consumer journey is always in movement. The challenge, however, is to understand the role of technology in this movement.

When expanding the resonance level, there are four sub-components identified by Keller (2001); these are loyalty, attachment, community and engagement. Curiously, for each of these sub-components, it is possible to identify technological applications:

- Loyalty stands for purchase repetition, which reflects a sense of quantity (e.g. how often consumers buy products, how many interactions consumers have with the product, etc.). Gamification is one way to encourage loyal behaviours. For example, loyalty programs reward consumers by their constant product use, such as the acquisition of points in different flights or points when you purchase a cup of coffee. With this, systems have the ability to calculate the amount of consumer interactions and transform them into points and rewards.

- Attachment means that consumers have a strong emotional link with brands. This emotional link can be reflected on User Experience design processes (UX). As mentioned by Hassenzahl (2008), UX is about understanding feelings and experiences that people have with technologies, particularly because people interact with these technologies in order to find pleasure, social conversations and insights. That is, once brands and technologies merge, brand managers and designers should pay attention to UX features. In this case, this emotional attachment could be understood by pragmatic (e.g. manipulation) and hedonic (e.g. pleasure, stimulation, identification, etc.) qualities of the brand or product (Hassenzahl 2005).

- Community is about social identification around the brand. (Muniz and O’Guinn 2001) explain that brand community can emerge from the collective association with brand values, in which they can share information about the brand and communicate with other consumers. With the growth of the presence of brands in social media (e.g. Facebook pages, Twitter, Instagram, forums, blogs, etc.), brand communities are getting a real voice.

- Engagement is about personal investment and involves loyalty, attachment and community. That is, engagement could be augmented by the support from social media, user experience design and gamification, for example.

In both Keller’s (2001) and Farnham and Newbery’s (2013) work, engagement is the strongest level of brand equity. However, can technology influence engagement?
Engagement can be mediated by technology. In fact, elements like having a sense of control, challenge or aspects of novelty and feedback could enhance engagement in digital environments (O’Brien and Toms 2008). For example, challenges in games are crucial in order to build engagement, whereas having a sense of control is strongly related to usability and user experience (O’Brien and Toms 2008). Engagement is also similar to the concept of game immersion. That is, in games, engagement is just the first level of game immersion, which goes through a stage of emotional attachment and a level of total immersion (i.e. presence) (Brown and Cairns 2004). The concept of immersion can also be augmented by technology. As Brown and Cairns (2004) mentioned, Virtual Reality could trigger game immersion. Considering this, it is possible to ask: Can emerging technologies like Virtual Reality promote a smoothly transition from brand awareness to resonance and higher levels of engagement? Can games and emerging technologies combine awareness and meaning, moving the consumer journey towards engagement? What would be the state of brand experience if consumers could experience the brand in each level of brand equity?

![Brand Experience Diagram](Image)

**Figure 2  Customer-based brand equity (Keller 2001)**

**Brand experience**

Experiences around brands could take the form of images or the projection that brands have upon people’s lifestyles, influencing consumer behaviour through mental concepts (Hultén 2011). This aspect is one of the pillars of multi-sensory brand experience, developed by Hultén (2011) as a way to understand the human characteristic behind experiences people have with brands, including sensory experiences and self-fulfilment. In this scenario, the sensory part of the brand evokes extremely high and engaging relationships between consumers and brands. What Hulten (2011) explains is that the brand experience becomes the brand image through sensors, sensations and sensory expressions (Hultén 2011, p.263), such as, for example, the sense of smell that would give an atmospheric sensation to the consumer and end up building sensory expressions like brand signature. The multi-sensory characteristic of the brand promoted by Hulten (2011) explores the multi dimensions of the brand, showing that brands are part of human lives in different levels.

It is important to remember, however, that brand experience could go beyond sensory design. Brand experience is also composed of sensory, affective, intellectual and
behavioural dimensions (Brakus et al. 2009). This suggests that brand experience incorporates actions, knowledge and understanding. That is, the experience is not passive. On the contrary, consumer experience involves co-creation and participation (van Doorn et al. 2010).

The experience that people have with the brand plays a huge role in the overall brand equity. This suggests that brand experience is a core element of a successful brand. However, the challenge is to understand how designers could manage and monitor such brand experiences.

One way to promote positive experiences to consumers is through consumer engagement using different brand touch points (Newbery and Farnham 2013). The idea of including touch points and a consumer journey behind the brand opens the door to sensory design and service design (Zomerdijk and Voss 2010). In this case, the brand could function as a service, mapping the consumer journey since the decision to buy a product until the decision to buy it again. With this, the brand experience could be seen as non-stop activity, functioning like a cycle and augmented by multi-sensory experiences. However, how can technology sustain this cycle? Is the consumer always back to the same level of interaction with the brand?

Consumer journey
Brand experience functions as a journey that consumers have around the several points of interaction with the brand. These points of interactions are the touch points of the brand (Zomerdijk and Voss 2010; Newbery and Farnham 2013). If considering the whole consumer journey, it is possible to separate this process into three stages: pre-purchase, purchase and post-purchase. This aspect was introduced by Davis and Dunn (2002) in a brand experience wheel, which functions as a cycle through several touch points related to each consumer stage (see Figure 3). Thus, for example, in the pre-purchase stage, consumers interact with advertising strategies and the company’s website, while in the purchase stage there is a strong presence of sales strategies and in the post-purchase phase consumers are introduced to loyalty programs. Thus, it is possible to underline touch points that would have the presence of technology like website, advertising, newsletters and loyalty programs. However, since consumers are embracing and adopting pervasive technologies, like mobile phones, it is possible that the connection between consumer and brand is more constant than ever. Considering this, in a digital context, it is possible that brands could use technology to manifest strategy, value, expression and engagement through digital experiences. Yet, there is still little understanding on how can technology contribute to a virtual brand design, particularly if considering new and emerging technologies. What would be the state of brand experience if the touch points in the pre-purchase stage were still present in the purchase and post-purchase stage?
With the constant use of digital devices by consumers, there is a strong influence of technology in each of those touch points from brand experience. Considering that people and businesses are also increasingly adopting emerging technologies such as Internet of Things (IoT), Virtual Reality (VR) and Artificial Intelligence (AI), it is possible that brands are becoming more human, more interactive, more pervasive and more multi-sensorial.

Combined with this, games and gamification are also design strategies that utilise a variety of technological inputs to design an engaging, fun and pleasurable experience to consumers. Thus, the brand touch point wheel would be in constant movement, perhaps in a loop, in which each consumer purchase stage is merged with the touch points. Considering those aspects, therefore, it is crucial to understand the impact and applications of games, IoT, VR and AI in the contemporary brand experience. In the next subsections we explore the influence of each of these digital experiences in brand design.

**Games and brand experience**

There are at least two ways to understand the application of games in order to enhance brand experience: advergames and gamification. Advergames are mainly advertising in form of games (Bogost 2007), whereas gamification is the use of game design elements in order to promote gameful experiences to people in non-leisure contexts (Deterding et al. 2011). The difference between them is that advergames function with all the game design elements, whereas gamification is a design strategy that uses “parts” of these game design elements to promote game-like interactions.

Advergames can help brands to build brand equity, particularly because of the interactivity promoted by the advergame (Deal 2005). This interactivity level has changed
since the first advergame, particularly due to technological advances. According to Bogost (2007), one of the first advergames was created in 1976. That was an Atari car racing game, sponsored by a brand. During the 1980’s, different products and services started to use advergames as advertising strategy. The games were played in console platforms. In the 1990’s, the Internet took a great part of the game’s format. With games created in Flash™, it was easier to build different approaches, like simulations of experiences with products. Increasingly, the advergames were created to build brand awareness and new experiences in different platforms and scenarios. Due to the use of advergames to advertise brands, the game itself could be centralised around a brand message (Chen and Ringel 2001), attracting attention to interactive content through pleasurable experiences (Cauberghhe and De Pelsmacker 2010). In other words, the game becomes the advertising, created around brand values and branded entertainment (Winkler and Buckner 2006). The expression of entertainment by or in conjunction with a brand appeared as a product placement strategy, particularly in TV, movies, and it is used to define branded entertainment (Lehu 2007). The entertainment and ease with brand interactions make customers familiar with the brand and develop an experience that they remember either as pleasurable, informative and useful or just fun and frivolous, something that does not trigger any desire to go ahead with a purchase either digital or physical.

Games and brands are becoming each time more pervasive. With the wide adoption of mobile games like Pokémon Go, the utilisation of Augmented Reality (AR) is becoming more common each time. In fact, KFC utilised a Pokémon Go style game to invite consumers to their stores using AR and mobile platforms (Alizila 2016). This shows that real and digital worlds are merging, which makes the brand experience more seamless. The ability of consumers to interact with the brand is called brand interactivity, which means that consumers can interact with the brand directly, facilitated by immersive technologies, such as game platforms, AR, mobile phones and others (Lee et al. 2013).

**Virtual Reality and brand experience**

Virtual reality is a concept that extends the idea of telepresence or in other words a sense of being “there”, mediated by technology (Steuer 1992). VR creates different opportunities for different types of brands. For instance for place brands it can offer interesting experiences of a place before a visit. VR can also be incorporated as brand experience for retail outlets. However in time to come it is probable that brands will create VR/AR experiences for customers so that they can experience brands through interaction by ‘physically’ holding objects. Rotating them and getting a “real” feel of the style and design. It would not take too much imagination to make an interactive game of dismantling an object or playing with a particular design element. For example, McDonald’s created a Happy Meal\(^3\) goggles for VR experiences, in which consumers could build their own VR goggles from the Happy Meal box and play a VR game using them with their mobile devices. This shows that VR can become an affordable technology and brands should see this as a new opportunity to develop positive brand experiences.

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\(^3\) [http://happygoggles.se/en/](http://happygoggles.se/en/)
Internet of Things and brand experience

Internet of Things is mainly about communication. This means that instead of human communication, everyday objects or “things” can communicate to each other through the Internet (Gershenfeld et al. 2004). Beacons could be one example of the utilisation of IoT in marketing and brand experience. For example, retail shops are utilising intelligent beacons (i.e. small devices that transmit data to other devices through Bluetooth) to send contextual messages to consumers when they visit their retail store, combining data from both online and offline shopping (Lewis 2016). If considering the brand touch points, IoT could be extremely useful in the pre-purchase stage, attracting consumers to interact with brands while making their experience more tangible and relevant; however IoT may also influence the post-purchase stage, communicating messages with consumers in order to straight the brand-consumer relationship.

Artificial Intelligence and brand experience

Technology has gained a boost from the advances on cognitive technology and Artificial Intelligence. In a report published by Deloitte (2016), showed that consumer experience has become more digital, more personal and more immersive. For example, cognitive technologies that utilise Artificial Intelligence (AI) algorithms can learn from the data, through natural language processing (NPL) and deliver a personalised consumer experience. That is, if considering Dunn and Davis (2002), model, it is possible that each touch point would be integrated to those algorithms, providing consumer data to brands. With this, the brand experience creates ramifications and becomes intelligent, just like a person would react to an action.

Another example of this application is the utilisation of chatbots, or in other words, “humanised” robots that chat with consumers through virtual chats. For instance, the Mall of America⁴ created a chatbot similar to a Facebook Messenger to talk to consumers and give them advices about what to buy during Christmas holidays. This “live” chat was designed to function just like a chat with a consultant, who would be able to help consumers to make choices. By using an interface similar to Facebook Messenger, iMessage and Whatsapp, brands are gaining voices, which are becoming each time more real. Could consumers tell the difference between a chatbot and a consultant using a messenger?

⁴ http://elf.mallofamerica.com
Table 1 Digital touch points and brand experiences

<table>
<thead>
<tr>
<th>Digital touch point</th>
<th>Brand experience</th>
<th>Stage</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Games</td>
<td>Interaction with the brand in different devices</td>
<td>Pre-purchase, post-purchase</td>
<td>A Pokémon Go style game designed to invite consumers to KFC stores</td>
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<tr>
<td>Virtual reality</td>
<td>Immersive experience with the brand</td>
<td>Pre-purchase</td>
<td>Happy Meal Virtual Reality goggles created with the Happy Meal box in which consumers could experience the brand using the goggles and play an online game</td>
</tr>
<tr>
<td>Internet of Things</td>
<td>Constant conversation with the brand</td>
<td>All stages</td>
<td>Intelligent beacons being used in retail stores to send data to consumer’s mobile phones</td>
</tr>
<tr>
<td>Artificial intelligence</td>
<td>Humanised brand</td>
<td>All stages</td>
<td>A live chatbot created to help consumers with their choices</td>
</tr>
</tbody>
</table>

The utilisation of games, IoT, VR and AI are expanding the role of the contemporary brand experience. In the examples mentioned in this section, it was possible to see a common point: that experiences are getting each time more seamless, more human and more pervasive. That is, if considering the consumer behaviour journey, how can these emerging technologies augment and sustain brand experiences? In order to address this question, we created a framework, which is presented in the next section.

A framework for brand experience in a digital world

Since the digital world is merging with reality and experiences became a commodity, emerging technologies are gaining space and changing the way people interact with brands. When studying the consumer journey of pre, post and purchase stages, these technologies could enhance the level of experience with the brand through different but integrated touch points.

Considering this, we ask:

- What will be the model of interaction pre-purchase and post purchase?

With this in mind, we introduce the framework for a spiral brand experience, based on the characteristics and applications of emerging technologies in the digital world. For that, we considered the three main stages of consumer journey: pre-purchase experience, purchase experience and post-purchase experience (Davis and Dunn 2002). The difference is that we added the challenges based on the touch points integrated with digital technologies like IoT, games, AI and VR. In addition, we introduced a concept of a spiral brand experience (see Figure 4). That is, consumers start their journey in one point, but once they go back to the first stage, this stage is different. We explain each of these stages in the next subsections.
Pre-purchase stage

This stage is when the consumer encounters the brand through various channels both physical and virtual. It is clear that the digital experiences that can be created have brought the customer closer to the brand than before. Websites now allow customisation of cars, design of clothes$^5$ and footwear$^6$, greetings cards$^7$, to name a few. Other brands aim to create a brand experience through gamification and advergames. Davis and Dunn (2002) has showed in their model that in the pre-purchase stage, websites are strong brand touch points, together with advertising strategies. With the quickly adoption of emerging technologies by companies and consumers, websites and advertising campaigns are getting more interactive and more pervasive. These technologies not only merge reality with digital, but it also increases the level of immersion that consumers have with the brand. For instance, consumers could have experiences with the brand before buying it. One example is United Airlines$^8$, which created a VR experience in 360º to show their new business class features to consumers before booking a flight. This could not only help brands to build stronger links with consumers before the actual experience, but it could also provide data for market and user research, since consumers could give feedback on the virtual world. Thus, combined

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$^5$ www.itailor.com  
$^6$ https://www.shoesofprey.com/  
$^7$ www.bluemountain.com  
$^8$ http://thinkingbox.com/unitedairlinespolaris
with consumer feedback, each interaction with those digital touch points, there would be important data that could inform about consumer’s lifestyle and choices beforehand. At this stage, chatbots can be also utilised. For example, consumers could interact with intelligent machines that would be able to give them advices on what to buy. Another engagement platform that is becoming increasingly important is the app platform, which allows digital engagement, as well as possibility of purchases. It has become very important in the consumption of ‘soft’ services such as education, recreational arts, health etc.

**Purchase stage**

The purchase stage occurs when the consumer has already decided to buy a product. In other words, in the purchase stage the consumer has already established attitudes towards the brand. If considering the brand equity model, it should represent feelings, judgements and brand associations. At this stage, technology could function as a facilitator, in order to promote a smooth journey for the consumer. In many ways the purchase stage is changing rapidly with sites such as Amazon actually predicting a customer’s behaviour and making the buying process easier. A better experience through a digital channel enhances the brand experience. New developments such as Alexa\(^9\) are now making ordering easier through voice recognition, providing a seamless Internet purchase experience. Companies’ websites can also provide this experience. Some brands now have interfaces that connect to the Internet via mobiles, offering post purchase help on working with the brand, be it a refrigerator, vacuum device, car or even a watch. These interactions can range from YouTube information to visual explanations for better use of the product. Companies are groping with making this more personalised and some send you updates and new offerings through emails or alerts, or personalised websites. Integrated with pre-purchase experience applications, like VR shops, for example, consumers would be able to purchase products by a click in a website or touch. With advances in mobile technologies, consumers could pay for their products by touch, contactless cards or possibly paying for goods with your eyes. For example Samsung has created a retina scanner that can detect your eyes and unlock mobile payments (Bell 2016). On Apple App purchases for instance, touch id can be used to facilitate purchases.

**Post-purchase**

As brand resonance is a relationship, it should be sustained overtime. Technology is a perfect partner for providing brand resonance. In fact the discussion above already alludes to this. A digital interaction happens post purchase and a better seamless interaction actually provides a customer with a chance to engage with a purchased item over time and interact with the brand and build a long-term relationship. Computers and mobile devices do this all the time as a result of software updates, new features, and new add-ons. However the trend towards smart machines and devices means that this interaction can happen with a range of products and devices. IoT will play a large part in this. The growth in technology means that there is an explosive growth in information. This information is now getting so large that the human brain cannot cope with it. In fact it is likely that in the future, customers would prefer to have brands that just inform them of

\(^9\) http://alexa.amazon.com/spa/index.html
changes when necessary, but otherwise communicate with the cloud and update their facilities seamlessly, only bothering the consumer once in a while. Maybe less attention means better brand resonance. At this stage, it is possible that consumers have left their digital footprint of their relationship with the brand. That is, since their first interaction with the brand, data has been stored in digital systems and could be used to inform brands about the post-purchase stage. In addition, it is possible that brands could have access to consumer’s social media, mobile phone or even physiological data (e.g. through the use of wearable technologies like smart wristbands). The access of this data informs brands about consumer’s lifestyle, mood and decisions in other aspects of their lives, which may influence their relationship with the brand. That is, brands could become consumer’s friends, building an emotional bond that is sustained through intelligent data analytics. In this context, gamification could still play a huge part through rewarding systems and loyalty programs. If combined with machine learning algorithms that could detect people’s interactions and reward them accordingly, there is a huge potential to keep the consumer engaged over a long time.

The spiral
The idea behind the brand experience spiral is that consumers start in the pre-purchase stage, going to the purchase action and the post-purchase phase, but they go beyond the cycle. Like a spiral, consumers in the pre-purchase level would not start at the same level as they have started in their first purchase, since it will not be their first experience with the brand (see Figure 4). Hence, there would be consumer expectations involved in the new level of brand interaction. Consumer expectations are related to repurchase behaviour, mediated by confirmation of expectations and satisfaction (Kim 2010). This would be a result from the difference between the first points of interaction with the brand and a new point of interaction with the same brand. This new point of interaction could reflect a loyal behaviour, suggesting that consumers would have expectations towards the brand, as they are now loyal to it. For each touch point, there is consumer data that could be integrated in order to promote a holistic experience to the consumer. In other words, it is a way to say that if consumers had positive and memorable experiences, these will trigger further behaviour, such as repurchase behaviour (Norman 2008). This means that consumers will be able to find value in each interaction with the brand. With this, the spiral is a conjunction of touch points that function like a network of data, informing brands the importance of each point of interaction with consumers.

The spiral framework functions, therefore, as a representation of the position of the emerging technologies in each brand touch point, considering the consumer journey in a holistic way. Thus, in order to expand the framework we posed four propositions for the future of digital interactions in brand experience. These are explained in the next section.

Propositions
In this section we introduce four propositions that could be used to investigate the impact of emerging technologies in contemporary brands and how brand managers could understand the applications and challenges of those technologies. Based on the arguments and discussions above, we make the following propositions as we slowly but surely become seamlessly integrated with technology:
P1: Consumers will embrace brands that offer them a good, engaging and informative digital experience in the pre-purchase stage.

This is based on the argument that as digital interactions become common and largely adopted, most individuals will react to the brand before purchase as discussed before and this will influence their likes or dislikes of this brand. This digital experience could encompass many forms such as AI interaction, gamification or advergaming interaction. In addition, consumers could virtually “experiment” the product before purchasing it through VR interactions.

P2: Brands that embrace IoT and can ‘talk’ to the cloud will enhance the purchase and post purchase experience.

The premise here is that the average individual is actually experiencing information overload in the current digital world. Any system which self manages and only needs occasional check ups will be favoured by the many. Basically customers need to be cushioned from too many tasks regarding a purchase.

P3: Brands will become more humanised.

Companies can now obtain large amounts of data with regards to a person and his/her preferences. Choices offered according to these preferences will ensure that the customer is kept informed and develops loyalty to the brand. With this, artificial intelligent algorithms can learn from this data and each interactive point with the brand, providing a more “human” experience to consumers.

P4: Brands that embrace a full pre-purchase, purchase and post purchase through digital touch points will create more loyalty than companies that do not take a holistic view.

The main principle of this proposition is the holistic and continuous characteristic of the brand experience. This is based on the framework presented in the previous section, which represents that for each brand touch point there is an outcome. For example, when consumers interact with the brand, there will be data from this interaction; at the same time brands would be able to learn from this data and deliver a relevant, consistent, contextual and personalised interaction for the consumer. This data would be stored and could be used again in order to promote more relevant interactions between consumers and brands. This holistic point of view could represent a non-stop interaction, since devices collect data from consumers in a content database. At this stage, games could help to build the first interaction (e.g. gamification, advergames, in order to build “habits”, new behaviours, brand awareness, etc.). After the “new” consumer behaviour is adopted and consumers are already engaged with the brand, they could be nudged to interact more with brands in a constant base. With this, brands will become more organic, humanised and personalised.

The four propositions presented in this section illustrate the role that digital interactions play in developing a holistic brand experience. Thus, it is possible that with new applications of digital technologies, the brand itself would change over the time. Would brands become more human? To this extent, it is also important to mention a few challenges that might emerge in this scenario. For example, the main challenge for brand managers and designers is to build a personalised brand, instead of an automatic one, based on user data. In addition, other challenges might emerge such as data ownership,
privacy, security and ethics. Since consumers are sharing their personal data with brands, brands should be transparent about what are they doing with people’s data.

Conclusions and implications

With the adoption of emerging technologies such as VR, AI, games and IoT by brands and consumers, it is possible to see a transformation in consumer behaviour, particularly at the different stages of decision-making. Taking this into account, this paper reviews the main applications and challenges posed by these technologies, with the aim of understanding the impact of digital technologies on brand experience. While observing these challenges, it is possible to notice various opportunities that technologies offer on the total brand experience, in effect transforming and informing the customer journey at each brand touch point. With this in mind, we introduced a spiral framework for brand experience, respecting the three stages of the consumer journey (pre-purchase, purchase and post-purchase), but with the addition of touch points indicating that consumers could expect more from the brand experience during their consumer journey (see Figure 4).

Developing and designing a good brand experience is becoming more important as mentioned by (Davis, 2017) as he mentions that ‘Despite the hype around ‘personalisation’ as a marketing trend, as many as 89% of brands report they cannot deliver personalised digital experiences, research by Acquia has found’. A lot seems to depend on how well personal experiences can be designed and executed.

This paper also introduced four propositions for the future of brand experience in the digital world. These four propositions embrace emerging technologies as agents of transformation, promoting a holistic brand experience through digital and real brand touch points. Challenges about data ownership, privacy, trust, transparency, security and ethics are also important points to consider. It important, therefore, that brand managers and designers should be aware that in designing a holistic brand experience would also bring huge responsibilities for brands.

In the future, we expect that the four propositions presented in this paper could be evaluated. Future research is also needed in order to validate the framework and take it further.
Table 2  Examples of digital touch points

<table>
<thead>
<tr>
<th>Example</th>
<th>Digital touch point</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Window Wonderland</td>
<td>Virtual Reality</td>
<td><a href="https://windowwonderland.withgoogle.com/">https://windowwonderland.withgoogle.com/</a></td>
</tr>
<tr>
<td>KFC <em>Pokémon Go</em> style game to invite consumers to their stores using AR and mobile platforms</td>
<td>Games</td>
<td>(Alizila 2016).</td>
</tr>
<tr>
<td>Happy Meal goggles for VR experiences</td>
<td>VR</td>
<td><a href="http://happygoggles.se/en/">http://happygoggles.se/en/</a></td>
</tr>
<tr>
<td>Retail shops are utilising intelligent beacons</td>
<td>IOT</td>
<td>(Lewis 2016).</td>
</tr>
<tr>
<td>Mall of America created a chatbot</td>
<td>AI</td>
<td><a href="http://elf.mallofamerica.com">http://elf.mallofamerica.com</a></td>
</tr>
<tr>
<td>United Airlines, which created a VR experience in 360⁰</td>
<td>VR</td>
<td><a href="http://thinkingbox.com/unitedairlinespolaris">http://thinkingbox.com/unitedairlinespolaris</a></td>
</tr>
<tr>
<td>Samsung retina scanner that unlocks mobile payments</td>
<td>AI</td>
<td>(Bell 2016).</td>
</tr>
<tr>
<td>Apps</td>
<td>Games/Purchases, interactivity</td>
<td></td>
</tr>
</tbody>
</table>

References


About the Authors

**Vanissa Wanick** is a PhD researcher at Winchester School of Art, looking at advergames across cultures. Her research interests are multidisciplinary and include cross-cultural HCI, games user research, gamification and sustainable consumer behaviour.

**Dr. Ashok Ranchhod** is Principal Teaching Fellow in Marketing Communications within Winchester School of Art at the University of Southampton. His research focuses on Branding, Serious Games Design and Marketing Communications, He has published extensively in these areas.

**Dr. Calin Gurau** is Professor of Marketing at Montpellier Business School. Calin has published widely in many top journals in areas such as digital marketing, communications and Entrepreneurship.
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Theme 6: Capabilities
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Section 6.a
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Introduction: Building New Capabilities in an Organization

DE LILLE Christine\textsuperscript{a}; PRICE Rebecca\textsuperscript{a}; WRIGLEY Cara\textsuperscript{b} and DORST Kees\textsuperscript{c}

\textsuperscript{a} Delft University of Technology, Netherlands  
\textsuperscript{b} University of Sydney, Australia  
\textsuperscript{c} University Technology Sydney, Australia

Introduction

There is an increasing need for organizations to adapt to rapid changes in society. This need requires organizations’ and the leader within them, to explore, recognize, build and exploit new capabilities. Researching such capabilities has drawn attention from the design management research community in recent years. Dominantly, research contributions have focused on perspectives of innovation and the strategic application of design with the researcher distanced from context. Descriptive and evaluative case studies of past organizational leadership have been vital, by building momentum for the design movement. However, there is a need now to progress toward prescriptive and explorative research perspectives that embrace context through practice and the simultaneous research of design. Therefore, the aim of this track is to lead and progress discussion on research methodologies that support the research community in developing explorative and prescriptive research methodologies for context-orientated organizational research. This track brings together a group of diverse international researchers and practitioners to fuel discussion on design approaches and subsequent outcomes of prescriptive and explorative research methodologies.

6 perspectives on approaching research in building design capabilities

We begin our conversation on the move, with \textit{The Application of UX Research in New Energy Vehicle Innovation}. The contribution from Ning Xiaoq, Menghan Tao, Xingfu Zhao, Yi Fan and Wenbin Liu provides rich insight into the China’s clean mobility innovation challenge and the importance of UX research for bridging the adoption from fossil to ‘clean’ energy fueled vehicles by China’s growing bourgeois. Conversation then turns to
managing design in a knowledge based economy, with Sylvia Liu presenting the contribution, *A Conceptual Framework of Dynamic Design Management Capability*. Liu will present and discusses a conceptual framework to manage design capabilities and performance – with the framework geared toward the nuances of a knowledge economy. This conversation provides an appropriate prelude to the following paper, *Using Design Thinking to Improve Strategic Decisions during Collaborative Sensemaking*. Ekaterina Kotina, Mikko Koria and Sharon Prendeville of Loughborough University London shift attention to addressing potential cognitive bias during strategic decision making through applying design thinking. This contribution offers a platform for future research via a framework on how to identify and mitigate confirmation bias during strategic decision making. Attention then turns toward service design. Sirpa Liisa, Alison Rieple and Caroline Ennis present, *A model of service design elements to understand innovative service processes*. This paper addresses an understanding of innovative services by comparing service design logic with the entrepreneurial logic of causation, effectuation and bricolage. Empirical evidence is provided to show how service design logic and entrepreneurial logic assists more innovative service design outcomes. The track continues with contribution from Abigail Hird of University of Strathclyde, presenting, *Externalising, sharing and comparing perceptions in design*. Hird will describes and reflects upon the notion of knowledge models in design. Antonius van den Broek and Alison Rieple of University of Arts London and University of Westminster then shift our attention to *Using actor-network theory to reveal strategy processes in design firms*. This paper illustrates the utility of actor-network theory (ANT) as a methodological approach to understand the effect of the eclectic characteristics of design firms on their strategy development processes.

This track has diversity of contributions - from originating institution, conceptual and empirical in nature, spanning various domains of design. We see a variation from industrial design, design management, service design, vehicle design and engineering to strategic design – all with the implicit but shared vision of how design can be applied to face societies emerging and known innovation challenges. This track in particular offers methodological guidance for future research at the intersection of design and innovation, with emphasis on proximity to the phenomena being studied. On behalf of the track editors, we thank the authors for their energy and commitment to the discipline. We wish the authors success and trust that the readers will find value immediately - and between the lines - of the articles within this track.
References


The Application of UX Research in New Energy Vehicle Innovation

XIAO Ning; TAO Menghan; ZHAO Xingfu; FAN Yi and LIU Wenbin*

GAC-TOYOTA MOTOR Co., Ltd., China
* Corresponding author: gzshiao@vip.163.com

New energy vehicles (NEV) as a new thing for sustainable development, in China, on the one hand has faced the rapid expansion of the market; the other hand, for the new NEV users, the current NEVs cannot keep up with the degree of innovation. This paper demonstrates the reasons for the existence of this systematic challenge, and puts forward the method of UX research which is different from the traditional petrol vehicles research in the early stage of development, which studies from the user's essence level, to form the innovative product programs which meet the needs of users and being real attractive.

keywords: new energy vehicles; UX research; essential thinking; product innovation

1. Introduction

With the increasing severity of global environmental problems and energy shortage, new energy vehicles, a type of environment-friendly vehicle with advanced technology, has been valued by governments, enterprises and users worldwide in recent years. It has achieved leapfrog development and become the future of automotive industry. In China, the development of NEV has become a national strategy.

NEV is a product of innovative technology, which means high costs in its development and manufacturing. Even though the cost has been coming down, it fails to fall below that of ordinary cars for a long period of time to come. In recent years, thanks to beneficial policies including government subsidies, the purchase cost of NEV became close to that of ordinary cars, resulting in a rapid expansion of domestic NEV markets as well as a surge of production and sales. These subsidies, however, is reducing year on year and will end up
zero in 2020. In the meantime, the cost of NEV is still high, giving rise to a urgent problem: how to persuade users to purchase expensive NEV?

At the same time, the development of NEV in China has two problems with regards to development method and users. On one hand, influenced by the thinking patterns and methods of traditional petrol vehicles, most NEVs in China’s market are developed based on traditional petrol vehicles, so that they are developed based on stereotype thinking patterns of vehicles. As consequence, NEVs, as an innovation, cannot present their advantages and is unattractive to users. On the other, users of vehicles in China are unique in their Chinese Scenery. In other words, they are insensitive to vehicle culture due to the lack of long-term influence, and do not have thinking set with regards to vehicles. As a result, they are more willing to accept new concepts and new vehicle products compared to customers in other countries. Furthermore, the number of NEV User Groups with Chinese Scenery is quite large around the world. Therefore, “How to attract them to buy NEVs” becomes a problem that is worthy of paying attention to.

In light of the status quo stated above, this thesis aims to conduct an in-depth study on users with research methods different to those used in tradition vehicle studies so as to put forward ideas that can influence or even change the research and development of NEVs. In order to persuade users to purchase relatively expensive NEVs and to popularize their usage, it has become vital to provide safe, convenient, comfortable and satisfactory experiences for users.

2. User Experience-Based Research Methods

2.1 Principles and Status Quo of Application of User Experience

The term "User Experience" was first put forward by Donald Arthur Norman (mid-'90s), a user experience designer. It is a terminology that describes the feelings, impression and evaluation of users on a certain product after they use it. User experience exemplifies how the product connects with the outside world and how it functions, namely how users make contact with and use the product. As the concept of "human machine interaction" is receiving increasing attention, evaluation criteria of systems and machine upgraded from simple usability engineering (function-dominated product) to a wider range of user experience. This encourages developers and designers in various fields to establish product plans and models that meet the real needs of users based on users’ experience.

Despite domestic research targeting on user experience are still at its infant age, it has great development momentum, with main focus on the design of internet and mobile handheld terminal. The application of user experience research in vehicle industry is still at the initial stage, whose theories are drawn from foreign studies. In addition, the product design and development process are underdeveloped. The research findings are limited as well. The focus of user experience research application is clear and definite: it lies in how to apply research results to the design and development of vehicle products, how to spread the concept of user experience among design and development personnel, and how to generate positive experience by different usage modes.

This research aims to solve the problems stated above and to introduce the new method of user experience research to the innovative research of NEV, a relatively complex and emerging product. The research also aims to find out the insufficiency of user experience
in the early phase of product design and development and tries to adapt it to the innovation of NEV in order to provide best experience to users.

2.2 **Difference from Market Research (Traditional Pre-phase Research Method)**

The main difference between this user experience research and market research lies in its aim and results. The aim of the latter is to formulate relative commercial and marketing strategies (e.g. market positioning and commodity definition) through defining potential markets and marketing opportunities, with the results of macro commodity solutions. The aim of the former, however, is to conduct studies on target user groups in the pre-phase of design and development, to set up concept models that meet the users’ need from the prospective of user experience, and ultimately turn it into shapes and functionalities that attract users. In this way, the user’s pain points are eliminated and the attractiveness of products are improved to the most extent. The relevance of the both is shown as Fig. 1.

![Figure 1](image)

**Figure 1  Relation between Market Research and User Research**

In addition, market research differs from UE-based user research in research objects, theoretical basis and research methods, etc. shown as Table 1.

<table>
<thead>
<tr>
<th></th>
<th>This experience-based user research</th>
<th>Market research in a narrow sense</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aims</strong></td>
<td>To innovate or to improve product design and development</td>
<td>To define marketing and product strategies, to provide basis for market positioning, commodity definition and marketing decisions</td>
</tr>
<tr>
<td><strong>Effects</strong></td>
<td>Improve market strength of products and attract target users</td>
<td>Improve the quality of marketing decisions</td>
</tr>
<tr>
<td><strong>Research object</strong></td>
<td>Typical individuals and its characteristics</td>
<td>Target groups, by summarizing the group characteristics and general characters</td>
</tr>
<tr>
<td>Output</td>
<td>Specific innovative plans of products</td>
<td>Macro commercial strategy (market positioning, commodity definition, etc.)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Theoretical basis</td>
<td>Anthropology, sociology, psychology</td>
<td>Marketing, statistics, sociology</td>
</tr>
<tr>
<td>Features</td>
<td>Mainly focus on qualitative investigation and emphasize on perceptual cognition</td>
<td>Take quantitative data as main verification basis and supplement with qualitative investigation</td>
</tr>
<tr>
<td>Methods: information gathering</td>
<td>Observation, interview, user-participated designs, life dairy, etc.</td>
<td>Quantitative questionnaire (face to face interview, phone survey, online interview, etc.), focus group discussion, mystery customer interview, etc.</td>
</tr>
<tr>
<td>Methods: information Analysis</td>
<td>Scenario analysis, persona, card sorting, brain-storming, cluster analysis</td>
<td>statistics analysis</td>
</tr>
<tr>
<td>Innovative points</td>
<td>In the process of information analysis, the method of workshop is integrated. Open mindniness and high activeness of mind result in an effect similar to &quot;1+1&gt;2&quot;</td>
<td>——</td>
</tr>
<tr>
<td>Participants</td>
<td>Specialists in industrial design, engineering, merchandise planning and marketing</td>
<td>Specialists in statistics, marketing, merchandise planning and advertising</td>
</tr>
</tbody>
</table>

Various precedents show that products which gain success in market research would not necessarily be popular after it appears on the market. The root cause for this is the lack of user research in the pre-phase of product designs and strategies, so that the product strategies cannot be implemented.

3. The Application of User Experience-Based Research in New Energy Vehicles Product Innovations

3.1 User Information Gathering
As stated above, user experience is the purely subjective feelings of users. This subjectiveness determines the multiple uncertainties of user experience. Therefore, it is necessary to develop a reasonable and effective process of user research so as to discover the innovative points that meet the users' need. This user experience research focusing on NEV helps develop plans of product innovation by an insight of user experience, discovery of typical NEV usage scenarios and an expanded analysis.

3.1.1 User Recruitment
Aim: to recruit users that fit the criteria of user research by screening the database of NEV.
Participants: researchers, user recruitment companies, NEV users
Method: data screening, phone interview screening
Output: a list of 10-12 users
The user recruitment has 2 steps.

1. Define users

The current users of NEV are mostly early adopters. Based on our research aim of improving user experience and delving into innovative opportunities of NEV, target users who have in-depth user experience are included in the research. Another reason of such inclusion is that one or a few representative target users can stand for the typical needs, habit of using, operational environment and impressions.

According to pre-phase brand research and market segmentation studies, features of NEV target user groups are drawn out (including basic characteristics, lifestyles and values):

- Age: 25 to 35
- Educational Background: bachelor’s degree or above
- Cities: Shanghai, Shenzhen, Guangzhou (first-tier cities)
- Models of Cars: BYD QIN, BYD E6, Venucia, ROEWE 550plug in, DENZA
- Lifestyle and values:
  1. Fond of new technologies, new designs and new experience, willing to share, strong-minded, confident, proud, fond of sports, health-sensitive, environmental friendly.
  2. The main reason of using NEV is that they are in favour of NEVs and new things. (Reasons such as low licensing difficulties, government subsidies and purchase tax exemption are excluded)

Base on the lifestyle and values stated above, researchers put forward the screening standards and edit a questionnaire.

<table>
<thead>
<tr>
<th>Questionnaire -SQ14. What do you think of innovative products?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compared to others, I am willing to buy innovative products</td>
</tr>
<tr>
<td>I will think twice and I will buy them after a friend recommend it to me.</td>
</tr>
<tr>
<td>I will buy them after they are widely accepted in the market.</td>
</tr>
</tbody>
</table>

2. Screening process (see Figure 2)

- Sample database screening of users: 100 users are screened out from a user database of approximately 1000 NEV users based on their basic characteristics (age, educational situation, model of cars and cities)
Questionnaire screening: According to the screening results of the questionnaire on lifestyle and values, researchers conduct telephone interview on 100 user samples, and 11 users included are willing to serve as the objects of the research.

3.1.2 Insights of Users Based on Scene Mining

Aim: to discover typical scenes of NEV use by having an insight on user experience on vehicles.

Participants: researchers, NEV users

Methods: observation, interview, participatory design, life dairy

Output: typical scene/ persona models

Researchers gather information through observing the user experience of typical NEV users. They will enter into their daily life, listen to their story on using NEV, observe their usage habit, and discover their needs. The aim is to analyse and integrate the information gathered and to establish several typical scenes of car usage.

A scene is defined as a process that users have to go through when they use the product to fulfil their goal. It can also be called as a Story. Some scenes describe successful results, while others reflect the problems in the usage of NEV. Through scene mining, researchers are able to delve into scenes to discover pain points and aspects that need to be improved, so that they can innovate on products.

It needs to pay attention that users and NEV have thousands of possible interaction situations, so scene mining should be targeted. This also explains why typical users are selected as research objects in the beginning.

In the observation of typical user experience from the 11 users selected, specified methods on user research are used, including observational technique, interview, participatory design and life dairy.

1. Observational technique: Researchers observe how users interact with NEV in real-time usage, including their usage of charging devices, in-car connectivity and in-car storage space. After observing static interaction, researchers stays inside the car while the user is driving and keeps observing his petty actions, operations and other more detailed experience in specific usage scenes. During observation, researchers take notes and use digital voice recorder, instant camera, digital camera and DV to record.
2. Interview: Researchers adopt the situational in-depth interview method. After observing the routine usage of NEV, researchers help users recover the life story about NEV by using visual tools such as cards and stickers, and collect materials that constitutes a scene.

3. Participatory design: Under user experience-based participatory design, users no longer accept ready-made products passively; instead, they participate in and make positive influence on design and development, so that the products can really meet their need. In this research, researchers help users to piece together an ideal NEV model and create ideal vision of cars with the aid of scene cards, so as to delve into the potential needs and aspirations of users.

4. Life diary: Users record the life diaries of weekdays and weekends in chronological order and sent them to researchers through Wechat. After receiving these diaries, researchers summarize them as elements to build up typical scenes.
3.2 Analysis of user information

3.2.1 Compilation and analysis of user information

Researchers compile the information and elements stated above into typical scenes and intensify typical features of users and set a foundation for the development of innovative plans.

Due to the fact that the information gathered is at a large quantity, in order to extract valuable information, researchers adopt several analysis methods including card-sorting, cluster analysis, scenario analysis and persona. Research results such as NEV users’ model and usage scenes are drawn from these analyses.

1. Using card-sorting to record the scene: Researchers record the scene by taking notes and photographs, drawing tables and diagrams and put them on cards. Users are required to give a clear and concise description of the scene without comments from others.

2. Using cluster analysis to merge the scenes: Researchers go through the scenes, find out the clues and common features, and sort the scenes and merge similar ones. Scenes will be analysed in this way twice with different perspectives as the clue. At last, researchers integrate the results of the three-round cluster analysis.
3. Using scenario analysis and persona to analyse and build up scenes: With scenario analysis, researchers combine segmented scenes and supplement them for the later development of innovative plans. During this process, researchers also adopt the method of persona to find out the actions, views of point and motive of real users and summarize their discovery as the description of typical users.

3.2.2 Discovery on Typical Users and Scenes
After three rounds of cluster analysis, researchers form typical scenes of 50 NEV users. With the use of persona analysis, researchers obtain two user models from the 11 users selected.

3.3 Formation of Innovative Plans

3.3.1 Innovation Workshop of Specialists
Aim: To formulate new ideas for individual scenes from the results of observation.
Participants: Hosts of workshops and their assistants, cross-divisional personnel of the company (12 to 16 people)
Method: brainstorming, World Coffee
Output: a bunch of innovative ideas on NEV
In innovation workshop, specialists of related fields are divided into several groups to brainstorm on the results of observation, and try to come up with as many innovative ideas as possible. Open-minded teamwork with highly active thinking results in an effect workshop.
In specialist selection, the experience of integrated new product development (iNPD) is borrowed to combine with models and principles of new product development. Specialists of design, marketing and engineering develop an integrated group during the "fuzzy initial phase" when the concepts of products are unformed. This group adhere to the sense of "user-oriented" during the design and development of product. With this in mind, products are more likely to be successful, more revolutionary and innovative.
Details of innovation workshop:

1. Participants are divided into 4 groups; each group shall contain specialists of design, marketing and engineering.
2. Within 2 or 3 days, researchers take NEV persona models and typical usage scenes as materials and weigh on the pros and cons of each scene with the perspective of users and under the help of hosts and tools. In this way, participants are able to focus on specific targets, discover opportunity points and problems and produce a great amount of NEV new ideas.

3.3.2 Summary of New Ideas and Formation of Innovative Plans
Aim: To formulate the final results of this research by summarizing the new ideas from the innovation workshop: innovative plans of NEV
Participants: researchers
Method: cluster analysis
Output: innovative plans of NEV
1. Phase 1 Screening: a preliminary evaluation of all ideas. Unreasonable ideas are screened out.

2. Phase 2 Summarizing: researchers cluster and deduce the ideas that are selected from different perspectives and complement them.

3. Phase 3 Define products: researchers integrate and analyse the cluster innovative concepts to form general innovative plans and innovative plans of individual car models.
   - Innovative plans for individual car models: researchers integrate new ideas and put forward corresponding individual model concepts. Details include car models, main/auxiliary functional features, persona, usage scene/mission.
   - General innovative plans: new ideas that are applicable to most NEV are integrated as general innovative plans. Details include specific functional features.

4. Research Findings and Prospects

Through the application of user-experience based user research method on NEV innovation and summary, researchers discover 2 types of NEV user models and 50 typical usage scenes during pre-phase information collecting and analysing. By analysing user models, researchers find that NEV users (excluding those who use NEV because of reasons such as licensing difficulties, government subsidies and purchase tax) have different values than traditional vehicle users. In other words, traditional gasoline vehicles are unable to satisfy the needs of these users. Therefore, new technologies and design plans are needed to produce new products, which prove the theories stated above.

In addition, the 50 typical usage sceneries are drawn from unique usage habits and experience of using NEVs. For example, as NEVs generate less noise while driving, users must be particularly careful when traveling on roads where pedestrians and vehicles are not separated in different paths; users must formulate detailed traveling beforehand so as to avoid “range anxiety”. These findings illustrate that the qualitative research methods used in this research can help discover substantive characteristics of new vehicles as well as advantages that traditional petrol vehicles do not have. These methods are suitable to apply on NEV research for the benefit of subsequent innovative plans.

In the final stage of innovative plans formulation, about one hundred ideas are formed; 10 breakthrough general innovative plans and 3 innovative plans of individual car models are put forward. These plans include technological breakthroughs such as charging the car in rainy days and open fields and combined traveling schemes that can reduce parking difficulties when users have parked their cars and are still miles away from their destinations. The plans also include ideas of unrealized technologies, such as photovoltaic charging films on the roof of the car and automatic winding machine for charging cables. In conclusion, these plans provide an important basis for upcoming NEV products.

This research also preludes the feasibility study in engineering, in which innovation plans with marketing potentials are analysed and samples that may go to mass productions are made.

The automotive industry is undergoing changes. The user-oriented innovative thinking that originates from industrial designs and becomes perfect in Internet industry is expanding to automotive industry. Future vehicle products will start from user experience,
based on technological innovation and develop a “new value” that the users are willing to ‘buy’. Automotive user experience will become a commercializing pivot and source of driving force that support this energy-saving, environment-friendly and safe technological innovation.

References

About the Author
XIAO Ning has a composite engineering background of Automotive Engineering and Industrial Design. He is the first batch certified as one of the top ten domestic outstanding designers. He pioneered and led the Trumpchi brand of industrial design innovation.
A Conceptual Framework of Dynamic Design Management Capability

LIU Sylvia Xihui
Hong Kong Polytechnic University, Hong Kong
Sylvia.liu@polyu.edu.hk

In the past decade, academic researchers and industrial practitioners developed various methods to set up a frame linking “good design” to “good business”. In most cases, their interest lay in the industrial economy and focused on the manufacturing industry. In the knowledge economy, dynamic capability is the new feature a firm should prepare for the new age. Design management capability is assigned new meaning in the emerged context. It’s time to develop a new framework of design management capability to reflect the dynamic nature of the knowledge economy. The relationships between design management capability, design awareness, business performance and design organization were explored in depth in previous studies. This is the time to integrate them into a holistic framework, to illustrate the relationships with explicit definitions of input, output and capability building. Through reviewing the previous studies and the emerged topic of dynamic characteristics in the knowledge economy, a conceptual framework is proposed here as a basis for further study.

keywords: design management capability; design collaboration; business performance; design awareness

Introduction
In 1974, Thomas J. Watson Jr., former CEO of IBM, stated that “good design is good business”. Subsequently, he achieved a reputation as a successful CEO leading the most explosive company growth to date. Today, given that the knowledge economy is the reality, design has significantly changed its role from product styling in the last century to the core of strategy in the new century, called design-driven innovation (Verganti, 2006).
Steve Jobs, CEO of Apple, indicated that “design is the fundamental soul of a manmade creation”, and emphasized the importance of design (Peters, 2003). The above statements about the role of design in business in different centuries imply three things. First, good design is a result of a CEO’s design awareness. Second, good design could lead to good business performance. Third, in the knowledge economy, the importance of design has increased significantly.

These matters are all in the scope of design management, which contributes to competitive advantages and strategic flexibility (Kotler & Rath, 1984; Bruce, Cooper & Vasquez, 1999; Chiva & Alegre, 2007, 2009; Acklin, 2010). To link the knowledge structure of design management and a guideline demanded by industrial implementation, the concept of design management capability has been developed. It is the capacity to deploy design resources in an adequate and dynamic way (Fernández-Mesa, et al., 2013; Acklin, 2010, 2013). It constructs the dynamic capability of an organization (Teece, Pisano & Shuen, 1997; Acklin, 2013). With it, a company could sense and respond to emerging opportunities in a timely manner, and create new value (Teece, 1998; Jevnaker, 2000). In the past decade, design management capability has been studied with diversified foci, and some basic frameworks have been established. However, the dynamic perspective is seldom taken in the previous studies and it is recognized as a critical factor influence the performance of design and innovation in a business organization. In this paper, a conceptual framework was proposed based on reviewing previous related studies to reflect the dynamical factors of design capability. A conceptual framework was suggested to raise a discussion about the issues. These led to the initial ideas of developing a research agenda of design management capability.

Design Management Capability
In the past decade, two streams of design management capability were evident. One was from academic research, specifically, a list of design management skills proposed by Dickson through quantitative methods. In Dickson’s (1995) study, the factors assessing design management capability were well developed with a discussion of CEO’s design awareness in small- and high-growth firms. However, the proposed relationships between design awareness, design management capability and business performance were not validated. The role of design was still viewed in a conventional way, a part of the product development process, instead of taking a leadership role in innovation activities in the digital economy (Cooper, et. al, 2009). Therefore, the relationships should be studied in the updated context and the factors of relevance to design management capability should be redefined.

The dynamic features of design management capability have only been reported more recently (Fernández-Mesa, et al., 2013; Acklin, 2010, 2013). There has been reference to deploying design resources and organizing design teams to fulfil a task, which effectively requires design collaboration (Christensen and Rosenbloom, 1995; Verona and Ravasi, 2003). However, this dynamic feature was rarely considered in previous studies. To properly capture the dynamic features of design management capability, it is necessary to identify its underlying factors and to thereby develop a taxonomy to describe its contribution.
Although the relationships between design collaboration and the other three dimensions have been studied, quantitative validation of the framework was not provided (Jevnaker & Bruce, 1998; Jevnaker, 2000, 2005; Song, et al., 2010). As a consequence, a quantitative method of research is proposed in this study.

Another stream is a guideline for assessing design management capability to lead industrial practice. The representative outcome of the stream is the Design Management Staircase, which was developed by Design Management Europe (Kootstra, 2009), and based on the Design Ladder (reported by Danish Design Centre in 2003). The design management staircase consists of four levels of design awareness and related factors. However, with assessment being the primary objective, firms have no clear direction for defining design strategies. A framework, linking design awareness to organizational preparation and implementation, is required to guide the development of a strategic plan.

In the knowledge economy, the previous framework and knowledge structure has to be updated, and a substantial basis for it should be developed through quantitative methods. To develop the research of design management capability further in the new economy paradigm, a review of previous studies and definition of its possible directions for further studies in the future is needed (Figure 1).

Figure 1  The changed economic paradigms of design management

A Dynamic Context

In 1995, Dickson proposed an index of design management capability consisting of five skills and a scale for measuring them (Dickson, et al., 1995). Based on this index, the relationships between the design management capability, product innovation, and business performance were studied in the past decade (Figure 2). According to the performance evaluated as result, these studies can be classified into four types: design management capability related studies, business/firm performance, product innovation and financial performance (Table 1).
Based on Dickson’s design management skills, design awareness and design function organization has been studied to explore the relationships between design management capability, strategic design management and functional design management (Borja de Mozota, 2003). Furthermore, its relationships with a design management absorption model were studied. These studies reflected the unique value of design management capability, contributing both to the academic framework for building knowledge structure in the field and guiding the practice in industries.

**Table 1. Previous studies based on the Design Management Skills reported by Dickson (1995)**

<table>
<thead>
<tr>
<th>Performance</th>
<th>Dimensions</th>
<th>Related studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design management capability</td>
<td>Design management absorption model</td>
<td>Zahra &amp; George (2002); Acklin (2011)</td>
</tr>
<tr>
<td></td>
<td>Design function organization</td>
<td>Chiva &amp; Alegre (2007)</td>
</tr>
<tr>
<td></td>
<td>Design awareness</td>
<td>Song, et al. (2010)</td>
</tr>
<tr>
<td></td>
<td>Product innovation performance, new product development</td>
<td>Löfsten (2014)</td>
</tr>
<tr>
<td>Company performance</td>
<td>Design management capability, design investment</td>
<td>Gemser, et al. (2001); Chiva, et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Financial service, design capability</td>
<td>Lin (2011)</td>
</tr>
</tbody>
</table>
The second category is business/firm performance. Factors evaluating business performance and firm performance are quite similar, since a firm is a business organization. The only difference is that firm performance has more factors related to organizational performance. Dimensions discussed in this category are divided into four types. The first type is the core ones, including design management capability, product design management and design capability. Secondly, organizational issues, especially organizational learning capability. Third, relationships with other performances, particularly those emphasizing product innovation. Finally, its relationships with financial issues, such as financial services and design investment. Besides the core dimension of design management capability, other dimensions were studied to explore their relationship with business performance. These studies developed a new notion that design management capability can contribute to better business/firm performance or product innovation performance through enhancing organizational capability, such as organizational learning or design investment.

In the third category, product innovation is the performance used as result of evaluation. Its performance is evaluated by product innovation performance as a result and new product development as a process. Beside the relationships shown in the above category, there are two dimensions emphasized especially in this category. One is design capability, another is design execution. This implies that product innovation performance can be improved by enhanced design management capability and operational capability, such as design capability and design execution. The forth category is financial performance. It links to design management capability and design capability.

All the dimensions studied are related to static features, and located in industry economy. Among the listed 14 studies in Table 1, 12 of these were published between 2001 and 2011. In the knowledge economy, the dynamic environment of innovation and business is the characteristic. Acklin and Fust (2014) proposed four modes of design management, these being simple, integrated, dynamic and entrepreneurial (see Table 2). According to their findings, the previous studies were based on simple or integrated modes, with an emphasis on product or project. As a result of the dynamically changing environment in the knowledge economy, a dynamic mode of design management is critical for sustaining competitive advantages through developing knowledge, design competences and capabilities (Zahra & George, 2002). Furthermore, in the entrepreneurial mode of design
management, design takes leadership in exploring opportunities, developing and managing an organization, and integrating resources (Acklin & Fust, 2014). However, design management capability in the emerged two modes was rarely studied in the past.

Table 2  Taxonomy of design management modes (Acklin & Fust, 2014)

<table>
<thead>
<tr>
<th>DM-Mode</th>
<th>Simple Mode</th>
<th>Integrated Mode</th>
<th>Dynamic Mode</th>
<th>Entrepreneurial Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Effective/ efficient design (project) management</td>
<td>Orchestration of touch points across function</td>
<td>Sustainable competitive advantage</td>
<td>Exploiting new business opportunities</td>
</tr>
<tr>
<td>Design capabilities</td>
<td>Sourcing, briefing, designers; managing and evaluating design</td>
<td>Planning, coordinating, aligning infusing design</td>
<td>Designing the capabilities of the firm; de/re-linking; (re-)configuring resources</td>
<td>Creating, recognizing, evaluation, exploiting opportunities</td>
</tr>
<tr>
<td>Contributions to corporate strategy</td>
<td>Improved products, appearances, etc.</td>
<td>Coherent positioning</td>
<td>Strategic flexibility and competitive advantage</td>
<td>New business segments, new business ventures</td>
</tr>
</tbody>
</table>

The Developed Four Dimensions
Concerning design management capability in a dynamic context, its contribution and value is defined as the capacity to deploy design resources in an adequate and dynamic way (Fernández-Mesa, et al., 2013; Acklin, 2010, 2013). With it, a company could sense and respond to emerging opportunities in a timely manner, and create new values based on it (Teece, 1998; Jevnaker, 2000). Taking a close look of design management capability developed in the past decade, dimensions for further study of its performance in the new economic paradigm can be explored. As a result, four dimensions are reported. They are design awareness, design management capability, design collaboration and business performance.

Design awareness
The close relationship between design awareness and design management capability has been reported in the two representative studies, Dickson’s design management skills and DME’ design management staircase. The initial question of Dickson’s research was to understand the CEO’s role in design management. This can be defined as the relationship between a CEO’s design awareness and design management capability in the firm. In DME’s design management staircase, the CEO’s design awareness was the decision factor to classify the four stages on the staircase. This implies that the academic frame, or practice-based frame, of design management capability are both tightly related to design awareness. Later, this is also proven by Song’s study (Song, et al., 2010). In Heskett and Liu study of managing design in SMEs, design awareness was also reported as a key factor of
assessing levels of design management (Heskett & Liu, 2012). Later, the factor was combined with the design ladder and developed into a new index (Storvang, et al., 2014). The main basis for design awareness was the four levels in the Design Management Staircase (DMS), which was the result of a survey conducted by Design Management Europe and developed from the Design Ladder established by the Danish Design Centre in 2003 (Kootstra, 2009). The four levels include 1) no design management (DM); 2) DM as project; 3) DM as function; and 4) DM as culture. Both the DMS and the Design Ladder are utilized popularly to assess design and design management capability in industries. It uncovered a positive correlation between design management rating and business performance, although causal links have yet to be determined. Another set of criteria was developed by Min Jeong Song in 2010. His study focused on the design awareness of the CEO and its correlation with support for design (Table 3). Both studies have linked design awareness with design management capability and business performance. However, until now, the positive correlation between design awareness and business performance has not been proven by quantitative study.

<table>
<thead>
<tr>
<th>Design Management Staircase (Kootstra, 2009)</th>
<th>Design Awareness of CEO (Song, et al., 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Aware of the benefits of managing design effectively;</td>
<td></td>
</tr>
<tr>
<td>2) Place and role of design;</td>
<td></td>
</tr>
<tr>
<td>3) Design in business or marketing plans and objectives;</td>
<td></td>
</tr>
<tr>
<td>4) Methods of decision-making;</td>
<td></td>
</tr>
<tr>
<td>5) Allocated design resources.</td>
<td></td>
</tr>
<tr>
<td>6) CEO’s interest in design and design management.</td>
<td></td>
</tr>
<tr>
<td>7) Design is viewed as a necessary factor for business success by CEO.</td>
<td></td>
</tr>
</tbody>
</table>

**Design collaboration**

The dynamic characteristic of organizational capability is developed based on two viewpoints, resource-based and capability-based. This is shown by the dimensions reported in the previous studies, such as design function organization with resource-based viewpoint, and design capability with capability-based viewpoint. There is organizational learning capability linking the two viewpoints, since the capability can be improved and enhanced via various resources. As a result, the topic focuses on the way and the types of design resources obtained. This is defined as design collaboration in this paper.

The concept of design collaboration evolved continuously in the past thirty years. In the 1980s, it focused on internal organization, the collaboration between designer and manager. Later, the research scope was extended to the relationship between internal and external design. Entering the new century, the issues of design collaboration were broadened to openness of organizational structure, means for participants, and related strategies with a capability-based view or organizational view (Table 4).
<table>
<thead>
<tr>
<th>Key topics</th>
<th>Previous studies</th>
<th>Viewpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal design (1980s ~)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designer’s role</td>
<td>Walsh &amp; Roy (1985)</td>
<td></td>
</tr>
<tr>
<td>Manager’s role</td>
<td>Gorb &amp; Dumas (1987)</td>
<td>Personal view of design</td>
</tr>
<tr>
<td>General practice</td>
<td>Dumas &amp; Whitefield (1989)</td>
<td></td>
</tr>
<tr>
<td>CEO’s role</td>
<td>Dickson, <em>et al.</em> (1995)</td>
<td></td>
</tr>
<tr>
<td><strong>Internal &amp; external design (1990s ~)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The relationship between internal and external design</td>
<td>Bruce &amp; Morris (1994); von Stamm (1997); Twigg (1998); Bruce, <em>et al.</em> (1999).</td>
<td>Organizational view</td>
</tr>
<tr>
<td><strong>Design collaboration (2000s ~)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration divided by two dimensions:</td>
<td></td>
<td>Capability-based view</td>
</tr>
<tr>
<td>(1) the predominant means of participation (closed vs. open); (2) the predominant governance structure (hierarchical vs. flat)</td>
<td>Pisano and Verganti (2008); Snow, Lettl &amp; Miles (2011).</td>
<td></td>
</tr>
<tr>
<td>Innovation strategy map</td>
<td>Chesbrough (2006)</td>
<td></td>
</tr>
<tr>
<td>(Open/close; incremental/ step change)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and typologies of partners</td>
<td>von Hippel (1988); Lundvall (1992); Brown and Eisenhardt (1995); Szulanski (1996); Laursen and Salter (2004); Laursen and Salter, 2006; Pisano and Verganti, 2008; Enkel et al., 2009; Keupp and Gassmann, 2009.</td>
<td>Organizational view</td>
</tr>
<tr>
<td>Phases of the innovation process actually open</td>
<td>Gassmann and Enkel (2004).</td>
<td></td>
</tr>
<tr>
<td>Direction of openness: inbound and/or outbound</td>
<td>Lichtenthaler (2008).</td>
<td></td>
</tr>
</tbody>
</table>
**Business performance**

There are three main indices of design influence on business performance (Table 5). Firstly, the financial performance of business. Secondly, product innovation performance as the measurement of design outcomes. Thirdly, the overall firm performance. The evolution of the indices implies an increased design impact on business.

### Table 5  Three sets of factors evaluating business performance

<table>
<thead>
<tr>
<th>Performance</th>
<th>Set of factors</th>
<th>Previous studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial performance</td>
<td>- Sales</td>
<td>Davidsson (1989);</td>
</tr>
<tr>
<td></td>
<td>- Return on capital employed</td>
<td>Zahra (1991);</td>
</tr>
<tr>
<td></td>
<td>- Return on assets</td>
<td>Delmar (1996)</td>
</tr>
<tr>
<td>Product innovation performance</td>
<td>- Replacement of products being phased out</td>
<td>OECD (2005);</td>
</tr>
<tr>
<td></td>
<td>- Extension of product range within main product field through new products</td>
<td>Fernández-Mesa et al. (2013)</td>
</tr>
<tr>
<td></td>
<td>- Extension of product range outside main product field</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Development of environmentally-friendly products</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Market share evolution</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Opening of new markets abroad</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Opening of new domestic target groups</td>
<td></td>
</tr>
<tr>
<td>Firm performance</td>
<td>- Financial performance</td>
<td>Chiva-Gómez et al. (2003);</td>
</tr>
<tr>
<td></td>
<td>- Manufacturing and storage costs</td>
<td>Chiva &amp; Alegre (2009);</td>
</tr>
<tr>
<td></td>
<td>- Corporate image</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Delivery time and after-sales service</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Size</td>
<td></td>
</tr>
</tbody>
</table>

**Studies on the relationships in the previous studies**

In the 1990s, Dickson defined a set of factors about design management skills and discussed its relationship with design awareness and business performance, especially small, high growth firms (Dickson, 1995). Entering the new century, the topic of dynamic design management enabled by design collaboration emerged. It focused on the relationships between design collaboration and other three dimensions, these being design awareness (Jevnaker, 2000; Song, et al., 2010), design management capability (Jevnaker, 2000, 2005) and business performance (Jevnaker & Bruce, 1998; Mathieu, 2001). The study of the relationship between design awareness and business performance then emerged, represented by the design management staircase (Kootstra, 2009). As a result, all the topics in these studies can be clustered into four dimensions, these being design awareness, design management capability, design collaboration and business.
performance. Although the relationships among the dimensions has been stated or predicted in these studies, they were not proven with quantitative validation.

**Design collaboration (DC) and business performance (BP)**

With fresh and creative ideas, external design was valuable for innovation and business success (Jevnaker & Bruce, 1998). Usually, collaboration creates more options for risk, cost and quality of design (Mathieu, 2001). However, this linkage has yet to be proven through quantitative study.

**Design management capability (DMC) and design collaboration**

In the past fifteen years, there has been an increased emphasis on the dynamic characteristic of design management. Jevnaker (2000) stated that design management should integrate competencies in a dynamic way to nurture multidisciplinary networking and build on a creative mix of talents and content. The critical importance of a dynamic collaboration among designers and business firms should be built in cognition of companies. The contribution of design collaboration to dynamic capability is described explicitly by Jevnaker (2005: 44): “...the firms’ “dynamic capabilities” were highly relational and activity-based, and were accumulated as more or less hidden treasures of constructive work relations.” Quantitative validation is needed to prove the relationship.

**Design collaboration and design awareness (DA)**

In accordance with the Russian psychologist Vygotsky (1986), design-collaborating experiences can serve as “generators” of consciousness. With good design awareness, design leaders will be more open to design collaboration (Jevnaker, 2000; Song, et al., 2010). However, to date, the relationship hasn’t been supported by quantitative validation.

**Design management capability and business performance**

As a consequence of the accelerated evolution of the role of design in the past decade, design was transformed from a sub-process of new product development (NPD) to process leader (Perk et al., 2005; Maciver & O'Driscoll, 2010). Accordingly, the importance of design management capability and its impact on business performance has been upgraded significantly, since design management relates to the organizational and managerial practices of a company to attain good design through efficient processes (Gorb and Dumas, 1987; Dickson et al., 1995; Ahire & Dreyfus, 2000; Best, 2010; Fernández-Mesa, 2013).

The initial study of the topic was conducted by Dickson in 1995. The set of factors of design management skills was small, yet high growth firms were reported in the study. This formulated the basis for further studies. In 2013, Fernández-Mesa gave a quantitative validation of the relationship between design management capability and product innovation performance. However, it applied Dickson’s factors of design management capability directly and ignored the transformed role of design, from a sub-process of new product development (NPD) to process leader (Perk et al., 2005; Maciver & O’Driscoll, 2010). The evaluation of business performance focused on product innovation performance, rather than taking a broader view to understand design impact.
Design management capability and design awareness

A CEO’s involvement in design was also a domain topic in Dickson’s study (1995). Design leaders can foster the dynamic design capability of an organization (Jevnaker, 2000; Bruce & Bessant, 2002). In Song’s study, the linkage between design awareness and design leaders’ support for design was proven in a quantitative way. However, its linkage to design management was not tested (Song, et al., 2010). The relationship was reported as “design attitude” to describe the integrated thinking of design and management (Boland Jr, et al., 2008). Although the relationship between design awareness and support for design was proven in a quantitative way, its relationship with design management was not tested (Song, et al., 2010).

Design awareness and business performance

Jevnaker reported that design champions can make new sense of business through design collaboration. This is a leading edge of a firm (Jevnaker, 2000). The linkage was reported by the DME in their survey in 2003. On the other hand, through design projects, managers could understand the value of design in their business (Brazier, 2004). In the proposed dimension of business performance, the broader factors such as product innovation performance, brand and service, etc., will be involved.

Through reviewing previous studies on the hypotheses, the research gaps were revealed (Table 4). The gaps were divided into three types: 1) the definition of the dimension is too narrow and factors involved are limited; 2) the linkage between the dimensions was not proven; 3) the linkage might be proven qualitatively, but not quantitatively.

Table 6 A summary of current studies on the six hypotheses and the gaps that will be filled by the proposed research

<table>
<thead>
<tr>
<th>The relationships</th>
<th>Existing body of knowledge</th>
<th>Gaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business performance &amp; Design collaboration</td>
<td>Design collaboration leads to better business performance.</td>
<td>Not proven by quantitative study.</td>
</tr>
<tr>
<td>Design management capability &amp; Design collaboration</td>
<td>They are complementary to each other.</td>
<td>Not proven by quantitative study.</td>
</tr>
<tr>
<td>Design awareness &amp; Design collaboration</td>
<td>The interaction between design awareness and design collaboration.</td>
<td>Not proven by quantitative study.</td>
</tr>
<tr>
<td>Design management capability &amp; Business performance</td>
<td>The importance of design management capability and its impact on business performance is upgraded significantly.</td>
<td>The linkage wasn’t proven.</td>
</tr>
<tr>
<td>Design awareness &amp; design management capability</td>
<td>Design leaders can foster design capability.</td>
<td>The linkage wasn’t proven.</td>
</tr>
<tr>
<td>Design awareness &amp; business performance</td>
<td>Good design awareness contributes to better business performance.</td>
<td>Narrow definition of business performance</td>
</tr>
</tbody>
</table>
A Conceptual Framework of Design Management Capability

Based on the above discussion, a conceptual framework of design management capability is proposed to reflect the dynamic feature of it in the knowledge economy and linking the design awareness as input to business performance as output (Figure 3). According to Table 4, some of the relationships have been reported in the previous studies, but they have not been proven with quantities methods. Others may have been mentioned, but without any evidence, and have not been proven.

The conceptual framework consists of four dimensions, these being design awareness, design collaboration, design management capability and business performance. Design awareness is viewed as input of design management. It includes design awareness of a CEO, managers and staff members. Although its relationships with design management capability and business performance have been studied in the past, there is not an explicit framework to illustrate the relationship and there is no base for duplicating the theory in another context. Design collaboration will represent the flexibility of design capability through dynamic relationships with various resources. As a new dimension proposed in the framework, its relationships with the other three will be studied to define the factors contributing to dynamic characteristics. Instead of separating the performance into business, firm and product innovation, the new dimension will integrate all the factors and view them at different levels. For the dimension of design management capability, besides the existing factors, new factors will be explored via expert or industrial interviews to reflect the current practice in the knowledge economy. Later, the key factors will be defined through quantitative methods.

The proposed conceptual framework not only represents a new structure to develop the understanding of design management capability in the knowledge economy, but also shows the possible directions of research in the topic. With this study, a new framework of design management capability will be established with validation. It will set up a solid basis for the related studies in the academic fields and guide the practice in industries with explicit factors.

Figure 3  A conceptual framework
Conclusion

In the past decade, academic researchers and industrial practitioners developed various methods to set up a frame linking “good design” to “good business”. In most cases, the context was the industrial economy and the focus was on manufacturing industry. In the knowledge economy, dynamic capability is the new feature a firm should prepare for in the new age. Design management capability is assigned new meaning in the emerged context. It’s time to develop a new framework of design management capability to reflect the dynamic feature in the knowledge economy. The relationships between design management capability, design awareness, business performance and design organization have been studied sufficiently in the previous studies. It’s the time to integrate them into a holistic framework to illustrate the relationships with explicit definition of input, output and capability building. Through reviewing the previous studies and the emerged topic of dynamic characteristics in the knowledge economy, a conceptual framework is proposed in this paper as a basis for further study.

In the conceptual framework, design management capability is the center entities, while business performance is the outcomes of it for evaluation. Design collaboration was utilized to inclusive the dynamic factors, such as relationship in co-design, integration of design resources and dynamic team management. Design awareness as the reflection of mindset of design and design management will impact on the investment in design, which will influence the design management capability and design collaboration. The relationships of the four entities have been reported in previous studies, however, they were neither proven nor proven by quantitative methods. The conceptual framework was reported for a holistic mapping of design management capability and its function in business management. It is a basis for a further study of the topic with quantitative methods and the outcomes will be applied in industries efficiently.

References


About the Author

**Sylvia Xihui Liu** is a research assistant professor in School of Design at Hong Kong Polytechnic University. Before, she was design manager at Nova Design, and drafted national design policy. Her research areas are design value and design policy.
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Using Design Thinking to improve Strategic Decisions during Collaborative Sensemaking

KOTINA Ekaterina*; KORIA Mikko and PRENDEVILLE Sharon
Loughborough University London, United Kingdom
* Corresponding author: E.Kotina@lboro.ac.uk
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Human cognitive limitations affect strategic decision-making. One of such effects is emergence of cognitive biases, deviations from rationality in judgment. These biases can negatively influence an organisation’s capability to capture and utilize new ideas, thus inhibiting innovation. Researchers have documented different strategies for mitigating cognitive biases – and many of them overlap with the ones emphasised in design thinking. However, research so far does not offer any specific “recipes” for mitigation of cognitive biases. This paper links together research on challenges of strategic decision-making, cognitive biases and design thinking. The paper investigates the effects of applying design-thinking tool in collaborative sensemaking stage, within a small business team, aiming to mitigate confirmation bias. The study indicated that newly introduced design-thinking tools did not have the expected positive influence on decision-making. The research contributes to the field by developing a new framework on how to identify and mitigate confirmation bias in strategic decision-making.

keywords: design thinking; cognitive bias; confirmation bias; strategic decision making

Introduction

Decision-making is a cognitive process where one selects a satisfactory solution among several alternative possibilities. Strategic decision-making is the process by which top-management in companies (individuals or groups of people) make the most fundamental decisions (Das, 1999; Mintzberg & Waters, 1982). Individual subjective factors influence
environmental and organisational perceptions and subsequently, strategy formulation (Anderson & Paine, 1975). Strategic decision processes are characterized by novelty, complexity and open-endedness, and lack of structure (Mintzberg, 1976; Mason & Mitroff, 1981). Decision makers usually begin with little comprehension of the situation and then deepen their understanding while working with the challenge. These challenges are often “wicked problems” (Churchman, 1967), which are also studied in design research (Dorst, 2015). To simplify these “wicked problems”, decision makers can rely on judgmental rules, or heuristics (Schwenk, 1984; Levy, 1994; von Krogh & Roos, 1996; Das, 1999). Sometimes these “rules of thumb” could be necessary and useful, but they can also lead to emergence of cognitive biases – systematic patterns of deviation from norm or rationality in judgment (Kahneman & Tversky, 1979; Kahneman, 1982; Haselton, 2005; Kahneman, Lovallo, & Sibony, 2011).

Researchers have documented different strategies for mitigating cognitive biases – many of these overlap with those emphasised in design thinking (Liedtka, 2014; McCollough, Denmark, & Harker, 2013; Dorst, 2015). For instance, in their review, Liedtka et al. (2014) discuss influences of tools like ethnography, visualisation, team collaboration, prototyping on projection, ego-centric empathy, focusing illusion, confirmation and availability biases. Some potential methods for mitigation of biases include increase of accuracy motivation (Hart et al., 2009). These are methods of self-awareness and self-assessment that are referred to as the two-system models of reasoning. However, research so far does not offer any specific “recipes” for mitigating cognitive biases. Indeed, in design-thinking, research and practices addressing “wicked problems” utilise the process of abductive reasoning, a creative inference that involves integration and justification of ideas to develop new knowledge that is important at the discovery stage of scientific hypothesis formation and testing (Walton, 2014). Furthermore, designers use “framing” as one of the key problem-solving processes through which they can conceive new approaches to problem situations (Dorst, 2015; Whitbeck, 1998). Investigation into how design-thinking methods could help manage biases has the potential to contribute to this field of study.

In this paper, we link together the challenges of strategic decision-making and cognitive biases with design-thinking research, beginning to build a basis for managers to effectively utilise design thinking to improve organizational decision-making. This could help managers to cognitively legitimise (Birkinshaw, 2008; Suchman, 1995) and support integration of the design thinking mindset and its approaches and tools within organisations (Schmiedgen et al., 2015). This can improve, for instance, organisational working culture (e.g., working in teams), and clarify design thinking’s utility as a method for improving organisational decision-making processes and outcomes. Specifically, the paper investigates the effect of design-thinking tool on confirmation bias in the sensemaking stage within small business team.

The research question asks:

*Can confirmation bias be identified, categorized and mitigated with the help of design thinking in the collaborative sensemaking stage of strategic decision-making?*

To answer the question, we will first introduce the key concepts connected to the chosen topic and review the literature on bias mitigation in business and design. Then we will
show through a pilot study in a small business team how confirmation bias was identified and targeted.

This research indicated that there is a potential for emergence of confirmation bias in strategic decision-making. Moreover, it was observed that newly introduced design-thinking tools did not have the expected positive influence on strategic decision-making, though the use of the tools was seen to be beneficial. The intervention was only short-term, and to achieve the long-lasting effect, one needs to work more with the mindset to change approaches for tackling strategic issues. Thus, there is a potential that if these tools are to be applied for a longer period of time, there likely could be a positive change in decision-making process. The research contribution is the new framework on how to identify and mitigate confirmation bias in strategic decision-making. It can be used further by researchers, as well as by managers in preparation of decision-making sessions.

**Strategic decision-making and collaborative sensemaking**

Strategic decisions reflect the inner corporate context (psychological, structural, cultural and political factors) and the outer context (for instance, competitive factors) (Pettigrew, 1992) and interaction with external environment (Ginsberg, 1988). They differ from routine decisions because they are mostly unstructured, as decision maker should utilise judgement, evaluation and insights when dealing with the challenge (Stahl & Grigsby, 1992). Strategic decisions usually involve a large proportion of corporate resources, as well as risk and trade-offs, they are difficult to assess in terms of performance; they are political, and rarely have one best solution (Wilson, 2003). It is essential that decision makers choose an optimal strategy when they face risk and uncertainty. Such frequently used management science techniques as linear programming, integer programming, network models, and simulation are used to improve decision-making. However, decision-makers have both limited capabilities for assessing consequences and a limited period of time for making decisions (Jones, 1999), as well as comprehensive information is not available for them (Liedtka & Ogilvie, 2011).

Strategic decision-making in organisations implies both individual sensemaking and collaborative sensemaking – communication of information, shared understanding, and interpretation of other’s interactions with information which helps to overcome individual limitations (de Terssac, 1996; Dervin, 2003; Paul, 2010) of decision makers. It is important for improving decisions through better information acquisition, different perspectives and options, perception, and consensus formation (Weick, 1995).

**Confirmation bias in strategic decision-making**

Biases are widely acknowledged in decision-making. For example, Bazerman (1994) discusses 13 types of cognitive biases occurring in managerial decision-making. Strategy scholars also identify several biases that could occur in strategic decision processes. For instance, Schwenk (1984, 1995) identifies 11 cognitive biases, including confirmation bias, single outcome calculation, illusion of control, etc. He then classifies and maps these biases onto the three specific decision stages (i.e. goal formulation, alternative generation and alternative selection). According to Barnes (1984), five biases occur among managers and strategic planners: availability, hindsight, misunderstanding the sampling process, judgments of correlation and causality, and representativeness. According to Liedtka
(2014), during design-thinking process several biases occur that can affect decision-making, including confirmation, projection, egocentric empathy, focusing illusion, and hot/cold gap biases.

One type of cognitive bias appears when people tend to defend their attitudes, beliefs, and behaviors from challenges (e.g., Festinger, 1957; Olson & Stone, 2005). Selectivity of this type has often been called a congeniality bias (e.g., Eagly & Chaiken, 1993, 1998, 2005), positive hypothesis testing (Klayman & Ha, 1987), confirmatory (e.g. Rabin & Schrag, 1999) or confirmation bias (e.g., Jonas, 2001). Confirmation bias is the human tendencies to search for, collect, interpret, analyse and/or recall information in a way that confirms one’s prior beliefs or wishes (Jorgensen & Papatheocharous, 2015).

Confirmation bias emergence is closely linked to the selective exposure to information. Hart et al. (2009) name the following motivational forces behind exposure decisions: defense motivation and accuracy motivation (Chaiken, Wood, & Eagly, 1996; Eagly, Chen, Chaiken, & Shaw-Barnes, 1999; Johnson & Eagly, 1989; Prislin & Wood, 2005; Wyer & Albarracin, 2005; Baumeister, 2005). People tend to believe in the accuracy of their views (defense motivation) because it gives them psychological stability and personal validation, but also cross-check their views with external reality (accuracy motivation), because they need accurate perceptions of the world around them. Current evidence shows, however, that people are almost two times more likely to select information, confirming, rather that disconfirming, their pre-existing beliefs (Hart et al., 2009).

Attributes of defense motivation such as commitment, value relevance, confidence, and challenge or support, closed-mindedness increase the selection of confirming information. On the contrary, information utility and open-mindedness lead to increase of accuracy motivation and therefore, mitigation of confirmation bias (Hart et al., 2009).

Past research has examined whether confirmation biases emerge at different information processing stages, like exposure, interpretation, and memory. However, so far meta-analysis has been conducted solely on emergence of confirmation biases at exposure and memory stages of information processing (Das, 1999), and there is not much information and research found about the emergence of confirmation bias at information interpretation stage (Bargh, 1999; Bruner, 1957; Darley & Gross, 1983; Duncan, 1976; Hastorf & Cantril, 1954; Lord, Ross, & Lepper, 1979), which in this paper is also referred to as sensemaking stage.

In a business context, there is also not much research done on biases. Some existing studies explore how managers systematically ignore disconfirming information and seek information that confirms their initial values and views and thus are prone to confirmation bias (Hogarth, 1987; Schwenk, 1988). Managers have a tendency to see the sources of confirming information more trustworthy than sources of disconfirming information (Schwenk, 1984). Biases also impact investment decisions and strategies (Verma, 2016). Belief revisions in auditors and search for evidence have also been connected to confirmation bias (McMillan, 1993), and professionals have a tendency to sell winning stocks too quickly and hold on to losing stocks too long (Shefrin and Statman, 1985). There has also been research (Krieger & Fiske, 2006) on unintentional discrimination in hiring and promotion practices. Confirmation bias affects due diligence in business contexts (Benoliel, 2015), justification of the deal when top-management “falls in love” with it
(Aiello & Watkins, 2000) and builds optimistic assumptions (Eccles et al., 1999). Kahneman et al. (2011) also refer to the effects of confirmation bias and the tendency to minimise the risks and costs of something that one likes and exaggerates its benefits. Jorgensen and Papatheocharous (2015) review empirical studies from the software engineering field connected with confirmation bias, and present a study examining how the prior belief in the benefits of a contract type among experienced software engineering managers affects the interpretation of evidence.

Most studies have been conducted with students as the subjects of research. Few studies have examined professionals and managers (Hart et al., 2009).

**Design thinking as a method to mitigate confirmation bias**

More traditional methods that could potentially mitigate cognitive biases include some methods leading to increase of accuracy motivation, for instance, two-system models of reasoning (Kahneman, 2011; Lilienfeld, Ammirati, & Landfield, 2009; Milkman, 2009; Morewedge, Yoon, & Scopelliti, 2015). In these models of reasoning, individuals first make an intuitive judgment that can further be altered after more systematic thinking was utilized: through “System 1” and “System 2” processes, respectively (Evans, 2003; Morewedge & Kahneman, 2010; Sloman, 1996). In effective debiasing training, information that could be overlooked during the “System 1” evaluation, is encouraged to be considered (e.g., Hirt & Markman, 1995), or individuals are encouraged to utilise statistical reasoning and normative rules (e.g., Larrick, 1990). Also, people utilise such debiasing methods as timesaving recommendation systems (Goldstein, 2008) and commitment devices when they cannot make choices appealing now but that could be beneficial to them in the long run (e.g., Schwartz, 2014; Thaler & Benartzi, 2004).

However, Morewedge et al. (2015) note that it is not evident so far whether training effectively improves general decision-making (Arkes, 1991; Milkman, 2009; Phillips, 2004).

There has been some recent discussion about use of design-thinking practices to mitigate sets of cognitive biases in different stages of decision-making process in both personal and structural (organisational) systems (Liedtka, 2014; McCollough, Denmark, & Harker, 2013). In their review, Liedtka et al. (2014) discuss that, for instance, at idea generation stage, such design-thinking tools as ethnography, visualisation, team collaboration lessen the effects of the projection, ego-centric empathy, and focusing illusion biases. Bias introduced by customers (say/do gap) can be mitigated with the help of research methods like journey mapping and tools like prototyping where one can precisely describe their experience and see what needs are not met. Other tools, for instance participant observation, could be argued to reduce the reliance on self-reports. Prototyping, explicit identification of detailed assumptions, market feedback collection, and reflection to stimulate solutions iterations mitigate the effects of testing biases. If they are combined with ethnographic methods, they lessen the effects of such biases as planning fallacy, confirmation bias, endowment effect, and availability bias, which positively influences the array of proposed solutions and supports desire to test different novel ones (Liedtka, 2014). A number of studies have highlighted how individuals rely on a variety of material practices and artefacts, such as drawings and prototypes (Bechky, 2003; Carlile, 2002; Sutton & Hargadon, 1996), slide presentations (Kaplan, 2011), visual maps (Doyle & Sims, 2002), and Lego bricks (Oliver & Roos, 2007; Heracleous & Jacobs, 2008), to support the
conversational practices through which they exchange, combine, and construct interpretations as they engage in collaborative sensemaking (Gioia, Thomas, Clark, & Chittipeddi, 1994; Gioia & Mehra, 1996) underpinning future-oriented group processes, such as strategy making, new product development, and planning of organisational change. Such material artefacts are important “sensemaking resources” (Gephart, 1993) that facilitate transitions from individual to collaborative sensemaking.

The study: using prototyping to mitigate confirmation bias during collaborative sensemaking

Description of typical confirmation bias study
A typical confirmation bias experiment looks like as follows (e.g., Frey, 1981): the participants are confronted with a decision case and are asked to reach a preliminary or a final decision. Next, participants are offered additional pieces of information that they can select (sequentially or simultaneously). In most experiments, these pieces look like comments of experts or former participants. In experiments with confirmation biases, the participants are sometimes asked to answer a set of questions prior to the experiment about their general views, their experience (Dow, 2012; Jorgensen & Papatheocharous, 2015), demographic and self-report assessments, or write an essay about the proposed topic; in some cases, participants are even told that their ideas will be later discussed in a group (Canon, 1964; Freedman, 1965) to see how the degree of confirmation bias changes. After that, the intervention activity is happening, and later post-evaluation phase is conducted.

In design-thinking experiments on prototyping (Dow et al., 2012), participants are requested to prepare from one to several prototypes (e.g. online ads) to share with their peers. Sometimes, participants need to rank the choices (Artiz & Walker, 2010; Kress, 2012) to better understand their initial preferences.

In both studies, after the experiment, the participants fill in follow-up forms and answer questions how their decision changed (Jorgensen & Papatheocharous, 2015), on the basis of what it changed, what was the group dynamics at the end of group discussion (Dow et al., 2012), or, in some cases, if they were told about the biases and their influence, whether they will support their decisions with debiasing techniques in future decision-making situations in similar or other fields (Morewedge, Yoon, & Scopelliti, 2015). In design thinking (Dow et al., 2012), participants’ joint prototypes are evaluated by experts. In these experiment designs, confirmation bias could manifest itself as a change of attitude, belief or behaviour the participant experiences during the experiment, according to accuracy or defense motivation behaviours noted by the researcher. The degree of confirmation bias is matched as well with the level of experience of the participant.

Jonas et al. (2001) argue also that degree of confirmation bias in experiments is influenced by how the additional information on the topic is presented and / or processed: sequentially or simultaneously. In business or political contexts, the decision maker seeks information sequentially, as he or she usually does not have all necessary information at hand in the beginning of the decision-making process (Vertzberger, 1990). When information is gathered like this, it is not possible to determine in advance how many pieces of confirming or disconfirming information one will request, as well, it is not
possible to delay processing the information before the selection finishes. However, as the questions are asked retrospectively, systematic memory distortion may emerge, thus being an alternative explanation for the study findings. Also, participants when receiving pieces of information sequentially would more focus on their decision, but if the participants receive pieces of information simultaneously, focus is more on the evaluation and comparison of the information pieces, not on the prior decision.

Dow et al. (2012) used open-ended questions at the icebreaker and follow-up stages to evaluate team dynamics. Four questions were from the Subjective Value Inventory (SVI), an assessment of viewpoints on negotiation (Curhan, 2006). The relationship questions from the SVI provided good overview of the team rapport in terms of overall impressions, satisfaction, trust, and foundations for future interaction. The fifth question derived from the Inclusion of Self in Others Scale, a measure of someone’s sense of connectedness with another individual (Aron, 1992).

It is also important to note that homogeneous groups (i.e. groups consisting of individuals with the same initial opinions) show a stronger confirmation bias when selecting decision-relevant information than heterogeneous groups (consisting of individuals with varying initial opinions) (Frey, 2009). For homogeneous groups, it was found that the larger the group was, the greater their perceived confidence in their decision was, and therefore, larger confirmation bias was observed. The larger the minority with different opinion within a group, the less confirmation bias is observed. Also, if in the group there is a representative who is to articulate group decision, the confirmation bias is larger among such representatives than among non-representatives. Based on the findings above, we can propose a conceptual framework (Fig.1) illustrating how confirmation bias manifests and might be mitigated at different stages of the study:

![Confirmation bias manifestation in strategic business decision-making](image)

*Figure 1  Confirmation bias manifestation in strategic business decision-making*
Study design

After the framework was developed, we applied it to the chosen case company. The company was a Russian small-sized biotechnology company. Seven participants (referred to here as C1F1-C1M5) were asked to find a solution to a company-provided strategic business challenge during a design-thinking workshop. Before the experiment and after it, interviews with the top-manager were conducted to clarify the challenge (before the experiment) and assess the implications of the experiment (after it). During the experiment, the participants were asked the following question: how can the company increase the value of its products and scientific projects to be more attractive for potential partners?

Drawing on the protocol for design thinking experiments on prototyping (Dow, 2012), each participant was requested to prepare written pre-sessional response to the question and prototype to share with their peers afterwards. Prototypes sketches were collected to check their consistency with the replies the participants gave before and during oral responses while sharing their ideas with others. Demographic parameters were calculated (average age, median age, gender, sex); educational background parameters (how many participants have higher education); and professional experience parameters (average length of stay in the company and position). This information was collected to check whether multidisciplinarity could be connected to the reported solutions preferences, as well as disposition for confirmation bias. The similarity and degree of inclusion of other participants’ comments was analysed. After the differences between the participant pre-response and transcribed oral response were analysed, we thematically categorized the ideas based on the thematic similarity of content. Each solution idea was encoded with a specific name like “participation in the exhibitions”, “searching for the market news”, and “uniqueness of solutions” (altogether 47 distinct ideas were identified, discounting the repetitions). Then these ideas were clustered into 21 subcategories, which were then formed into seven big categories (IP, Partnerships, Marketing, Offering, Staff, Sales, Funding).

It was checked how these categories and subcategories appeared in pre-responses and in the responses in the post-questionnaire that took place a month later after the experiment. In addition, for the post-questionnaire, mean value of self-originated opinions, mean value of other-originated opinions, and the ratio between them were calculated, to understand participants’ preferences towards either their own or other-originated opinions.

Moreover, the following classification of participants’ responses was performed: generalist verses specialised responses. The unit of analysis for generalist/specialised responses was the whole response given by the participant. The cut-off point between generalist and specialised responses was in the level of solution detalization. Generalist responses were those that included discussion by participants of different solution methods from multiple fields (“themes”) with the same level of detail. If the person went into more details in the specific field of discussion (like “marketing”) and gave more examples on this one specific field, then the reply was categorised as specialised. It was checked whether “generalists” were less prone to confirmation bias than “specialists”.

From the follow-up questionnaire, the average rating that participants gave each idea was calculated, and self-originated verses other originated statements comparison was performed. The ratio of mean value of self-originated opinions to mean value of other-originated opinions was calculated. The analysis performed was to check whether in the post-response participants rated their initial ideas higher than others’ ideas, or were complementary with other-originated opinions. Moreover, the mean rating of the self-originated statements was compared to everyone’s other-originated statements. The means of self-originated responses were compared to other-originated responses statistically with the use of Mann-Whitney U-test\textsuperscript{128}.

Further, to estimate how the solutions list of participants changed from initially preferred solutions (during the workshop) to solutions chosen a month later (in post-questionnaire), the subcategories named during the workshop were listed, and then compared to the list of subcategories rated by participants as of most importance in post-questionnaire. In addition, after the results from the post-questionnaire were received, average ratings of the categories were calculated to find out the most “popular” solutions.

Further, to relate participants’ responses to the confirmation bias discussion, the participants’ responses were analysed against motivational forces that mitigate or strengthen confirmation bias. The selected unit of analysis for the motivation categorisation was the whole post-response of the participant in the workshop session. The response of each participant was analysed in terms of
1) Repeating/confirming/adding/questioning of pre-response in oral response;
2) Generality/Specialisation of response; 3) inclusion of others’ comments or solutions;
4) degree to which the participant changed his/her opinion between responses; 5) focus of response (one idea or several ideas); 6) qualitative check of whether there were clear differences across groups based on age, sex, position, and career experience.

\textit{Study results}

A total of 96 segments were identified in the responses, and categorised according to content.

\begin{table}
<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>Number of segments</th>
<th>Example of reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
<td>focus on the uniqueness of our biotechnology methods</td>
<td>4</td>
<td>«idea that is our product should match 2 main criteria – uniqueness and demand»</td>
</tr>
<tr>
<td></td>
<td>protect our IP</td>
<td>5</td>
<td>«patent therefore should also be unique and on demand»</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
\end{table}

\textsuperscript{128} Mann-Whitney U-test estimates that it is equally likely that a randomly selected value from one sample will be less than or greater than a randomly selected value from a second sample.
<table>
<thead>
<tr>
<th>Partnerships</th>
<th>Count</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>partner with external professionals and scientists</td>
<td>6</td>
<td>«attraction of scientific experts for evaluation»</td>
</tr>
<tr>
<td>partner with external laboratories to create new IP</td>
<td>4</td>
<td>«for sales, it is important to increase its real (scientific) value - attracting outsourced laboratories for the expertise of the IP»</td>
</tr>
<tr>
<td>form good partnerships</td>
<td>5</td>
<td>«also, there is the way to increase the value of IP is to use it in a real project by ourselves and then sell it to partners»</td>
</tr>
<tr>
<td>build good connections</td>
<td>2</td>
<td>«it is connections, scientific potential»</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Marketing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>participate in conferences</td>
<td>3</td>
<td>«participation in conferences, invited lecturers, advertising of projects and products (they should not be necessary scientific, they should be at least of image value)»</td>
</tr>
<tr>
<td>follow the development of demand in the field</td>
<td>5</td>
<td>«prognosis of field development, following trends of novel methodologies»</td>
</tr>
<tr>
<td>search for new emerging needs</td>
<td>3</td>
<td>«we can develop something like a mix - a product on demand with an interesting package»</td>
</tr>
<tr>
<td>have clear and active marketing strategy</td>
<td>16</td>
<td>«to increase the value of IP, one needs to develop the clear &quot;cover&quot; of the company - site, marketing materials, precise branding on B2B market»</td>
</tr>
<tr>
<td>inform the scientific community of our patents</td>
<td>2</td>
<td>«it is not only important to patent something, but to inform scientific community about it»</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Offering</td>
<td>have a great product</td>
<td>4</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---------------------</td>
<td>---</td>
</tr>
<tr>
<td>check other products on the market and</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>create similar products by ourselves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>develop more services and/or product on</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>create new services for other companies who</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>also want to protect their IP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>have many projects</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Total** 15

<table>
<thead>
<tr>
<th>Staff</th>
<th>focus on our staff</th>
<th>3</th>
<th>«I can say that the first effort that the company should do is staff»</th>
</tr>
</thead>
<tbody>
<tr>
<td>showcase success within the company</td>
<td>2</td>
<td></td>
<td>«catch the employees on their successes»</td>
</tr>
</tbody>
</table>

**Total** 5

<table>
<thead>
<tr>
<th>Sales</th>
<th>target specific client groups</th>
<th>5</th>
<th>«institutions, universities and scientists»</th>
</tr>
</thead>
</table>

**Total** 5

<table>
<thead>
<tr>
<th>Funding</th>
<th>secure funding</th>
<th>10</th>
<th>«investments are needed»</th>
</tr>
</thead>
</table>

**Total** 10

**Total** 96

All participants during the oral response presented the same information they had previously written in their individual questionnaire. They did not refer to other speakers' responses while presenting their prototypes. After oral presentations, in the follow-up questionnaire, four participants noted that some of the specific steps suggested by the others were good for solving the problem. Also, in their follow-up questionnaire, six participants stated that their initial solution was correct. Two people included parts of others' solutions in their plans. Two engineers and the marketing person were more specialised in their approach and focused on some particular solution, whereas four participants with more “generalist” approach (economists, managers) provided more general ideas. Generalist approaches were found in both young and old participants, as
well as in participants who worked in the company for different amounts of time. However, the assumption that “generalists” could be less prone to confirmation bias than “specialists” was not proved, at least for this study sample.

During the pre- and post-interview with top-manager, the main focus of his response was the personnel. However, he changed his emphasis from “more “generalists” are needed” to emphasis on including more creativity into corporate life and that people need to be praised for their successes.

The studied team had rather diverse demographics with the age of participants ranging from 28 to 61, highly educated, with different career experience. However, the analysis shows that the degree of preference in post-questionnaire a month later after the workshop of own verses others solutions is similar among all participants:
<table>
<thead>
<tr>
<th>Solutions / Participant’s response</th>
<th>C1F1</th>
<th>C1F2</th>
<th>C1M1</th>
<th>C1M2</th>
<th>C1M3</th>
<th>C1M4</th>
<th>C1M5</th>
</tr>
</thead>
<tbody>
<tr>
<td>focus on the uniqueness of our biotechnology methods</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>partner with external laboratories to create new IP</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>form good partnerships</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>partner with external professionals and scientists</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>secure funding</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>participate in conferences</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>build good connections</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>promote the IP we already have</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>have a great product</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>follow the development of demand in the field</td>
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<td>check other products on the market and create similar products by ourselves</td>
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<td>5</td>
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<td>search for new emerging needs</td>
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<td>have clear and active marketing strategy</td>
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<td>protect our IP</td>
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<td>target specific client groups</td>
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<td>develop more services and/or product on demand</td>
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<tr>
<td>create new services for other companies who also want to protect their IP</td>
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<tr>
<td>have many projects</td>
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<td>4</td>
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<td>2</td>
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<tr>
<td>focus on our staff</td>
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<td>inform the scientific community of our patents</td>
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<td>showcase success within the company</td>
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</table>
When the mean ratings were calculated for self- and other-originated statements, and ratio of mean value of self-originated opinions to mean value of other-originated opinion, the calculated average rating of own responses by participants was 1.25, and of others' responses 1.75. The average ratio of own responses rating to the others’ responses rating was 0.70, which means that still the participants found their previously held opinions more important than their colleagues’ solution suggestions in the post-questionnaire. A Mann-Whitney U-test showed that this difference was statistically significant (U=1196.5, p=0.013). However, as six out of seven participants gave the top importance rating to more solutions in their post-response list of solutions than they had generated themselves in their workshop, they could still be argued to see after the experiment a broader picture than before.

After the results from the post-questionnaire were received, average ratings of the ratings groups in total were calculated to find out the most “popular” solutions. Figure 2 shows average ratings of the proposed solutions with the participants’ preferences calculated. The participants’ preferred solutions were: inform the scientific community of our patents (Marketing category), have a great product (Offering category), promote the IP we already have (Marketing category), develop more services and/or product on demand (Offering category), protect our IP (IP category), build good connections (Partnerships category), partner with external professionals and scientists (Partnerships category):

![Figure 2](image_url)  
**Figure 2** Average rating of solutions among participants

When the responses of participants were analysed against prevalence of factors potentially increasing defense or accuracy motivation to showcase how the confirmation bias manifests itself in the experiment, the presence of the following elements was showcased as potentially strengthening confirmation bias (defense motivation): commitment, reversibility, closed-mindedness, and overconfidence. Another defense motivation factor according to Hart et al. (2009) – quality of information available (disconfirming rather than confirming information of high quality) – was not found in
participants’ responses. On the other hand, open-mindedness, the element that potentially mitigates confirmation bias (accuracy motivation), was showcased in participants’ responses. Other factors potentially mitigating confirmation bias – outcome relevance, utility and quality of information available – were not found in participants’ responses.

**Discussion**

The literature review showed that there is a potential for emergence of confirmation bias in business decision-making, and there are several cases that can be referred to (e.g., Jorgensen & Papatheocharous, 2015; Verma, 2016). The literature analysis also suggested that design thinking and its practices and tools can help strategic decision makers to deal with challenges and mitigate cognitive biases, including confirmation bias. These tools encourage team members to withhold from judgment and avoid debates, thus helping to create more innovative solutions (Liedtka, 2014). However, limited theoretical and empirical research has been done on this topic.

The empirical study conducted might showcase the selectivity exposure (Cotton, 1985; Frey, 1986), prevalence of defense motivation, and emergence of confirmation bias in strategic decision-making. The study indicated that applying isolated elements of design thinking without an awareness of interdependencies of its mindset and tools did not have the expected positive influence on strategic decision-making in such a short intervention. Many factors increasing the levels of confirmation bias were present during the workshop (presence of top-manager, short timing, stress due to uncertainty about the topic and methods used, no prior experience with prototyping and group work, highly skilled specialists familiar with only their fields of work).

The participants perceived the idea of giving follow-up comments on others’ prototypes as an opportunity to showcase that their particular initial solution was correct, adding that some details from others’ answers were appropriate as well. In the conducted workshop noteworthy is the connection between the participants’ typical role in the company and the initial preference of challenge solution (pre-response and oral response).

The most positive outcome is that the top-manager noticed the importance of such group sessions and creative techniques and decided to focus more on employees' wellbeing and recognition of their successes. Also, according to the results of post-questionnaire, participants’ knowledge about the challenge subject has been broadened. To us, it seems reflective of the intangible value that design thinking could bring to organisations and impact collaborative sensemaking.

**Conclusions**

In this paper, we discussed the challenge of identification, classification and mitigation of confirmation bias in the sensemaking stage of strategic decision-making. The current research served as a contribution towards grounding design-thinking research in the cognitive bias framework (Liedtka, 2014) by introducing the conceptual framework of how confirmation bias can be identified and targeted in strategic decision-making. That could be utilised further in other research design, and by managers in preparation of decision-making sessions. This could help managers to support holistic integration of design
thinking in the organisational culture, and clarify design thinking’s utility as a method for improving organisational decision-making processes and outcomes. The conducted empirical study resulted in increasing awareness of the top-management in the case company of the opportunity associated with integrating design-thinking tools in the problem-solving sessions.

The literature analysis and empirical study showed that confirmation bias could be identified and classified in strategic decision-making (Das, 1999; Krieger & Fiske, 2006; Benoliel, 2015). That being said, the introduction of design-thinking tools did not have the expected positive influence on strategic decision-making: the lasting effect was not achieved, though the use of the tools was seen to be beneficial, from the received responses from top-manager and other participants. Therefore, while we managed to investigate how to identify and classify confirmation bias, more research is needed to study the potential and ways of its mitigation with the help of design thinking. There is a possibility that if design-thinking tools are to be applied for a longer period of time, they could positively impact strategic decision-making.

The limitations of the conducted study include limitations of qualitative method chosen (poses some restrictions for analysis), sample size, language barrier for assessment of study results, lack of prior research studies on the topic, and self-reported data (one researcher designed the study, made observations and analysis). It could be inferred that more elaborate studies with extensive data collection, and utilization of in-depth qualitative approaches and quantitative approaches, could contribute to the chosen field of study. Moreover, it would be beneficial to collect qualitative data on how design thinking manifests itself at different stages of strategic decision-making process in companies to help utilise design thinking, and what difficulties managers express at different decision-making stages. This will help broaden the implications of proposed bias mitigation framework, as well as see bigger picture of what difficulties managers experience (other biases and cognitive limitations), and where they can use design thinking more to impact strategic decisions being made.

It is suggested that comparative workshops could be done with different purposes: one, for instance, without management representative, and one where the purpose of the study is explained (Morewedge, Yoon, & Scopelliti, 2015). It could be noteworthy to compare results in company already utilising design-thinking methods, and in the companies that are unfamiliar with the topic. To add, it would be important to try different research designs, like creating several prototypes at once and measuring the degree of confirmation bias, giving specific pieces of information about the challenge before the workshop to participants that could bias them towards their chosen solution, propose awards (Dow et al., 2012). It would be as well important to work with the challenges, solutions to which will be implemented certainly, to check the change in accuracy and defense motivations among participants and the degree of confirmation bias. It could be suggested that further research could be done to check whether still some difference between “generalists” and “specialists” thinking exists to assess confirmation bias emergence. It is as well noteworthy to tie open-mindedness or closed-mindedness and presumably other potential accuracy or defense motivation factors to confirmation bias mitigation.
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References


About the Authors

**Ekaterina Kotina** is a PhD Candidate in Loughborough University London. Previously worked for biotechnology industry in R&D and business development. Her key expertise is management of R&D projects and fundraising.

**Mikko Koria** is the Professor and the Director of the Institute for Design Innovation at Loughborough University London, UK, and a Visiting Professor of Management at the Aalto University, Finland. His current research interests include design management, business models, business design, design ecosystems, change and creating value for the future.

**Sharon Prendeville** is a lecturer in design innovation at Loughborough University London. She researches new contexts for design and their potential to enable sustainable futures. This encompasses how sustainability manifests in urban spaces such as grassroots movements and circular cities.
A model of service design elements to understand innovative service processes

LASSILA Sirpa
\textsuperscript{ab}*; RIEPLE Alison\textsuperscript{a} and ENNIS Caroline\textsuperscript{a}

\textsuperscript{a} University of Westminster, United Kingdom
\textsuperscript{b} Haaga-Helia University of Applied Sciences, Finland
* Corresponding author: Sirpa.lassila@haaga-helia.fi

This paper aims to provide an understanding of innovative service design processes by comparing service design logic with the entrepreneurial logics of causation, effectuation and bricolage (CEB). The paper draws upon empirical data to show how both service design logic and entrepreneurship logics may help us to create more innovative service design outcomes. In this process, we hope to understand how the creation of value enters into the service innovation process through co-creation between customers, organisations, ecosystem members and society. Data used within this paper includes deep qualitative interviews with key stakeholders, written documents and participative observation. From our analysis, we develop a model of service innovation design that shows how design logics and entrepreneurial logics influence the development of new and innovative services.

keywords: service design; service innovation; effectuation; bricolage

Introduction
This paper explores innovative service design processes by comparing service design logic with the entrepreneurial logics of causation, effectuation and bricolage with the aim to better understand how innovative services are designed. The intention is to enhance the understanding of how applying both service design and entrepreneurship logics may help us to create a more desirable entrepreneurial outcome. Therefore, this research explores the process of service innovation design and draws upon Venkataraman, Sarasvathy, Dew and Forster (2012) to suggest that markets and opportunities are the products of a
designing process, constructed through the actions and interactions of service entrepreneurs and stakeholders. The conceptual framework deployed herein as specific to design is based on understanding design as something that brings change (Borja de Mozota, 2003) and facilitates strategic innovation (Rieple & Pitsaki, 2001). Moreover, with regard to identifying what can be considered as design and who is able to design, the study draws upon Simon’s (1969) definition of design which states that "Everyone designs who devises a course of action which is aimed at changing existing situations into preferred ones" (p. 111). The theoretical approaches deployed within the framing of the argument and the subsequent analysis arise both from the literature related to service design and from the entrepreneurship literatures.

Our research takes place within the lively discussion that studies the processes deployed by entrepreneurs in identifying, exploiting and operationalizing an opportunity for a new service (Arend, Sarooghi & Burkemper, 2015; Wiltbank, Sarasvathy, Dew & Read, 2016). Through using service design logic as a lens, as well as comparing it with three alternate sets of cognitive logics as associated with entrepreneurship (causation, effectuation and bricolage (CEB)) the aim of this paper is to understand how innovative services are designed. It follows Whetten’s (1989) suggestion to use journalistic questions in order to describe building blocks for theory that explore the elements of: What is being designed, how and why? Who is designing, when and where? In justification of the theoretical framing it is pertinent to note that Fisher (2012) also compared and contrasted causation, effectuation and bricolage using Whetten’s building blocks for theory and did so by utilising a deductive research approach. We contend that a combination of service design logic and entrepreneurial logics offer a new understanding of how the value related to the range of stakeholders (customer, organisation, ecosystem and society) enter into opportunity creation within the design process, but also that service design innovation processes are more complex than is suggested by using only the CEB or service design logic as a pre-set framework. Applying a synthesised service design logic and entrepreneurial logics as a lens may shed new light on how the different levels of stakeholder value in relation to customer, organisation, ecosystem and society, enter into the service innovation process (Buchanan, 2001; Den Ouden, 2011).

The research is conducted within a new service venture called Health Company (a pseudonym, as are all other names), which was established in 2014. The firm offers occupational healthcare and wellbeing services to knowledge workers by deploying the business model as advocated by Den Ouden (2011) which describes the offering as being a meaningful and transformational innovation which address the different levels of stakeholder value. The service which aims at changing behaviour, disrupts the traditional structures in the ecosystem, and requires a long-time period for value to be realised; and quite importantly, as a radical solution, it is not yet evident if the business model is a viable one that will be accepted by the customers. However, Health Company aims to challenge the traditional design of the services for occupational health care by focusing on the design and provision of preventive services, offered for a fixed monthly fee, and by handling approximately 65% of their services digitally through eHealth solutions. This is in stark contrast to the traditional face-to-face service delivery methods typically found in occupation health service providers.
During one year of participant observation research at Health Company we conducted semi-structured interviews, engaged in informal discussions, attended meetings, events, and development days and to some extent also became involved in the everyday work of the service. We also had access to internal e-mail communication, presentations materials, meeting memos, customer research material as well as internal and external social media channels (Brewer, 2010). This enabled us to get close to people working in Health Company to understand the processes, meanings and everyday practicalities of service design and service provision within the organisation.

**Literature review**

**Defining services**

There are different perspectives in service marketing and management literature as to how to define the service concept and how to articulate what services are. Service research has historically focused on studying the provision of service tasks in a specific context (Chandler & Lusch, 2015). As the context of services has changed quite rapidly so too have the priorities of service research which has moved towards enhancing the understanding of value creation in complex systems, multi-actor networks and collaborative contexts as well as investigating the changing roles of customers, employees, and technology in the value creation process (Ostrom et al., 2015).

Importantly, the service concept has developed from meaning merely the service activity or process towards understanding service as customer service logic, provider service logic or customer dominant logic. Logics then tend to underlie how services are now understood. Service as an activity is where a service provider assists a customer in everyday activities. Customer service logic changes the focus and emphasises the role of the customer in value creation and how they create value for themselves. Provider service logics focuses on creating a business model which is based around the customer’s own value creation processes, so that the customer becomes more involved in the design and co-creation of the service to enable the service provider to more specifically meet their needs and to engineer out non-value adding elements (Clark, Johnston & Shulver, 2000; Grönroos, 2008).

Most recently the service concept has increasingly been defined by a focus on the customer’s processes and touchpoints, a perspective known as customer dominant logic (Heinonen & Strandvik, 2015). This is in contrast to the provider service logic which focusses on the provider’s activities (Edvardsson, Gustafsson & Roos, 2005; Grönroos, 2008). Notably, a customer dominant logic focuses on how customers embed services within their own ecosystem and processes by engaging with different providers (Heinonen & Strandvik, 2015). Due to the inherent complexity of the service context, the service experience may be affected by different dispositions and ecosystem participants leading to unique, changing and fleeting service experiences (Chandler & Lusch, 2015).

As the definition of service concept has evolved and recognition of service complexity has grown, service design has emerged as a new field (Mager, 2009; Patricio, Fisk & Constantine, 2011). Many of the complex problems that we face today are not well addressed by fragmented knowledge and specialisation (Buchanan, 2001) and service design theory is currently unable to address the requirements of a services sector
dominated by customer-dominated logics theory. We argue that a more inclusive service design philosophy, which brings in the logics of entrepreneurship and innovation, offers a holistic approach to considering the service offering thereby enabling us to understand the connections and interactions in complex ecosystems (Buchanan, 2001; Mager, 2009).

Service design

Service design, as an outcome-based practice, focuses on bringing about a service that is: usable, desirable, efficient and effective. In order to do this the design process should be: human centric and holistic in nature; and involvement in this process should be: systematic, iterative and user-oriented (Mager, 2004). Service design when described as a human centric approach, emphasises the need to apply techniques to foster ‘user understanding’ for the service designer to understand the actual context of service use (Buchanan, 2001). This is to develop new service ideas and solutions as well as providing guidance towards implementing them (Moritz, 2005). In line with customer dominant logic and the role of other stakeholder within the ecosystem, Mager and Sung (2011) provide a justification for service design which emphasises co-creation with users, employees and other stakeholders. Pertinently it determines that there is a need to strive to innovate new service solutions by using creative and visual methods to explore the whole series of interactions within the customer journey.

Theory on service design has developed from focusing only on the outcome and process into precursor factors: “Service design is the design of overall experience of a service as well as the design of the process and strategy to provide that service” (Moritz, 2005, p. 39). Design has also been seen as means for communicating values to the employees and acting as a glue in multidisciplinary projects as well as enabling better connections (Pitsaki & Rieple, 2011). Service design is not just a short-term project but an ongoing process which aims at continuous evolution; it affects the whole organisation, business structures and processes (Moritz, 2005).

Service design research has typically been approached from the service marketing and service management literatures (Holmlid & Evenson, 2006; Edvarsson et al., 2005; Wetter-Edman, 2010; Sangiorgi & Prendiville, 2014; Sangiorgi & Meroni, 2011) with the aim of trying to position the concepts as well as providing theoretical grounding and advancement for the discussion of service design. However, even though there is advanced knowledge about how organizations manage services, few researchers have explicitly used design theories (Kimbell, 2011) to understand the service creation and development process. The design process if mentioned at all has merely been seen as a component of new service development (Scheuing & Johnson, 1989) or the redesign of existing services (Berry & Lampo, 2000). Instead of seeing design, and design thinking (Liedtka, 2013) as something that can create new concepts and knowledge (Kimbell, 2011), its role has rather been that of an adjunct. Applying CEB logics is a new approach to conceptualising service design and service innovation and has the potential to enhance the power and influence of service design. A better understanding how service design and entrepreneurial logics may help us to create more desirable service innovation outcomes, as well as understand how customer, organisation, ecosystem and society value can usefully enter into the service design and innovation process.
Entrepreneurial processes

For many years, entrepreneurship research relied largely on theoretical frameworks that were imported from other domains (Fisher, 2012). The focus of entrepreneurship research was on the relative performance of companies and individuals, which had already been explored by strategic management scholars and was arguably not an appropriate basis from which to understand entrepreneurship processes and performance (Venkataraman, 1997). Another weakness was the definition of entrepreneurship itself as most researchers defined it solely in terms of the entrepreneur as an individual: who they are, and what they do (Venkataraman, 1997).

The focus for entrepreneurship research was subsequently extended to include not only the individuals but also the opportunities that they seek. Venkataraman (1997) defined entrepreneurship research as a scholarly field which studies how, by whom, and with what consequences opportunities are discovered, created and exploited into future products and services. Since then entrepreneurship researchers have begun to form their research questions around the conceptual domain of opportunities, asking how the creation of new products and services come to be, why certain people find and exploit these opportunities while others don’t, and what are the different modes of action that are utilized to exploit entrepreneurial opportunities (Shane & Venkataraman, 2000).

Over the last two decades emerging theories of entrepreneurship have extended the traditional focus to understanding entrepreneurial action through economic thinking, demand–supply imbalances (Casson, 1982; Kihlstrom & Laffont, 1979) and opportunity exploitation (Shane & Venkataraman, 2000) in order to understand how entrepreneurs exploit and identify opportunities. This describes the differences between the traditional planning approach (causation) and emerging theoretical perspectives of effectuation (Sarasvathy, 2001) and bricolage (Baker & Nelson, 2005).

These theoretical approaches to entrepreneurship have mainly evolved and developed independently of one another even though they have much in common (Fisher, 2012; Archer, Baker & Mauer, 2009; Chandler, DeTienne, McKelvie & Mumford, 2011; Fisher, 2012). These new theories suggest that opportunities can be constructed, created through iterative learning processes rather than through exploiting existing known opportunities (Alvarez & Barney, 2010). Effectuation emphasizes the uncertainty of market conditions, which lead to dynamic and interactive process of creating new artefacts. Instead of focusing on identified pre-existing opportunities effectuation includes the very creation of the opportunity (Sarasvathy, 2001). In a dynamic environment goals change and the entrepreneur has control over the means only. Focusing on means when making decisions entrepreneurs ask questions such as: Who am I? What do I know? Whom do I know? in order to uncover opportunities (Sarasvathy & Dew, 2005). The means consists of personal knowledge, skills and networks on individual level and physical, organisational as well as human resources at a company level (Barney, 1991). Effectuation and causation processes don’t exclude one another, but on the contrary they overlap and intertwine depending of the actions and context of decisions (Sarasvathy, 2001).

Part of this emerging approach to entrepreneurship is based on the concept of bricolage, which was used by Levi-Strauss (1966) to say that there may be many mechanisms that can be used to achieve a certain state. Bricolage as an entrepreneurial process can be
defined as making do by applying combinations of resources at hand to new problems and opportunities (Baker & Nelson, 2005). Entrepreneurs who enact bricolage consider new value for forgotten, discarded, worn or single-use items, engaging customers, suppliers and hangers-on in the project, creating services by amateur or self-taught skills, creating markets by offering otherwise unavailable services as well as refusing to consider standards and regulations as limitations (Baker & Nelson, 2005).

Venkataraman et al. (2012) suggests that entrepreneurship, and which we argue also applies to service design, has three premises:

1. Opportunities are made as well as found. Markets and opportunities may be the product of a design process, constructed through the actions and interactions of entrepreneurs and stakeholders.
2. Transformations are a central concept. If we consider the environment not as a given and static, then the inter-boundary may be radically transformed.
3. In order to understand entrepreneurial processes, we need to look at both inner and outer environment: actions, relationships and interaction.

Service design logic differs from the CEB logics by assuming that the customer or the user is the starting point for opportunity design. However, effectuation and service design have several processes in common. Both of them consider the opportunity construction process to be iterative, including stakeholders and taking place in a changing environment.

Bricolage and service design also both deal with problems that have to be solved using creative or innovative solutions. Effectuation, bricolage and service design all emphasise the openness of the process and the importance of interaction with stakeholders.

Comparing the different approaches, it seems that causation is clearly distinctive from the other processes as it has rather different philosophical underpinnings (Sarasvathy, 2001). Summarising we could say that causation is linear, effectuation is experimental, bricolage is flexible and that service design logic implies constant reframing. We believe that a more complete model of new service development, or service innovation, should incorporate all of these logics into one overarching framework.

**Research Methodology**

The research is conducted within a new service venture called Health Company, which was established in 2014. The service offers occupational healthcare and wellbeing services to knowledge workers. Health Company aims to challenge the traditional design of the service for occupational health care practices by focusing on the design and provision of preventive services, offered for a fixed monthly fee, and by handling approximately 65% of their services digitally through eHealth solutions which is in contrast to the traditional face-to-face service delivery methods.

During the one year of participant observation research at Health Company we conducted semi-structured interviews, engaged in informal discussions, attended meetings, events, and development days and to some extent also became involved in the everyday work of the service. We also had access to internal e-mail communication, presentations materials, meeting memos, customer research material as well as internal and external social media channels in the manner of ethnography (Brewer, 2010; Hammersley, 2013, 2016) which enabled us to get close to people working in Health Company to understand
the processes, meanings and everyday practicalities of service design and service provision.

**Findings**

In this section, we explore to what extent different logics associated with causation, effectuation and bricolage as well as service design logic enhances our understanding of the service innovation design process of Health Company.

When the two founders of Health Company described their behaviours, and reflected on their thoughts during the early stages of the new venture, processes associated with causation were almost totally missing from their accounts. In contrast with their own stance, they argued that competitors had used a causation-based approach in which they designed their business models around the constraints that they perceived in the environment. They regarded many of the existing actors in the occupational health care industry as inflexible and blinkered, seeing the environment as static and linear, and as a result failing to spot changes that were coming to the payment system or increasing digitisation of service processes. The founders considered that their new venture challenged conventional thinking and the dominant view of the market. The other founder, with previous experience of new ventures, suggested that they explicitly tried to avoid written and long term planning:

> As I had practised service design a little bit, so I got an idea that instead of doing the same as we did in Company X (the company he had established earlier) that we sat in a room behind the closed doors and sometimes we made hundred PowerPoint slides, sometimes 30 and other things. We knew some five years ahead how we are going to run the business. Here we did the other way around in that sense that the first thing we did after deciding to start a new venture we started contacting our old acquaintances.

The only evidence of causation processes related to systematic information gathering, which was aimed at learning from the international actors in the healthcare business, knowing about the laws and regulations in healthcare business and learning about the occupational health care market in general. Instead of causation, Tables 1-3 show examples of effectuation, bricolage and service design within the company.

<table>
<thead>
<tr>
<th>Effectuation</th>
<th>Effectuation processes in Health Company</th>
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<td>The primary set of means is formed by who the decisions makers are, whom and what they know, selection criteria based on affordable loss or acceptable risk (Sarasvathy, 2001)</td>
<td>Opportunity design influenced by heterogeneous educational backgrounds, knowledge and experience from different fields and from earlier ventures, as well as by the wide network</td>
</tr>
<tr>
<td>Investing only own work input and a small amount of capital</td>
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<tr>
<td>Choosing alternatives with smaller capital requirements (technological systems, premises, doing by yourself)</td>
<td>People identify new means-ends relationships that arise from change to discover entrepreneurial opportunities (Shane &amp; Venkataraman, 2000), experimenting with different strategies, effectuation processes may even start without an intentional decision of starting a business (Sarasvathy, 2001)</td>
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<tr>
<td>Focus on the controllable aspects of an unpredictable future (Sarasvathy, 2001)</td>
<td>Creating market by bringing in stakeholders who buy into the idea (shared values)</td>
</tr>
<tr>
<td>New markets created through strategic alliances and other stakeholder precommitments (Sarasvathy, 2001)</td>
<td>Cooperation with different service providers to reduce entry barriers</td>
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</table>

While causation processes seem to be absent, all the basic principles of effectuation (Sarasvathy, 2001) can be found within the opportunity design processes of Health Company (Table 1). The question ‘who am I and what do I know’ came up continuously in the service design conversations from both of the two founders at the very early stages of the new venture process as indicated in three incidences:

*What can a person do if his both grandparents were doctors, brother is a doctor, cousin is a doctor and uncle is a doctor and I’m the black sheep. And to add to that, my wife has worked in occupational health care.*

*We started talking that what if we would do the same as Company X (the earlier company established by the other founder) had done in law services. What if we would start building right from the beginning a concept in occupational health care and wellbeing that we ourselves believe in.*
We discussed a lot at home, what were the means, which Company X utilised when it disrupted the market.

Also, the network that both founders had developed, played an important role in enabling them to get access to new people. The two founders were also frequently asking themselves ‘who should I know?’ and finding ways to get access to these new contacts. Their guiding principle was to be open and talk about their idea with the people they met. They soon found out that many questions and problems were solved through these informal discussions.

<table>
<thead>
<tr>
<th>Bricolage</th>
<th>Bricolage processes in Health Company</th>
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<tr>
<td>Making do by applying combinations of resources at hand for new purposes (Levi-Strauss, 1966), rejecting the limitations of the environment. (Baker &amp; Nelson, 2005)</td>
<td>Using human resources, digital channels and systems in a new way and new combination</td>
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<tr>
<td></td>
<td>Interior design partly with used furniture</td>
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<tr>
<td></td>
<td>Disregarding assumed rules, standards and practices in the healthcare sector</td>
</tr>
<tr>
<td>Capable of creating innovative solutions in resource constrained environment (Senyard et al., 2014)</td>
<td>Disrupting the market with a new business model</td>
</tr>
<tr>
<td>Involved employees, customers, suppliers, and hangers (Baker &amp; Nelson, 2005)</td>
<td>Employees, customers, suppliers and other stakeholders as co-creators, suppliers as customers, customers as suppliers</td>
</tr>
<tr>
<td>Opportunity exploitation through other means too expensive (Baker &amp; Nelson, 2005), resource constraint and competitive environment (Senyard et al., 2014)</td>
<td>Limited resources as a new firm; trying to find innovative ways of solving the problems</td>
</tr>
<tr>
<td></td>
<td>Very competitive market, large companies as competitors, traditionally heavy investments required</td>
</tr>
</tbody>
</table>

Health Company can also be seen to have engaged in bricolage by using resources in a new way, involving stakeholders in the opportunity design process and trying to cope with limited resources by coming up with creative solutions (Table 2).

Bricolage processes are argued to enhance innovativeness in resource constrained environments (Senyard et al., 2009). The occupational health care sector in Finland is a regulated and highly competitive, with a few large service providers who all have rather similar business models. The legal environment sets many boundaries concerning required documents, licenses and expertise, all aimed at ensuring quality and safety in health care services. Another group of boundaries set by law concerns the operational implementation of occupational health care services. As the whole healthcare sector is rapidly changing it sets pressure on interpretations of the law and constant reframing of instructions. However, these new interpretations tend to be applied reactively. Pertinently, Health Company has rejected these limitations by introducing digital services and a fixed payment model, which innovation has allowed it to become a forerunner.
among its competitors. A third group of boundaries are assumption of regulations or assumptions of how services should be. Health Company has tested the limits of codes, standards and professional norms concerning processes, roles, premises and primary value of the service. One example of assumed regulations took place when the design of the premises started. As all the health care centers in Finland tend to share much the same outlook, it was assumed that it is due to the regulations. However, after investigating legal requirements, it became clear that there are rather few statutory limitations to how a health care center should look like which enables much wider service design possibilities.

When looking at the opportunity design process by applying service design logic (Table 3), we are able find out how the initial and rather vague idea based on effectuation logic (who am I, what do I know, who I know) turned into something that is of value for the customer/end-user, organisation, ecosystem and society.

Table 3  Service design logic in Health Company

<table>
<thead>
<tr>
<th>Service design</th>
<th>Service design processes in Health Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumes the customer/user as the starting point or lens into a specific service models how the service can be performed (Holmlid &amp; Evensson, 2008), integrates the possibilities and means to perform a service with the desired qualities, within the economic and strategic intent of an organization: strategies, structures, processes, interaction (Holmlid &amp; Evensson, 2008), a holistic approach (Mager &amp; Sung, 2011)</td>
<td>Experiencing the gaps in the ‘old’ service model as a customer, gathering customer understanding, designing services by thinking what creates value for the owner him/herself, customer/end-user, organisation, ecosystem and society</td>
</tr>
<tr>
<td>Creative, human-centered and user-participatory methods,</td>
<td>Focus on customer experience and employee experience</td>
</tr>
<tr>
<td></td>
<td>Channels: several different channels available for customer contact (emphasis on digital channels)</td>
</tr>
<tr>
<td></td>
<td>Payment model: from the accrual payment to fixed monthly payment</td>
</tr>
<tr>
<td></td>
<td>Process: designing new service processes</td>
</tr>
<tr>
<td></td>
<td>Premises: designed to be part of the desired customer and employee experience, from sterile hospital environment to cosy, relaxed, home feel</td>
</tr>
<tr>
<td></td>
<td>Roles: from hierarchy to equality (employees), from object to subject (end-users)</td>
</tr>
<tr>
<td></td>
<td>Emotions: relaxed, friendly, positive, personal</td>
</tr>
<tr>
<td></td>
<td>Communication: designing a distinct, value-laden story, emotions embedded in the communication</td>
</tr>
<tr>
<td></td>
<td>Customer profiles and customer service paths</td>
</tr>
</tbody>
</table>
interdisciplinary and visual (Mager & Sung, 2011), constant reframing (Saco & Concalves, 2011) | Ideation, experimenting fast with different service ideas  
Mentor group meetings (‘oracles’)  
Co-creation with founders, suppliers, potential customers, design professionals and mentors  
Visual customer profiles, customer service paths and interior design  
Iterative process: Listening customers actively, testing fast, emerging business model, which is constantly reframed

Capable of dealing with “wicked problems” for which there is no single solution and in which stakeholders play roles in defining the nature of problem (Buchanan, 1992), to create usable, desirable, efficient, effective, human centric and holistic services (Mager & Sung, 2011) | Increasing social and health care costs:  
government and public interested in preventive health care solutions  
Knowledge workers as users of health care services: companies interested in preventive health care solutions  
Knowledge workers as subjects in health care services: end-users interested in alternative solutions  
Designing easy to use, fast, low-threshold personalised services as well as long-term health plans with a focus on preventive health care services

"Everyone designs who devises a course of action aimed at changing existing situations into preferred ones" (Simon, 1969), co-creation (Mager & Sung, 2011) | The founders were explicitly thinking how to solve the problems within occupational health  
Actively contacting and talking to people thereby increasing the opportunity for serendipity  
Discussing the first ideas, alternative solutions and competence needs with potential users and decision makers to develop the ideas further  
Customers as developers and innovators, suppliers as customers  
Health Company as innovator and developer for the suppliers

Sustaining change, redirecting practices towards sustainable futures (Fry, 2009) | Change at personal level: willingness to do something purposeful  
Change at industry level: Conscious aim of disrupting a conservative industry/market, modernisation of services
In Health Company the choice of business sector (occupational health care) was affected by the founders’ education, work and entrepreneurial experience as well as the presence of close relatives working in the sector. However, these effectuation processes did not particularly address the question, ‘how does value enter into the design process?’. The owners had decided that they would start a new venture in occupational health care, but they did not yet have an idea about scope of the new venture and what it would be like.

After deciding on the sector, and deciding that they wanted to start a new venture, the two founders proceeded with a question: ‘what is the change I want to make?’ When answering this question, the two founders applied metacognitive processes to the design of their services. Metacognitive processes enhance adaptable cognitions which enable us to ‘think beyond or reorganize existing knowledge structures and heuristics’ (Haynie, Mosakowski & Earley, 2008, p. 217) in uncertain and new situations. Metacognitive strategies are learned strategies, thinking about thinking; these affect how one reflects on one’s own motivation and environment, then formulates and evaluates multiple alternatives based on experience, knowledge and intuition (Haynie, Mosakowski & Earley, 2008). The metacognitive processes led to the question of ‘what is the change I want to make?’ In the case of Health Company these related to:

- Experiencing the gaps in customer value in the previous work place and reflecting on the causes for those gaps and thinking about different alternatives to offer better customer value
- Dissatisfaction in leadership style in previous work place and reflecting that earlier experience with Company X as a great place to work
- Reflecting on the earlier experience of disrupting the market and thinking about the disruption alternatives in occupational health care sector
- Reflecting on the experience and knowledge of service design and thinking about the alternative paths to opportunity design
- Reflecting on own experiences as a customer and end-user of occupational health care services
- Reflecting on own motivation: what is it that I want to achieve?

Answering the question of ‘what is the change I want to make’, enabled the founders to scope their idea a little bit further; having already established that they wanted to enhance wellbeing and health in Finland, and to help companies to have healthy and productive employees, including their own. They also wanted to disrupt the occupational health care market by creating new value for the customer and solving the present bottlenecks in the service. Notably, one of the biggest bottlenecks from the customer side seemed to be the accrual payment system therefore the owners started thinking about the design of a fixed payment system. By exploiting service design logic they started
openly discussing about their idea with their contacts. In one of these discussions one of their contacts had said:

*It is like, have you ever heard about the story of the Chinese doctor. People in the village paid for the doctor, but by no means did they pay based on number of clinical visits and operations. Instead, all the healthy villagers paid. According to the principle, the better the villagers felt, the better the doctor earned. He had financial incentives to keep the villagers healthy.*

This became the story and vision of Health Company. In the proceeding co-creation event called *Oracles’ Evening* the question to be discussed was: what would the services be like if the aim was to keep people healthy? In this event, the first ideas for the new services were discussed. However, the founders wanted to get a deeper understanding of the customers and conducted 50 interviews among potential customers who were mainly managing directors, HR managers or financial directors. These interviews enabled the founders to design their emerging business model, which included choices of channels, payment model, customer processes, service offering, premises, roles, emotions and communications. The initial ideas were tested in discussions with potential customers and other network. Also, a short workshop was organised by a service design agency around customer profiles and customer paths; all adding to the overall design activity.

**Discussion**

Effectuation and bricolage logics seem to share similar philosophical underpinnings and enabled us to understand how service opportunities were recognised and developed. However, service design logic, as a lens, revealed several new elements in the opportunity design process which were not covered within any of the CEB logics. When we attempt to understand how service innovations can be designed, we can determine that by combining the CEB logics with service design logic, this enables us both to understand and develop the process (Table 4).

<table>
<thead>
<tr>
<th></th>
<th>Causation</th>
<th>Effectuation</th>
<th>Bricolage</th>
<th>Service Design</th>
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</thead>
<tbody>
<tr>
<td>What</td>
<td>Effect as given; focus on selecting between means to create that effect, a given goal to be achieved or a decision to be made: usually well-structured and specific (Sarasvathy, 2001)</td>
<td>A given set of means. The primary set of means is formed by who the decisions makers are, whom and what they know. Selection criteria based on affordable loss or acceptable risk (Sarasvathy, 2001)</td>
<td>Make do with what is at hand (Levi-Strauss, 1966)</td>
<td>Assumes the customer/user as the starting point or lens into a specific service models how the service can be performed (Holmlid &amp; Evensson, 2008)</td>
</tr>
<tr>
<td>How</td>
<td>Systematic information gathering, making plans, setting goals and implementing, linear process (Kotler, 1991)</td>
<td>People identify new means-ends relationships that arise from change in order to discover entrepreneurial opportunities experimental and iterative process (Shane &amp; Venkataraman, 2000)</td>
<td>Making do by applying combinations of resources at hand for new purposes (Levi-Strauss 1966), rejecting the limitations of the environment (Baker &amp; Nelson, 2005)</td>
<td>Creative, human-centered and user-participatory methods, holistic, interdisciplinary and visual (Mager &amp; Sung, 2011), constant reframing (Saco &amp; Concalves, 2011)</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>Why</td>
<td>Focus on the predictable aspects of an uncertain future (Sarasvathy, 2001)</td>
<td>Focus on the controllable aspects of an unpredictable future (Sarasvathy, 2001)</td>
<td>Capable of creating innovative solutions in resource constrained environment (Senyard, Baker, Steffens &amp; Davidsson, 2014)</td>
<td>Capable of dealing with “wicked problems” for which there is no single solution and in which stakeholders play roles in defining the nature of problem. (Buchanan, 1992)</td>
</tr>
<tr>
<td>Who</td>
<td>Rational entrepreneur who seeks for profit maximisation (Sarasvathy, 2001)</td>
<td>Decision makers as who they are, whom they know and what they know (Sarasvathy, 2001)</td>
<td>Involved employees, customers, suppliers, and hangers-on (Baker &amp; Nelson, 2005)</td>
<td>&quot;Everyone designs who devises a course of action aimed at changing existing situations into preferred ones&quot; (Simon, 1969), co-creation (Mager &amp; Sung, 2011)</td>
</tr>
<tr>
<td>When</td>
<td>Constraints on possible means, more useful in static, linear and independent environments (Sarasvathy, 2001)</td>
<td>Due to rapid change the future is unknown; explicit assumptions of dynamic, non-linear and ecological</td>
<td>Opportunity exploitation through other means too expensive (Baker &amp; Nelson, 2005)</td>
<td>Sustaining change (Saco and Goncalves, 2008), redirecting practices towards sustainable futures (Fry, 2009)</td>
</tr>
</tbody>
</table>
Service design logic strongly advocates the importance of change (Fry, 2009; Saco & Gonsalves, 2008), which in turn leads to a better future, which is at the core of opportunity design. Notably, within Health Company the change that was taking place touched the founders themselves, along with customers/end-users, organisation, society and the whole ecosystem. The idea of the change was the premise from which the opportunity design started to take form and thereby further developed by utilising customer understanding and finding more concretely what creates value for the customer and where the gaps were (Texeira et al., 2012). The ideas about what needed to be changed was combined with ideas of how things should be changed to create value at different levels (Euden, 2011). The ideation and experimentation approach continued during the entire design process in an iterative manner, sometimes in more formal setting, but often in informal discussions and meetings too. Overall the service innovation process was an open, iterative and constructive process which invited different actors from the ecosystem to participate in the process. Through the open and co-creative process which was shaped by the founders cognitive and metacognitive processes, customer, organisation, ecosystem and society value entered into the service innovation process. The outcome of the service innovation process was an emerging business model in line with the approach advocated by Saco and Concalves (2011), which was considered not to be final but under constant reframing.

In considering the behavioural comparison of emerging theories of entrepreneurship, Fisher (2012) argued that bricolage and effectuation logics ignore market needs in uncovering an opportunity and refers to the argument for transformation as determined by Sarasvathy (2001) and Baker and Nelson (2005). However, it could be argued that both effectuation and bricolage build on customer needs, and that the information does not come through formal market research as it comes in ongoing interaction with people. Pertinently, service design logic aims to go deeper into understanding what people value and what the gaps are. Therefore, when applying service design logic ideation starts from what makes value for different stakeholders instead of focusing on the explicit needs. Service design logic includes people with different competences, experience and knowledge in the co-creation process and the outcome may be something that the customer or user was not able to imagine as one of the founders put it:

*If we had asked the customer, what they want, we would have never come up with our present business model. People are not able to imagine different futures.*
Our model of service design innovation can be used by design researchers and service designers to understand how design logics and entrepreneurial logics influence the development of new and innovative services. To conclude with Euden’s (2011) words “If they are well designed, transformational and innovative solutions create value for their users and for the organizations involved in developing and delivering them, and as a result they generate sustainable value for society at large” (p.13).

References


About the Authors

**Sirpa Lassila** has over ten years of experience in service design and innovation projects. She gives lectures and organises workshops on service design. Her undergoing PhD research in Westminster University is focused on designing services in new venture context.

**Dr Alison Rieple** is Professor of Strategic Management and Director of IDEaS, WBS’ Innovation Design Entrepreneurship and Strategy Research Group. Research interests include management of strategy, design and innovation, management of creative and cultural industries such as music and fashion.

**Caroline Ennis** is an operations management academic with a research interest in service design. She researches the design of business and management learning within higher education; specifically in relation to its value proposition and responsiveness as a service quality determinant.
There is a need for organisations and the leaders within them to explore, recognise, build and exploit new capabilities. Some of this ‘new’ capability could be better utilisation of the resources already at their disposal. For example, highly skilled designers and engineers. This paper explores the notion of knowledge models in design with two driving motivations. Firstly, a new urgency in the light of the forth industrial revolution, from a digitisation perspective: can we integrate designer’s thoughts with AI. Secondly, a longer-standing concern, from the point of view of the inherent need to communicate and express and model clearly in achieve the objective of design. A conceptual analysis of the role of models in design is presented before a potential new approach is proposed.

Keywords: digitisation; knowledge models; communication; perceptions

Introduction

Engineering design is uniquely valuable as a creative and inherently uncertain activity within a world that has become increasingly automated and, in many senses, predictable. It is a valuable and precious resource. However, the outputs generated, the thoughts and ideas produced, often disappear into the ether. The opportunity for interrogation, deeper understanding, comparison and analysis is lost. In a more practical sense, the meaning and intent and perception informing a decision is gone. Those later in the product life-cycle are left to guess and those present in the decision making process are forced to make assumptions. Is everyone on a design team really thinking the same thing? Without an exhaustive, unwieldy and frustrating process of rationale capture it can be difficult to tell.
What if there was a different way to capture these perceptions – the half-baked ideas that are laced with uncertainty and absolutely integral to design although they aren’t really quite knowledge. What if we could capture them and pause to explore them more?

Digitisation is increasingly central to the process of manufacturing and through-life management of products. Whilst we explore the possibilities for capturing knowledge and perceptions from a digitisation perspective, the same end-goal of externalising perceptions so they can be shared and communicated spans across traditional, non-digitised design practice.

**General Guidelines**

Improvements in technologies relating to measurement, communication and isolation have enabled a step-change from the automation ‘Industry 3.0’ of cyber-physical systems working semi-independently to a paradigm that interconnects the physical and virtual in a type of ‘social manufacturing’ where customer needs and behaviours are directly linked to industry production and where machines to machine communication and closed loop decision making enable autonomous decision making (Wang, 2015). This shift in paradigm coined as ‘Digital Manufacturing’, ‘Smart Manufacturing’ and ‘Industry 4.0’ represents a significant conceptual and practical transition in Manufacturing practice. Through-life intelligence of smart products is integral to realising the full advantages of such paradigms. Increasingly, emphasis is placed on embedded intelligence within the life-cycle phases and within the product itself (Duffy et al., 2016).

Machines can manufacture, monitor manufacture and make decisions about the design of manufacturing process parameters. Although there are still technical challenges within manufacture (limitations of sensors, etc.), the actual management of information, the management of information through control loops and mechanisms for autonomous decision making are relatively well developed and, to some extent, realised in practice. In a manufacturing domain, data describing processes exists in abundance: providing it can be measured it can be modelled mathematically.

During design, the product or system is in the process of being realised. Therefore, parameters cannot be definitely quantified, they must be modelled (an approximation of reality). Sensors can collect data of machine temperatures or the path of material through a supply chain but until a design is realised there is nothing tangible to measure. Design involves creating new value. To do so knowledge tied to experiences, intuition, unarticulated models or implicit rules of thumb is required. This is known as tacit knowledge.

Tacit knowledge is gained over a long period of time. It is difficult to express and can only be transferred with willingness (Nonaka, 1991). Because it isn't readily explicit and is challenging to model, we are some way off creating it in a format that is that is intelligible by machines.

**The role of models in engineering design**

The objective of Engineering Design is to create an artefact, process system or product that performs a function. In addition to performing a specific function and, in order that the system is viable, the artefact or process must be designed subject to physical and non-physical requirements. The skill of a Design Engineer lies in their ability to describe and
analyse systems in order to predict their behaviours. Where models in science are usually
used to predict the outcomes, models in design are most often used to demonstrate that
time and money can be invested with reasonable confidence because the predicted
outcome can be trusted (Simon, 1996). Achievement of confidence is not binary. Through
skilled modelling of the problem and corresponding solutions, confidence can grow whilst
ambiguity and uncertainty decrease. Usually, absolute certainty will not be possible prior
to the product being realised but it is the role of the Design Engineer to reduce and
manage risk.

The integration and balancing of an array of design requirements and, the setting-out,
communication and specification of this balance in a plan for realisation of an artefact or
process is the focus on design and design management activity. This is a non-trivial
matter: a whole plethora of requirements must be considered. From business objectives,
manufacturing constraints and through-life considerations to the performance objectives
of the system: somehow harmony must be obtained.

A plethora of literature describes endeavours to facilitate and manage the integration and
balance of requirements but the art and science of design remains subject and skill
dependant. Much of the contextual and expert knowledge resides in the minds of
designers (Lawson, 2006; Cross, 2008). Horvath (2004) suggests that the function of
engineering design is to transform rational and empirical knowledge in a form that can be
used for practical realisation of a system. The design takes from through the process of
creating models. Designers don’t just exchange geometric and mathematical data.
Modelling involves general knowledge of design and of the product development process
including specifications, design rules, constraints and rationale. Chandrasgaran et al.
(2013) present a detailed and useful model of Knowledge representation in product
design. The model elegantly illustrates the important concept of design foresight as well
as the range of modelling methods used at each design phase. For the purposes of
illustrating some additional concepts Chandrasgaran et al. (2013) model has been
adapted.

1. Firstly, the in use phase is an important consideration and receiving increasing
attention as Smart Products become operational and big-data influenced design
decision making. The integration of through-life data into design decision making
is one area that requires further exploration.

2. As products and processes become smarter, reflection upon design decision
making becomes as important as foresight. What are the implications of changing
the system? What are the limitations of the design? The Knowledge required for
design insight is a new addition to the model. Supply chain data and traceability
becomes increasingly important. This is also true from a sustainability
perspective.

3. Internal, tacit knowledge models are not included in Chandrasgaran et al. (2013)
original model (by definition, they aren’t representations of knowledge).
However, internal models do influence how knowledge models are created and
interpreted and are of significant to foresight; retrospective insight and sharing
within teams as such, they shouldn’t be discounted in efforts to improve
knowledge representation in design. The more abstract and subjective the model (the less defined the design) the more room there is for ambiguity.

Although unrepresented in Figure 1, within a single design activity sharing information and knowledge is critical. A great deal of effort is required for designers to communicate their rationale and perceptions about design parameters and the impact of parameters upon the design objectives (Klein, 1993).

Figure 1 Knowledge models through-life. Adapted from Chandrasagar et al. (2013) to show the influence of data; tacit, internal knowledge models and the reflective perspective

Clarity of shared information is critical within design: from an end of life to design perspective looking back to design; from design looking forward anticipating future life cycles phases (manufacturing or end of life, for example) and; within a design phase (between members of a cross-functional design team). Ambiguity is ubiquitous in subjective expert perceptions and interpretation within an immediate context and time. This is amplified across geographical, contextual and temporal chasms. As products and systems become more complex or have longer life-in service this is an increasingly pressing challenge. In order to address this challenge it is essential that we develop ways of sharing expert and tacit knowledge objectively. In addition to improving design practice as it stands, it is essential that new and intuitive tools for knowledge acquisition are developed if we are to move toward digitisation of design or AI supported design. This is not to say that design would or should ever become fully autonomous, but that there is room to improve upon the design process as it stands by modelling expert knowledge in digitised and AI supportable form.

Expert knowledge acquisition becomes the bottleneck (Chandrasegaran et al. 2013). This is especially true as we move towards digitisation. With increasing pressure to consider products through-life and the digitisation and efficiencies of surrounding processes,
engineering design is becoming the weak link in the information management chain and under increasing pressure to innovate. AI decision support could be revolutionary in enabling comprehensive through-life decision making, reducing lead times and cost and waste associated with unplanned rework.

**Physical models**
Physical models, for example prototypes, create a visual replica of the system being designed. The appearance often corresponds to some aspect of the intended physical reality of the object of design. Physical models may also allow some or all of the product functionality to be tested by may have less emphasis on aesthetics of equality. A scaled version of an object can enable aesthetic of aerodynamic evaluation, for example, without the invest in a full expression of functionality and detail. Physical models are tangible and enable clear communication of some aspects of a single implementation scenario. That is to say, a physical model cannot simultaneously represent two solutions and does not represent the design space. Although the physical model is tangible, the manufacturability knowledge relating to the rationale driving the radius of a specific curve remains in the mind of the designer. Physical models can be accompanied by a linguistic description or a schematic model and may be underpinned by (or underpin) mathematical analysis.

**Schematic and pictorial models**
Pictorial model represents the aesthetic qualities of a single implementation scenario. Quite often they are a two dimensional version of a physical model. They might include users and may illustrate the system being used in practice. They make it easy to envisage the design or an aspect of the design in practice although they may be completely fantastical and misleading in terms of viable functionality. They are often used to engage customers and non-technical stakeholders. For the purposes of technical design, they are more often integrated with a schematic model. Something of the internal and tacit is represented in a sketch. They contain an idiosyncratic style associated with a designer and may intangible aspects of personality, mood and character but these aspects remain subjective even when externalised. Schematic models tend to be more abstract than physical models. They are a pictorial representation so relationships between spatial, functional and non-functional parameters. Although they can correspond to reality, they don’t attempt to represent the literal visual appearance of the system they allude to. Schematic models represent an abstracted reality (a map, a flow chart, an electrical schematic) or, may be a more tangible representation of a mathematical model (graphs, histograms and infographics, for example).

**Linguistic models**
Verbal or linguistic models are more abstract than physical and schematic models in the sense that there can be no tangible representation of the physicality of a product or system and, perhaps no recorded representation at all. A speech based model like a sentence, for example, can just exist momentarily as a representation. It will be absorbed by listeners although the representation at that point will become internal and subject to the experiences and perceptions of the new recipient. Visualisation of linguistic models is internal and requires imagination. Verbal models can range from auditory to a written collection of words which may describe a products functionality in rich detail. Use case scenario descriptions are one example of this. Verbal models enable detail of the context
to be communicated however, they are subjective in nature and meaning can be ambiguous. When verbal models are used to describe a specific relationship between parameters i.e. a 'word equation' (Kieras, 1978) they can easily be translated into mathematical models (Gorzalczyz, 1988).

**Mathematical models**

Mathematical models use a structured and specific language to describe an abstraction of an intended reality. They represent aspects of the real world through symbols which comprise of equations which detail relationships between variables. Although they are the most abstract type of model they provide a precise description of relationships and can be used to describe 'design space' as opposed to a single implementation scenario. Their unambiguous structure enables clarity and insight to be gained without the distraction of complex or superfluous information. A variety of different types of mathematical model exist. Each type of model will use a specific set of rules to construct representations of reality. Linear models, for example, can be used to represent time-series relationships or correlations between parameters. Stochastic models are able to capture randomness and, depending upon the methods used, a given set of inputs can result in a range of solutions (Buzacott, 1992). Deterministic models are used to describe solutions without randomness but which are challenging to solve or describe. For example, the transportation problem (Dantzig, 1951) or Knapsack algorithms (Cohen, 2006).

Mathematical models simultaneously offer the most abstract and most objective representation of knowledge, it follows that mathematical models might offer a useful way of sharing knowledge within and between life-cycle phases and disciplines and across space and time. Whilst subjective models are open to misinterpretation. The abstract nature of mathematical models allows them to describe a whole design solution space rather than just single implementation scenarios. The challenge with creating mathematical models that describe general relationships is that they invariably require a large volume of data and this is contrary to the fundamental definition of tacit knowledge.

**Combinations of models**

Frequently, design crosses the boundaries of model types. A single model may contain aspects of model than one type. And, certainly, more than one type of model will be used in the process of realising a design. This combination approach is especially useful when considering abstract mathematical relationships. Categorisation and Regression Trees (CART) are built on a foundation of mathematical models but are presented schematically. Computer Aided Design systems couple mathematical relationships and schematic on-screen models.

**Digitising expert knowledge**

If AI is to play a role in design, digitising expert knowledge is essential. Also, from a more immediate perspective, if perceived and subjective relationships and ideas could be modelled objectively, shared understanding would be unambiguously achieved and relationships could be interrogated through discussion. There are four broad schools of thought regarding digitisation of expert knowledge: design rational capture methods (an approach emerging from the field of design); Semantic web methods (an approach inspired by the development of World Wide Web languages); Conjoint analysis (a method
used primarily to understand perceptions for marketing purposes) and; a new method proposed by Hird (2016) which stems from resource forecasting in the absence of data.

**Design rationale capture methods**

Design Rationale capture is a field of study which has existed for several decades (Morgan, 1996). Regli (2000) provides a comprehensive review of existing methods and defines Design Rational as “an explanation of why an artefact or part of an artefact is designed the way it is”. Although this definition doesn’t encompass systems or processes, it is considerable that, in principle, the concept could be extended include. This explanation includes logic knowledge, deliberation and details of decision making pertaining to the creation of the design. This information can be useful to people involve with the artefact (or system or process) later in its lifecycle as well as other designers.

Despite the widely accepted importance, Design rationale capture tools are rarely used in practice: they are onerous and unwieldy and fail to inform the process of design or aid communication and collaboration. They are a formality and, when they are used, it is usually to record rationale post event. DRed which has been incorporated into Rolls-Royce PLM system (Bracewell, 2009) is an exception to lack of adoption.

Rationale Capture tools combinations of modelling methods, largely in their standard format but organised through software packages. Tools are generally either process oriented or feature oriented and can be argumentation-based or descriptive.

Process oriented methods are usually descriptive. Examples include IBIS (Kunz, 1970), DRL (Lee, 1991), PHI (Shipman, 1997). The description is represented through a graph like schema where each branch represents a specific implantation scenario. Nodes are usually questions which link out to various options. Links can be made between multiple nodes and options and, there is also the advantage that various types of multi-media models can be included – models could be schematic, verbal, virtual prototypes or mathematical. The issue with this approach is its unwieldy nature and, is difficult to represent using computers (Fischer, 1989). Although it can help designers formalise progress, it does not lend itself to provoking additional insights.

The feature-based method is essentially a domain specific knowledge base. As such, they are more formal and easier to integrate although still rarely used in practice. This method is associated with a description of design space through the use of questions, options and criteria. This would suggest that a general description of relationships throughout the space was enabled but actually, current methods only describe specific implementation scenarios. No rational capture method exists to provide a general description of design space.

Design rationale capture systems are used to aid communication within teams and Lee (1991) lists the benefits of such systems: better support for redesign and reuse; collaboration, dependency and constraint management; design maintenance; learning; documentation. Detailed documentation of design rationale contributions towards alleviating the problem of knowledge leaving and organisation when an employee leaves. Rationale capture systems tend to be intrusive. Capturing the rationale and is a significant challenge. In addition to being intrusive, the inherently structured approach imposed on the designer isn’t conducive with capturing tacit knowledge and as such, has not been widely adopted in practice.
Ontology and semantic web models
Ontology and semantic web models offer a primarily symbolic, linguistic architecture-based approach to modelling systems knowledge using formal modelling methods such as Unified Modelling Language (UML). When a formal modelling language is used, these models can be machine readable. This method is used to model product platforms and product families for information and design retrieval purposes. Providing expert knowledge is externalised, this is a useful way to make subjective knowledge explicit enabling objective discussion.

The semantic web approach offers models that can be queried and examined objectively. They are advantageous, especially in complex systems design and have demonstrated significant benefits in practice (Van der Vegte, 2002). These models represent an expression of design knowledge that can be computer readable and as such are pertinent to the digitisation agenda. Furthermore, the process of creating the models compliments the design activity and contributes to removing ambiguity and uncertainty from complex through-life decision making. They structure and organise information for easy retrieval and reuse. However, they don’t lend themselves to articulating tacit knowledge and perceived relationships clearly as neither the mind of a designer or the design process has a fixed order.

Conjoint analysis
Conjoint analysis is another means of developing mathematical models of perceived relationships. It is traditionally used for marketing purposes in order to establish which attributes are perceived as most valuable but it has been successfully applied in design to test for consistency in user preferences (MacDonald, 2009) or to explore Design utility (a single value for ranking designs) (Wassenaar, 2003) or as a component in an optimisation process (Ren, 2011). Although Conjoint Analysis does offer a means of creating a model of perceptions and allows expert perceptions to be integrated into decision making systems, to the best of our knowledge, conjoint analysis has not been used to model expert knowledge independently of the concept of preference or in for the purpose of describing relationships between design attributes in order to modelling design knowledge with a view to reflect retrospectively.

Perception modelling
Based on Design of Experiments method (Fisher, 1949), Hird (2016) proposes a method for modelling tacit expert knowledge without an abundance of historical data. This modelling method allows perceived relationships to be represented as regression equations. We propose that there may be potential for a similar method to be used to model expert knowledge within the context of design.
Perception modelling method has so far only been applied to resource forecasting. In a resource forecasting context, the process of creating the models is integrated into the planning activity. From a design perspective, if the activity of creating the models can be integrated and can provide value to the designers rather than being an administrative burden, this should provide incentive for use in practice contrary to current rationale capture methods.

**Conclusions and future work**

Digitising expert knowledge is increasingly important. Design is essentially the process of creating models with a view to reducing risk and increasing confidence that the desired outcome can be realised. As such, one might expect that Engineering design would be exemplary in terms of knowledge representation (which also involve modelling). However, design currently involves a heavy reliance on internal mental models which, by definition, are not explicitly represented.

Perceived relationships are difficult to clearly articulate and interrogate. Mathematical models on the other hand are objective, are externalised and abstract and are relatively easy to cross-examine but require an abundance of data to develop. If perceived relationships could be presented in mathematical models they could be clearly articulated and examined leading to fuller understanding and better decision making through-life. They could be stored for future evaluation; complex inter-dependencies could be studied and their evolution could be quantified.

Information and knowledge management are central to the progression of design practice and digital manufacture. Although are long-standing challenges, the implications and opportunities that would emerge as a result of the ability to model tacit knowledge are incentive to revisit capturing and modelling tacit knowledge in design. The structured perception modelling method proposed by Hird (2016) could provide an interesting line of
enquiry. In addition to improving design practice, applying such a method could also offer opportunities for understanding perceptions within design, communication within teams and knowledge evolution through-life.

The next step will be to explore the possibilities for creating structured perception models through studies with designers and, to evaluate what insights can be gleaned from analysing the models.

References


About the Author

Dr. Abigail Hird is a lecturer in Engineering Management at department of Design, Manufacture and Engineering Management at Strathclyde. Her research interests include information management, systems engineering, product development planning, decision making, knowledge modelling.
Using actor-network theory to reveal strategy processes in design firms

VAN DEN BROEK Antonius\textsuperscript{a} and RIEPLE Alison\textsuperscript{b}

\textsuperscript{a} University of the Arts London, United Kingdom
\textsuperscript{b} University of Westminster, United Kingdom
* Corresponding author: antonius@designstrategy.eu

In this paper we illustrate the utility of actor-network theory (ANT) as a methodological approach to understand the effect of the eclectic characteristics of design firms on their strategy development processes. The need for creativity, expertise knowledge and the constant need to innovate suggest that the mainstream strategy or decision-making theories provide unsatisfying insights into how strategy of the design firm emerges. These culture laden organisations often operate with limited formality, therefore require attention to the social side of decision-making. To address this rich complex social-fabric of decision-making, we suggest to study strategy development as the result of the formation of actor-networks. By illustration of data collected from 13 interviews with design firms in mainly Europe and a longitudinal study of a global digital design firm, we illustrate how an ANT-based approach allows theorists to analyse the rich cultural complexity of design firms’ decision-making in a focused and coherent manner.

keywords: strategy; actor-network theory; design firms

Introduction

In this paper we explore the use of a specific research methodology within context-oriented organisational research. We focus on the use of Actor-Network Theory (ANT) (Callon, 1986; Latour, 2005) as a methodological lens to explore strategy processes in creativity-dependent design firms. By “creativity dependent” we mean design firms that are “creativity-hungry”, which focus on building custom-made, innovative capabilities and who work primarily in the digital economy. These firms are typically involved in digital
design (Christopherson, 2004; Nylén et al., 2014; Yoo et al., 2012), service design (Kimbell, 2011; Sangiorgi & Prendiville, 2017) and user-experience design (Moser, 2012).

Strategic decision-making is long recognised as an erratic, non-sequential and complex process involving multiple actors throughout the organisation (Mintzberg & Westley, 2001), especially in creative and knowledge intensive businesses (Malhotra et al., 2006). Some scholars have attributed this to the pluralistic nature of organisations (Denis et al., 2001; Regnér, 2003). In particular, creative enterprises demonstrate pluralism as an inherent characteristic in the way they organise (Abdallah, 2013; Cohendet & Simon, 2007). In such pluralistic contexts power is distributed and visions among management vary. This causes that traditional strategic decision-making theories are ill-equipped to capture the rationale behind this way of organising (Cohen & March, 1986; Denis et al., 2007). Denis et al. (2007) recommended the use of an ANT lens in such pluralistic contexts as a means of solving the mismatch of traditional methodologies and the subject. In utilising an ANT lens, strategic direction is not explained as a deliberate, cognitive act driven by a select group of key actors, but the result of a network of alliances among people, artefacts and technology that embody the strategic direction of the organisation (Steen et al., 2006). Building on these suggestions, in this paper we suggest that ANT as a methodological and theoretical lens helps to identify insights into how strategic direction is developed in design firms. We illustrate this by drawing from a two stage study: an explorative study including interviews with 13 design firms in Europe and US, and an in-depth study of a global digital design firm headquartered in London.

This paper begins by discussing the contingencies of strategy in design firms. Subsequently we will discuss the key characteristics of ANT as a methodological lens. Then we briefly describe the research design of the study. Subsequently, we discuss how the key characteristics that influence strategy development processes in design firms are better studied from a socio-material perspective. By using illuminatory data obtained from 13 design firms, we illustrate how issues around the inherent need for creativity and knowledge, the decentralised nature of power and the influence of culture and identity are key in understanding how strategy emerges in these types of firms (see Figure 1). This leads us to discuss the key implications of ANT as a methodology to study the relation between a design context and strategy.

![Figure 1](image_url)  
*Figure 1  Actor-network theory to understand strategy in design firms*
The strategic contingencies of design firms

One of the key requirements for design firms is their ability to exploit the creative act (Andriopoulos & Lewis, 2010). It is through the effective utilisation of “creativity” and their innovative capabilities that design firms gain a competitive advantage (Lampel et al., 2000). Therefore, understanding better what enables or blocks creativity provides insight into strategy development in design firms. Creativity may be defined as the production of novel and useful ideas in a domain (Amabile et al., 1996). In design firms, creativity often arises from interdisciplinarity teams, where different knowledge bases interact (Garud et al., 2008; Perretti & Negro, 2007). This means that it is often unclear at the outset of a project how it will develop and what unforeseen opportunities will arise from it.

Therefore, creative individuals require a certain amount of autonomy (Amabile, 1998; Newell et al., 2009) to capitalise on emerging ideas. This requires a flat organizational structure, which causes managers to have less direct control, resulting in an ambiguous power distinction between managers and knowledge workers (Empson & Langley, 2015). To address the autonomy of individuals and teams, instead of top-down control, work is often organised in projects (DeFillippi, 2015; Grabher, 2002). Projects are self-governed entities, based on informal relationships rather than a formal structure (Bettiol & Sedita, 2011). While such project based organisations are able to quickly adapt to changing circumstances, they do not always benefit the organisation on a strategic level. As Sydow et al. (2004) point out, in project-based organisations decisions are predominantly made in favour of the projects at hand, rather than in benefit of the prosperity of the organisation as a whole. For example, project selection enables the organisation to learn, which is a key activity to remain competitive. The decision as to which project to undertake, and into which technical frame to embed it, can determine the overall strategic direction of the organisation, as it might open up new markets. A sensitivity “on the ground” allows project members to sense which technologies and which future trends are going to be worth investing in. In these contexts, power, and therefore strategy, are distributed, based on relations rather than individual actors. In these contexts the process is nonlinear, pluralistic and knowledge-intensive. Given these attributes the traditional models of strategic analysis and long term planning appear rather unsuitable for these organisations and more “local”, conceptualisations of strategic development are appropriate, as Chia & Holt (2009, p. 142) aptly state:

> What differentiates this local strategy from centralized deliberate strategy is that it is characterized by an absence of a ‘proper locus’ of control - a legitimate place or position from which resources can be mobilized and purposeful action deployed as well as events monitored and controlled.

Another characteristic of creativity-hungry design firms is that they are knowledge-intensive (Abecassis-Moedas et al., 2012; Dell’Era & Verganti, 2010). They create useful new products and services through the application and merging of various types and new types of knowledge (Hargadon, 2002). In the design companies that we focus on, knowledge does not exist prior to production, but emerges from the interactions among experts and artefacts. As with creativity, knowledge cannot be “held” centrally by top management, partitioned and distributed to employees systematically according to
production requirements (Clegg et al., 2006), but is inherently local and circulates in arbitrary ways throughout the organisation. Due to the innovative nature and customised production, there is often little attempt to codify this knowledge in texts, such as project documentation or papers; it is embodied in people and objects, and only moves where those embodiments move. As the industry is highly fluid, such knowledge is highly mobile and moves between projects, and also between firms by the freelancers that are shared among firms and who take their knowledge with them (Sunley et al., 2011). It is only the personal relations between individual knowledge-holders (Teece, 2003) that acts to encourage, or block, knowledge from moving. ANT helps to uncover this process by tracing the movement of actors, and including the physical artefacts that influence this process - whether symbolically or physically.

As a result of the distribution of knowledge, considerable power lies within individual experts instead of the governing body (Clegg et al., 2006). Power in these contexts is best understood as a complex network of relations, which in a project-based organisation is in the form of a “satellite” organisational structure (DeFillippi & Arthur, 1998). Networks consist of hybrids between people and objects: the central position of artefacts such as technology, designed objects and physical space in such contexts enables us to trace power to the various actors, both human and nonhuman, that act together to shape the organisation’s future direction. In novel design areas, impacted by digital technologies, network-based power-relations are fast-paced and continuously reshaped. This network structure is another reason for regarding ANT as a suitable methodological lens for understanding design firms.

Because of distributed power relations, lack of a formal hierarchy, and the need for fast responses to changing external contingencies, culture is an important constituent of the organisation and control of design firms (Alvesson & Willmott, 2002; Kunda, 2006). As culture can be conceived of as an interactive system of power-flows (Alvesson & Sveningsson, 2015; Ray, 1986), ANT is once again a useful lens for understanding how it influences behaviour, project selection, and creativity. One of the interesting paradoxes of creativity is how in a highly collaborative process of design production, in which different people with different identities with values come together to create something new without the differences between them resulting in the “classic” conflict that results from heterogeneity and the failure to understand the ‘other’. Design firms do operate as coherent systems in which various identities work together, despite their sometimes contrasting world-views (DeFillippi et al., 2007). We are interested in how strategic coherence comes about.

From the review of the literature and with the intent of contributing to the theme of the track: “to progress toward prescriptive and exploratory research perspectives that embrace context through action and the simultaneous research of design” in the following section we discuss why we suggest actor-network theory to explore how strategy is developed in creativity-hungry design firms.

**Actor-network theory**

ANT received significant attention in a wide range of disciplines over the last decade. Design researchers as well have recognised the usefulness of ANT to understand design practices (Storni et al., 2015). For example, Terrey (2012) used ANT to provide insights into
designing new processes and practices in the Australian tax office or Yaneva (2009) illustrated how designed objects perform social ties. Yet limited research has utilised ANT to shed light on how strategy emerges in these design firms. As such, we argue that ANT is not only useful to understand better design processes, but is especially useful to examine design firms’ strategy development processes because there is coherence between what designers focus on and what ANT focuses on. Designers focus on the meaning imbued in form or functionality, and on how abductive processes break down cognitive heuristics leading to new ways of thinking and doing. ANT similarly surfaces the use of the material i.e. space and physical objects, as a relational context in which relationships develop (or not), that are used as a semiological guide to interpretation of meaning and organisational direction. ANT is particularly useful since it takes materiality into account and focuses on how unconscious values are expressed in the physical, and, in turn, how the physical can change beliefs and behaviour.

ANT also brings temporality into the research by considering organisational development as an emergent consequence of a mechanism that aligns asymmetrical actors and holds them together (Alcadipani & Hassard, 2010; Steen et al., 2006). In a pluralistic network- or project-based type of organisation, as design firms typically are, tracking the changes in network participation and the movement of power and knowledge between the different projects is useful. ANT is particularly helpful in such pluralistic contexts as it regards agency as resulting from an ordering of a collective of actors, that is, a network of actors instead of sole actors that have agency individually. The unit of analysis is not solely the actors themselves, but the actors and their relations to others, hence the hyphen between actor-network (Durepos & Mills, 2012).

The expansion of, or inclusion within, a network occurs through the process of translation in which a new actor enrols in the network. The actor becomes then not only part of the network as another node, but becomes an active part as they actively promote the existence and goals of the network. The process of translation is not necessarily linear (Callon & Law, 1982; Elbanna, 2012; Knights et al., 1993) and not always successful; there is a high possibility of failure to enrol an actor (Callon, 1986; Maitlis & Lawrence, 2003). Even more so, the rationale of the network may be altered by the enrolling actors.

In an ANT analysis nonhuman actors such as “collectivities of humans, ideologies, methodologies, concepts, texts, graphical representations, computers, and other technical artefacts” (Sarker et al., 2006, p. 53) can become part of the network. By extending the unit of analysis to nonhuman actors, the full complexity of organising in an intertwined “socio-technical” and culturally specific context can be addressed (Orlikowski, 2009). In a translation process, the initial problematisation of the focal actor can be solidified by the replacement of a nonhuman actor that represents that idea, which is termed an “inscription” (Latour, 1991). For example, a research report helps the raison d’être for a research project and makes the network stronger and more attractive (see for example Callon, 1986). Unlike human actors, which change goals (Hodgkinson & Starbuck, 2008; March, 1971; Witte et al., 1972) and are emotionally laden (Law, 2009; Liu & Maitlis, 2014), material actors are better in holding the network together as they are consistent in their presence. Without such inscription, or “material durability”, decision-making networks are fragile, unstable and solely depend on capabilities and stubborn of the key actor. As Czarniawska (2006, p. 1554) notes: “It is to point out the special role that objects
play in associations: they stabilize. This is why contracts are written, obituaries carved in stone, and technical norms built into the instruments to make the users behave in a prescribed way”. Therefore, the distributed nature of agency, the inclusion of nonhuman actors make ANT a suitable methodological approach to study strategic organising practices in design firms.

**Research design**

This study is based on two phases: an explorative study that revealed the strategic issues of the design industry (Company 1-13, see Table 1 below), and a longitudinal study where we applied ANT to trace strategy development processes in a global digital design firm (Company 14, see Table 1). The companies in the explorative study were mainly based in Europe and were selected purposively (Creswell, 2007) to illuminate the processes of strategy development in a variety of design firm types. Their services ranged from branding, packaging, marketing, visual effects, animation and digital design. We decided to interview the owner/managers of these firms. While they might not always be responsible for the development or implementation of strategy, they are the “gatekeepers” of strategic action (Jarzabkowski, 2005). Respondents were contacted at industry conferences and located through professional networks websites such as Linkedin.com and Xing.com (a German equivalent of Linkedin).

**Table 1 Overview data collection**

<table>
<thead>
<tr>
<th>Company ID</th>
<th>No. of Employees</th>
<th>Specialisation</th>
<th>HQ country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company1</td>
<td>30</td>
<td>Digital design</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Company2</td>
<td>50</td>
<td>Animation and visual FX</td>
<td>Germany</td>
</tr>
<tr>
<td>Company3</td>
<td>10</td>
<td>Animation and visual FX</td>
<td>USA</td>
</tr>
<tr>
<td>Company4</td>
<td>100</td>
<td>Branding / Communication design</td>
<td>Germany</td>
</tr>
<tr>
<td>Company5</td>
<td>15</td>
<td>Advertising / Communication design</td>
<td>Germany</td>
</tr>
<tr>
<td>Company6</td>
<td>5</td>
<td>Social media design</td>
<td>Denmark</td>
</tr>
<tr>
<td>Company7</td>
<td>200</td>
<td>Service design</td>
<td>UK</td>
</tr>
<tr>
<td>Company8</td>
<td>120</td>
<td>Digital design / Film production</td>
<td>UK</td>
</tr>
<tr>
<td>Company9</td>
<td>200</td>
<td>Brand design</td>
<td>UK</td>
</tr>
<tr>
<td>Company10</td>
<td>120</td>
<td>Digital design</td>
<td>UK</td>
</tr>
<tr>
<td>Company11</td>
<td>30</td>
<td>Digital design</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Company12</td>
<td>25</td>
<td>Digital advertising</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Company13</td>
<td>100</td>
<td>Service design</td>
<td>UK</td>
</tr>
<tr>
<td>Company14</td>
<td>120</td>
<td>Digital design</td>
<td>UK</td>
</tr>
</tbody>
</table>

Interviewing the owner/managers of these firms allowed us to construct a picture of the most significant issues of strategy development in this this particular design sub-sector. The interviews covered the various aspect of managing a design firm, where we focused our questions on their perspective on strategy. We asked them about for example, which decisions they perceived as strategic, how they structured and managed their
organisation, how they make (strategic) choices, who was involved, how they secured
their competitive position in the industry, and difficulties they have had or foresee in the
future. The interviews lasted between one and two hours and were recorded and
transcribed. Because one of the authors of this paper had worked as designer and director
in the industry for nine years, he was familiar with the work that these firms did, hence
had knowledge of the strategic contingencies that affected the industry. Bias that may
have resulted from this knowledge was countered through the use of reflective processes
(Schön, 1983) and regular discussions between the two authors concerning what could be
considered justifiable assumptions and admissible data. Ultimately, however, as with all
subjectivist research (Hammersley, 2011) we make no claims for the generalisability of our
findings; instead we put forward a transparent narrative that others may interpret as they
wish. After transcription a coding exercise using NVivo software allowed for key themes to
emerge. From these we could identify a number of sub-themes relevant to the strategy
development processes in design firms, namely, (1) managing creativity & knowledge, (2)
distributed power, and (3) culture. These three themes were the basis for applying the
ANT lens to study a global design firm (Company 14), based in London, in depth.

The figure above (Figure 2) illustrates the focus of our analysis and functioned as our
framework in the second phase of our study where we studied one digital design firm in
depth (company 14). As we wanted to focus on the decisions that affected the strategic
direction of the organisation, networks of alliances were traced as they went through the
process of translation, guided by the ANT methodological lens. Similarly to our explorative
study, we started our investigation by interviewing the managing directors as they are
most likely aware of strategic action within their organisation. Although we do not suggest
that managers are the only individuals that have control over an organisational strategy
(Hendry & Seidl, 2003), they are considered the figuration of strategi change, as they
post-rationalise change through their actions (Hendry, 2000). This means that while
certain decisions on “local level” altered the strategic direction of the firm, it is often that
management rhetorically post-rationalise these “deliberate” decisions. Here, ANT enables
to trace the origins of “strategic agency”, in other words, ANT uncovers the practice and social ordering that causes these networks to come into being and stabilise long enough to have agency that influences the strategic direction of the organisation. By interviewing the founders of the organisation we were able to identify key aspects that could change the strategic direction of the organisation. Once identified, subsequent interviews were held with other employees involved in those changes. Moments of translation identified through the interviews were then traced backwards in time to explore their “origin”, or better, their relation to other actor-networks. This was done by collecting additional documentation, such as, presentation files of earlier meetings, financial calculations, e-mails, and additional documentations that were retrieved from the intranet of the organisation. Additionally management meetings were observed and video recorded to understand better the social dynamics among the actors. This rich collection of data was the basis on which the actor-networks that prevail organisations, which include, of people, documents and technology were “reassembled” (Latour, 2005). In the following sections we discuss how the ANT lens allows us to understand how these influence strategy development.

Using ANT to understand strategy development in design firms
In this section we focus on how ANT can reveal the critical contingencies of design firms that influence strategy. These emerged from knowledge of the industry as well as an inductive analysis of our interview data from the explorative study, and helped to frame data collection and analysis of the longitudinal study.

Managing creativity and knowledge
A key aspect of strategy development in design firms is the utilisation of creativity and expert knowledge. Utilising these most efficiently and effectively contributes to the competitive advantage of the firm. Unlike traditional industries that are capital or labour intensive, such as manufacturing where resources can be managed quantitatively, in knowledge-intensive and creative firms managing key resources is about managing autonomous professionals. Therefore, in creative and knowledge intensive organisations, often there lacks formal organisational hierarchies of subordination (Costas, 2012). As one of the directors of the main case stated:

> Because the fundamental thing is that we all get along as friends at the end of the day and that's the most important thing (Company14)

Indeed, the lack of such formal hierarchies enables these professionals to more freely interact. This is particularly useful since creativity and knowledge comes from the interaction among these professionals, the outcomes are difficult to predict and the people hard to manage (Townley et al., 2009). Key resources of knowledge and creativity are highly mobile and distributed throughout and outside of the organisation. As one of the directors of the company explained:

> Well I mean we try to rotate people out so they've actually...so the learnings that we get from the brands or the bigger stuff we do for the clients get bought into our own IP. And then maybe the kind of slightly
Therefore, production knowledge is highly mobile and resides within individuals who can move to other projects or other companies. As such, knowledge is distributed throughout the organisation and the wider industry. We argue that ANT helps the analyst to identify the factors that allow or encourage knowledge to circulate through the organisation (or get lost to external networks) by focusing attention on the relations among individual creative knowledge workers. Which actors, including physical artefacts that influence this process (whether symbolically or physically), block (or encourage) knowledge from moving through network, can be revealed through an ANT-based methodology. In particular with the intense use of information technology, objects (financial documentation, computer databases, network access) are considered to be a key actor to either broadcast or withhold knowledge. Here, the inclusion of nonhumans such as technology as rightful agents enables to see how knowledge circulates or is restricted. For example, in our main case, the company suggested transparency and openness. Details about their finances were shared on designated moments with all employees in the studio. To quote one of the directors:

Yeah we tried to be as open as...actually...being open is an intentional strategy. We try to be as sharing as we can as transparent and visible [...]
so we show people how much cash and how much net assets [we have]

(Company 14)

However, outside of these designated moments, financial documentation was only accessible by a select group of individuals. Therefore, even though there existed an atmosphere of being open, transparency and equality, through the analysis of the material we found that this “equality” was mediated by material objects that forced a differential access to strategic resources.

**Distributed power**

Since creativity is a key resource within design organisations, which lies within individuals rather than the firm as whole, power sometimes lies within individuals that may be only loosely related to the organisation, because of the widespread use of project-based freelancers, as pointed out earlier. Studying power from a dimensional or structuralist perspective, where organisations and their actors are “frozen” in time and space (Clegg et al., 2006, p. 221), provides unsatisfying and incomplete insights into dynamic and pluralistic contexts. Whereas conventional management theory focuses on chains of command in which employees are controlled through intentional “deskilling” of employees’ practices alongside the holding back of knowledge or knowledge “partitioning” within the organisations, in contrast, creative organisations require the opposite approach, where sources of value creation, hence knowledge and creativity, are essentially distributed throughout the organisation rather than kept centrally. The requirement to let the main source of value circulate throughout the organisation, instead of being “protected” behind a partition, requires an alternative view on power. Power then is better understood as a complex network of relations. It is here where ANT provides a fruitful methodological frame since it focuses study on relations, rather than
power structures that are supposedly fixed in time and space. Especially in novel design areas, such as digital or service design where actors come and go and new technologies emerge in an increasingly faster pace, power-relations continuously change and are reshaped.

Returning to the theme of design firms structuring their activities around projects, a project-based organisation leads to a “satellite” organisational structure in which all the necessary skills and knowledge have to be contained within a specific project. This means that projects are self-governed entities, connected to each other based on informal relationships (e.g. personal relationships, interests, knowledge, functions), rather than a formal structure (Bettiol & Sedita, 2011; Hertog, 2000). For example, we found the formal hierarchical distinction among managers ambiguous, as the founder explains:

*Although there is a hierarchy, no-one, I think nobody ever abused their power. And that’s because it’s so baked in at the heart of the culture. You know, we’ve...we are very [particular] who we hire. Because, if you start would start picking the wrong people in the company and that is...they people is what make the company (Company 14)*

Here, decision-making power is shifted from the individual (e.g. top-management) to others within the organisation. Decision-making authority does not necessarily lie in the hands of the people on the top, but is rather distributed throughout the organisation. As much design work takes place in temporary projects, knowledge and power is rarely stable but changes over time as personnel move from one project to another. In this context any methodology which focuses on static relationships and cross-sectional designs would encounter great difficulty in mapping the movement of creative knowledge from one project to another. In addressing this constant shift in power, ANT focuses on how change happens and becomes anchored in different networks at different times.

This devolved decision-making power is also for example apparent when it comes to project selection. As projects enable the organisations to learn which is a key aspect in staying competitive in the design sector, the choice of projects (and clients) can be of strategic impact as learning can potentially be exploited in future projects. Therefore, deciding which project to undertake, and into which technical frame to embed it, can determine the overall strategic direction of the organisation, as it might open up new markets. As one owner/manager notes:

*If I get a director/producer to fall in love with [a project] and we got the right team, we accept the project. If none of the guys wants to do it, I say no. Because it’s my problem otherwise (Company 8)*

*It is a difficult market because, there is so much technology happening and you just don’t know which one is gonna survive. Is Apple gonna buy that technology that’s really cool and embed it in their operating system? Or are they gonna kill it? (Company 8)*

In these cases, a sensitivity “on the ground” is necessary in order to anticipate which technologies are going to become worth investing in. The distribution in power is a central theme in design firms. Their dependence on technology, the autonomy of employees, the distribution of knowledge cause power to be distributed over a variety of actors. Here
ANT’s distributed notion of agency enables to trace these sources of power, as agency is attributed to the network, rather than sole actors (Callon & Law, 1995). As these networks consist of hybrids between people and objects, power needs to be considered a relational characteristic. Such notion is particularly useful in design firms, as the central position of artefacts in such contexts (e.g. technology, designed objects, physical space) enables us to trace power to the various actors, both human and nonhuman, that act together.

**Culture & identity**

In knowledge-intensive, creative and informal organisations in which top-down control is counterproductive, and where power is decentralised, culture is a lens through which to understand how power circulates (Alvesson et al., 2008). The highly collaborative nature of design production, where various disciplines work together on innovative products, result in different identities coming together. In particular, the “classic” conflict between exploration and exploitation found in creative organisations is a returning issue for conflict (Daigle & Rouleau, 2010; DeFillippi et al., 2007). These conflicts can be traced back in the objects that binds these conflicting actors together. Especially in design firms, where cultural values are inscribed in material objects, a socio-material lens becomes particularly useful. Artefacts are both physical enablers (or blockers) of activities and semiological shapers of beliefs and values. The physical is an important concern of design. Hence there is congruence between what ANT focuses on and what design is concerned with. Another example of how ANT is helpful emerged from the main case company, where the corporate styled presentation slides of the financial director were not taken serious by the team members with a design or creative background. When comparing the presentation slides made by the financial director when he just joined the company with his slides a few years later, the cultural code of creativity was clearly visible in the objects he produced. That the visual and material are important in these firms, was pointed again by one of the directors, who stated:

*To be honest, you could just kind of say it’s a little... it’s organisation and it’s wrapping paper. But that’s important, because presentation is important* (Company 14)

As such, ANT enabled us to reveal the power of organisational culture and surface them by tracing the origins of produced “physical” objects.

**Discussion: key implications of ANT as a methodology**

In the spirit of the aim of this track to “lead and progress discussion on research methodologies” that develop knowledge through context-orientated organisational research, this paper has examined the use of ANT as a methodological lens to study strategy development processes in design firms. Studying strategy in informal and non-hierarchical organisations is challenging. The lack of formal power structures, highly independent and autonomous actors, and the constant requirement for creativity and exploration of new technologies and market applications, requires alternative methodologies to understand how decisions are made. The key characteristics of design firms as identified in our study, namely, the need for creativity and knowledge, distributed power and the prominence of culture and identities suggest an alternative way of strategy development, different from those described in the mainstream management literature.
Where power is decentralised, strategy emerges rather than being formally constructed through top-down analysis and “rational” decision-making (Cohen & March, 1986; Denis et al., 2007). As such, the social dimension of decision-making provides an alternative view on agency. In such contexts, strategic direction is therefore an “achievement” (Law, 1992, p. 390) not by alignment through formal power structures, but by a “mechanism” that enables alignment and collaboration among a variety of asymmetrical actors. It is this mechanism that is of interest: how asymmetrical actors align and how they are kept in place. A strategic direction can be seen as a flexible agreement between a variety of actors with different visions that have access to differentia; organisational resources. This agreement is not immutable, but shaped and reshaped by constant negotiations and struggles between actors. Strategy as such is then the mechanism that “holds” the agreement (Law, 1992, p. 389).

Since both design processes and design outcomes are inherently relational, understanding the impact and the success of them requires to study individual actors as a system, rather than a singular entity. As strategy in these informal contexts does not emerge from individual actors but from the result of the association of various actors, we found ANT a fruitful methodology to surface the key ingredients for strategic decision-making processes. By utilising a socio-material lens enables key actors of design firms, namely, technology, designed products and services or documents in the analysis. Whereas most theories around strategy are focused on a dimensional or structural view in which actors are considered steady and fixed entities, as our paper outlines, the fluid nature of design firms require an alternative approach to study these inherently dynamic and culturally laden environments. By utilising ANT as a methodological lens, the fluid nature of these organisation is exposed. By conceptualising these organisations as formations of alliances which result in networks of social ordering, the focus shifts from static actors to the dynamic and performative nature of accumulating and growing of actor-networks which are developed over time through the processes of translation (Callon, 1986; Steen et al., 2006).

However, there are some limitations. While ANT enables to surface alternative characteristics of organisations, the method in itself does not enable “causal explanations” (Mol, 2010, p. 261) of why certain relationships exists or come into being. Instead, ANT helps to categorise the various activities that occur in a observed setting and places them into relation with each other. Czarniawska (2006, p. 1553) summarises this point well by stating “[Actor-network theory is] not a theory of the social, but a theory of how to study the social”. Once the networks are deconstructed and reassembled, a further theory is needed to explain why those relations came into being and how these relations are made durable. Since design and design processes can be best understood as the result of stabilising a network of artificially constructed, performing actors, our study revealed that ANT is a suitable approach to study contexts where strategy is the result of distributed agency. This methodological approach can help to expose certain ways of operating that are distinct for design firms; the motivation for creativity, the importance of knowledge and learning, the need for distributed power, culture and identity. We suggest that this focused methodological sensitivity can also be applied to sectors outside of the design discipline. Especially those organisations that want to become more design focused, this
methodological approach can highlight already existing potential for design-led organisation, or can highlight a lack of it. Therefore, the ANT methodology as such does not provide direct incentives how to improve a design environments and as such is not a prescriptive methodology (if this were possible), nevertheless it helps pinpoint the key aspects necessary for design contexts to flourish strategically.

**References**


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**About the Authors**

**Alison Rieple** is Professor of Strategic Management at Westminster Business School and Director of IDEaS: Innovation Design Entrepreneurship and Strategy Research Group. Her research interests include management of design and innovation, especially in the creative and cultural industries.

**Antonius van den Broek** is a PhD candidate studying strategy in digital design firms. His research interests include strategy, sociomateriality, digital design and management of innovative collectives. He is interested in exploring strategy meaning in highly creative and dynamic contexts.
Section 6.b
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Introduction: Exploring Design Management Learning: Innovate with ‘user’ oriented design and KM perspectives

BORJA DE MOZOTA Brigitte\textsuperscript{a}; NAM Ki-Young\textsuperscript{b} and WOLFF Fabiane\textsuperscript{c}

\textsuperscript{a} Designence, France
\textsuperscript{b} KAIST, South Korea
\textsuperscript{c} Unisinos, Brazil

Our complex present environment calls for new talents and skills of contemporary managers such as creativity, critical thinking attitude, agile and open innovation, focus on engagement and empowerment. The recent buzz of “Design Thinking” used in management as a creative tool is a good example of the interest being pertinent for leaders and decision makers.

Understanding designerly ways of thinking becomes more and more strategic for leadership. And, design managers have to adapt to this new context of the increased importance of Designers skills in Management Science.

In this track, we discuss topics on:

- Understanding how companies learn and absorb design management knowledge through design experience within and beyond the corporate design function;
- Exploring the influence of design management knowledge on how companies manages design and technological questions;
- Providing evidence of the pertinence of adopting a “user oriented design process” for design management learning in order to fit the needs of different users and evidence for user-centred approach to DM knowledge learning from different stakeholder groups’ viewpoints, including social design and social inclusion.

We thank our authors from eight different countries for the diversity of research presented in this section and the great insights they brought us.
Industrial Evaluation of a Toolkit of Methods for Engineering Knowledge Management of Simulations

SCHWEIGERT Sebastian*; MARAHRENS Nils; CARRO SAAVEDRA Cristina and LINDEMANN Udo

Technical University of Munich, Germany
* Corresponding author: sebastian.schweigert@pe.mw.tum.de

Simulations offer the potential of improving product and development process quality. However, a lack of overview of existing simulation methods and of documentation may make it difficult to apply them efficiently along the entire development process. To tackle this problem, a knowledge-based framework was developed to enhance simulation knowledge management, give an overview over all possible simulations, and provide means to standardize simulation processes for experts. This paper presents the first industrial evaluation of the framework concept by two workshops. The results exhibit a wide interest in the knowledge-based framework in industry and demonstrate aspects for further industrial application. Critical points particularly include an intuitive user interface and the integration into the specific IT environment of a company, which will be the next steps for evaluating the system in industrial conditions.

keywords: knowledge management; toolkit of methods; industrial evaluation; simulations

Introduction and State of the Art and Research

Simulations play an increasingly important role in the design of technical systems. They open up the chance of improving products, as well as the procedures by which products are designed, and deal with the complexity of engineered systems (Karlberg, Löfstrand, Sandberg, & Lundin, 2013; Koziel, 2010). Consequently, these improvements may lead to
higher quality standards and a simultaneous reduction in costs. Applications of simulation methods in the design process are vital and include parametric optimization to evaluate different design variants (Sobester & Forrester, 2015) and the quantification of uncertainties (Allaire & Willcox, 2014), just to name a few. (Koziel & Leifsson, 2016)

Despite their rising application in product development processes, however, simulations are yet far from being optimally used along the entire development process (Pavasson et al., 2014; Novak et al., 2012). This is often due to a lack of overview of available simulation methods. Currently, knowledge-based simulation solutions primarily exist in the context of specific assistance functions, like the one presented in Bernst, Kaufmann and Frochte (2016), but do not support a general procedure, applicable along the entire development process.

Additionally, people that are inexperienced with simulation methods, such as design engineers, may not have the proper knowledge to apply simulation methods correctly. This leads to the research question: “How must an assistance system be designed to support knowledge management in the context of mechanical simulations?”

To answer this question, a toolkit of methods within a holistic knowledge framework has been proposed to achieve a better overview as well as a more standardized procedure for simulations along the product development process (Carro Saavedra, Schrieverhoff & Lindemann, 2014). The evaluation of the framework concept is now the topic of this paper.

The framework was filled with the concepts and methods developed within the FORPRO² project. The project FORPRO², which was initiated in the end of 2013 and lasted till the beginning of 2017, had the goal of conducting research on means of increasing the efficiency of both product development and manufacturing process development. It consisted of ten subprojects from university, with a research focus divided into three areas: knowledge management, product simulation, and manufacturing process simulation. The developed framework of this paper was part of the knowledge management research group. Alongside the academic research partners, the project also included more than 25 industrial partners that ranged from small over medium to large companies. While the research areas on product and process simulation developed novel concepts for knowledge-based simulation support, the subprojects on knowledge management were intended to tackle knowledge-based applications in the development process with the goal of better integrating simulations in the design process (see Figure 1).
The procedure to fill the toolkit with the methods from FORPRO² is presented in Carro Saavedra et al. (2016). The procedure can also be applied to gather and structure the knowledge from different departments, in order to come up with an individual framework for the content of the company (Carro Saavedra et al., 2016). Consequently, the next step after presenting the toolkit concept and its development in the aforementioned papers was to evaluate the prototypic toolkit in an industrial environment.

This paper therefore presents and evaluates the results of two industrial workshops. After a brief review of the framework concept, the following sections explain the workshops and evaluation methodology. Finally, the results and impressions from the workshops are gathered and compared to draw conclusions about the evaluation and propose directions of further research and improvements of the framework concept.

Framework Concept
This section briefly explains the structure and the idea behind the framework. Subsequently, a closer look will be taken at the specific contents of the toolkit.

Components of the Framework
In order for the framework to lead to an enhanced structuring, higher transparency, and better integration of various simulation techniques into the development process and thereby support the design of technical products, the framework is divided into three main components: the user interface (UI), the main part of the toolkit of methods itself (TKM), and the knowledge base (KB).

The user interface aims at providing a starting point for the user to find proper simulation methods and apply them correctly. Therefore, it contains all possible goals or development situations the user might encounter and that are addressed by respective methods in the toolkit. Furthermore, it lists the necessary steps in order to reach these goals and to help the user identify the right method for his or her current development task.

Building up on the workflow of the UI, the toolkit of methods supplies concrete methods that can be applied in order to fulfill the goals of the current procedural step. To provide the necessary flexibility to the user, the toolkit is subdivided into three different levels: the general level (G), the application-specific level (AS), and the project-specific level (PS, see Figure 2). On the general level, generic information about the method (e.g. finite element simulation) and its pros (e.g. possibility to capture local effects) and cons (e.g. time-
consuming) are provided. On the application-specific level, this basic information is concretized towards a certain application (e.g. finite element simulation for deep drawing). Lastly, on the project-specific level, the information from the application-specific level is further concretized towards a certain project, in which the respective method has already been utilized (e.g. finite element simulation for deep drawing of a door covering). Each of the different levels in turn contains various fields that capture aspects like objectives, pros and cons, and hints for the application of the method on that specific level and structure its information (Carro Saavedra et al., 2016).

The user is meant to first look on the general level to see if a suitable method has already been incorporated into the toolkit. If that is not the case, the user may be the first one applying this method in his or her company or the method has not yet been documented. If the method has been documented though, the user is then supposed to check if he or she finds his or her application for this method on the application-specific level. If no suitable applications are found, the user uses the information and files provided on the general level (see path 1 in Figure 2). In order to use the files provided in the knowledge base, the user will need to adapt the general file templates as well as the procedures for his or her specific application. Thereby, the user is left with less work than coming up with the file from scratch. Furthermore, the process is less prone to error, since more general files and methods are provided that are then concretized, rather than using specific knowledge from one project and trying to transfer it to yet another project that might have completely different boundary conditions.

In case the user finds an equivalent application, he or she is supposed to check the project-specific level and see if even an equivalent project is documented there. If no

![Figure 2: Workflow of the connection between the User Interface, the Toolkit of Methods, and the Knowledge Base.](image-url)
projects are found, he or she can use the information and files from the application-specific level and adapt them according to the specific project (path 2 in Figure 2). In case an equivalent project is found, he or she may directly use the information and files from the project-specific level (see path 3 in Figure 2).

If the paths 1 or 2 are taken, the user may fill the more specific levels, after he or she is done performing the simulation. This part of the workflow is not depicted in Figure 2 due to simplicity. Consequently, the next user that encounters a similar or equivalent situation can start from one of the specific levels and build on the knowledge provided by colleagues. Overall, this division helps towards standardizing simulation processes and make them applicable to a larger amount of development situations instead of merely providing the project-specific information.

**Specific Content of the Toolkit of Methods**

At the point of time of this submission, the framework had only been realized in tables where the mere information is gathered, structured, and visualized. This current status represents a preparation for the implementation in an actual software prototype.

The toolkit contains all developed simulation modules and methods for simulation management from the FORPRO² project. Each one tackles a specific objective along the development process and provides actions to assist and improve the usage of simulation knowledge. Table 1 shows the contents of the user interface. In addition to the description and the objective of the method, each point in the user interface includes a number of steps. Each of these steps may refer to various methods in the toolkit of methods, as depicted in Figure 2 – Step 2.

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Objective</th>
<th>Literature sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacturing-specific Structural Optimization</td>
<td>Structural optimization towards required mechanical capacity under minimal material requirements and process-specific design</td>
<td>Hautsch et al., 2015</td>
</tr>
<tr>
<td>2</td>
<td>Finite Element Analysis Assistance System</td>
<td>Execution of simulations with support of the FEA Assistant</td>
<td>Kestel &amp; Wartzack, 2015; Kestel, Sprügel, Katona, &amp; Wartzack, 2015</td>
</tr>
<tr>
<td>3</td>
<td>Patch Optimizer</td>
<td>Enabling communication flow via a CAD model</td>
<td>Goller et al., 2016</td>
</tr>
<tr>
<td>4</td>
<td>3D Surface Registration</td>
<td>Validation of a simulation with an ideal 3D model; methods for the model preparation with real geometric elements</td>
<td>Katona, Lušić, Koch &amp; Wartzack, 2016</td>
</tr>
</tbody>
</table>
In the last column of Table 1 publications with regard to the described methods are documented. This is only an exemplary filling of the toolkit and by no means complete. It rather serves as a central element for gathering and documenting the developed methods within the research project and for a first concept evaluation in an industrial environment.

**Evaluation Plan and Methodology**

In order to assess the prototypic framework, workshops in two major German companies were performed. They were intended to transmit the basic ideas of the framework usage and toolkit content, have the participants apply the concepts on their own and finally discuss and document their experiences by means of a questionnaire. In the following, the procedure of the workshops, as well as the questionnaire used for evaluation are presented.

**Workshop Settings**

The two companies for the workshops were selected because of their involvement in the design of the framework from the beginning. Furthermore, due to their size they had the potential to integrate such a system into their IT infrastructure. Both workshops had a duration of three hours. Workshop A was held at the research institute while workshop B was conducted at the company.

The performed workshops both focused on finding out if employees accept the concept of the framework and if the concept is understandable. Additionally, the evaluation was also intended to get further stimulations and find improvement potential for a final realization.

In order to include a combination of people with various backgrounds, people from design, from process management as well as from simulation departments were invited in both companies. This was done for two particular reasons.

Firstly, the framework was intended especially to support the collaboration between design and simulation departments.

Secondly, insights from inexperienced simulation users, usually from the design department, as well as simulation experts coming from the simulation departments could be taken into account in this way.
Regarding their prior knowledge, the two companies had different starting points. Most participants from company B (a simulation department manager, a process manager, a simulation expert, and a design engineer) were informed about the framework concept, but had not yet had deeper insights into its contents and application to an actual development process and to specific simulation methods. In company A on the contrary (an innovation department manager, an innovation manager, and a two production experts), only one of the participants (the department manager) had been in touch with the framework and its contents prior to the workshop.

All of the participants had multiple years of work experience in the field of simulation-assisted product design.

Workshop Procedure
Both workshops were started by introducing the concept of the framework. Therefore, it was of particular interest to transmit the idea of the user interface with its relation to the toolkit of methods. Furthermore, the division of the toolkit into different levels, as well as the subdivision of these levels into categories was outlined.

It was essential to point out to the participants that the workshop was not about the implementation of the framework. Therefore, before examples from the framework were shown, an oral explanation (workshop A) or a few short video clips (workshop B), which demonstrated a possible web interface for the framework, were presented.

This was done in order for the participants to get an idea what the final system might look like and how they would interact with it as well as to explain that no final software prototype was to be evaluated. For the rest of the workshop, the participants worked with the media elements shown in Figure 3. To give them first-hand insights, some examples were presented until all participants had a basic notion of the framework concept, especially about the division of the framework into user interface, toolkit of methods, and knowledge base as well as the three levels of the toolkit.

1. Overview on a flip-chart 3. Documented process on wallpaper
2. Details for the levels of the toolkit of methods incl. references to UI and KB on printed sheets 4. Files from the knowledge base on a PC

Figure 3  Workflow of the workshop with the different media elements
Subsequently, the participants were shown a flip chart depicting a table with the overview of the contents of the framework (Figure 3, step 1). Further information for each method was provided in tables that were printed on paper sheets (Figure 3, step 2). Based on the different methods contained in the overview and specified in the tables, the participants were asked to identify methods within their process model that was shown on a poster (Figure 3, step 3, marked in red dashed boxes). To give the participants a more realistic idea of the methods, files from the knowledge base were provided on a computer that could be examined by the participants and was supposed to demonstrate how the participants may benefit from the available resources contained in the framework (Figure 3, step 4).

For workshop A, for which no documentation of a company process existed, the participants first had to collect a process sequence with all its steps and aspects. Based on this information, they were asked to identify possible tasks, where methods from the exemplary framework contents shown in Table 1 may be applied.

Contrary to that, workshop B was based on a previously documented process description in form of a BPMN diagram (Business Process Model Notation, schematically depicted in Figure 4). First, the participants were asked to go through each step and either identify the company-specific methods they normally apply or look for methods from the toolkit that could be used. After all methods according to the process steps had been gathered, the participants worked on filling the framework with best-practice experience. This included the recording of pros and cons of a respective company-specific method and the steps necessary to perform it (dashed arrows in Figure 4).

![Figure 4 Basic procedure of identifying the methods along the process](image)

**Questionnaire**

To take note of individual experience, a questionnaire was given to each participant at the end of both workshops. In this questionnaire, the participants were asked to rate different statements with five possible answers, representing their level of agreement with that statement (see Figure 5).

All statements were supposed to be answered with one out of five choices, ranging from complete agreement over neither agreement nor disagreement to complete
disagreement. The only exception was statement 17 that was supposed to be answered with merely yes or no. All questions that are followed by a line had the possibility for individual answers.

<table>
<thead>
<tr>
<th>Agree</th>
<th>Tend to agree</th>
<th>Neither disagree nor agree</th>
<th>Tend to disagree</th>
<th>Disagree</th>
</tr>
</thead>
</table>

Figure 5  Possible answers of the questionnaire that were handed out to the participants in both workshops

As shown in the box below, the questionnaire is divided into three different categories: feedback on the structure (I.), feedback on the application to an example process (II.), and feedback on the benefits and objectives of the toolkit of methods (III.).

In the various statements, the participants were confronted with both general aspects about the necessity of a knowledge-based system as well as specific aspects regarding the first impressions and application of the framework and the toolkit of methods by the participants. Additionally, some questions left room for individual answers and feedback. The first category was meant to capture how the concept of the framework and especially the division of the toolkit into different levels was perceived by the participants. A particular interest lay in finding out if the structure is easily comprehensible and how the participants would rate benefits of using it. Furthermore, the participants were given the chance to leave their personal comments about the division, so that they could cross out or add categories they would have found useful. The first section was finished by asking the participants how the structure could be improved.

In the second section, the experience of the participants in applying the toolkit to an actual example process was captured. Here again, a particular focus was on the comprehensibility and benefits they experienced during the application. Finally, the participants were given the chance for individual answers on improvements regarding the application.

The last category was meant to supply deeper insights into the company perspective on the framework and knowledge management in general. Therefore, the questionnaire asked for the importance of knowledge management and previously implemented knowledge management systems in the company. Furthermore, it was intended to get first impressions on how realistic an implementation of the toolkit within the respective company was. The last two questions provided room for overall positive or negative points on the toolkit.

After explaining the intentions behind the workshop and specifically the questionnaire, the following sections present the specific results from the evaluation.
I. Feedback on the structure:
   1. The division of the framework in user interface and toolkit of methods is comprehensible.
   2. The division of the framework in user interface and toolkit of methods is beneficial.
   3. The user interface is comprehensible.
   4. The user interface is beneficial for getting an overview of the contents of the toolkit of methods.
   5. All columns of the user interface are beneficial.
      Please cross out or add columns in case you disagreed with this statement.
   6. The division of the toolkit of methods into three levels (general level, application-specific level, and project-specific level) is comprehensible.
   7. The division of the toolkit of methods into three levels (general level, application-specific level, and project-specific level) is beneficial.
   8. All columns on each level are necessary.
      Please cross out or add in case you disagreed.

<table>
<thead>
<tr>
<th>Goal of the simulation element</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the foundations of the method?</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Definition</td>
</tr>
<tr>
<td>Pros</td>
<td>Cons</td>
</tr>
<tr>
<td>9. The division of the levels into various categories (foundations, objectives, and knowledge) is comprehensible.</td>
<td></td>
</tr>
<tr>
<td>10. The division of the levels into various categories (foundations, objectives, and knowledge) is beneficial.</td>
<td></td>
</tr>
</tbody>
</table>

What are your improvement advices on the structure of the toolkit of methods? ___________

II. Feedback on the application on an example process:
   11. The toolkit of methods is generally applicable to an example.
   12. The methods in the toolkit of methods can be easily found.
   13. The application of the toolkit of methods leads to beneficial results.
   14. The toolkit of methods helps in applying new methods correctly.
   15. The toolkit of methods helps with the integration of simulation within product development.

How can the application of the toolkit of methods be generally improved? ________________

III. Feedback on the benefits and objectives of the toolkit of methods:
   16. There is a demand for knowledge management in my company.
   17. There is a comparable system to the toolkit of methods in my company.
      If so, please explain briefly. ____________________________
   18. The documentation of the methods is important and reasonable.
   19. The documentation of the methods with the toolkit of methods is beneficial.
   20. The implementation of the toolkit of methods in my company would be reasonable.
   21. The implementation of the toolkit of methods in my company is realistic.

How would you evaluate the toolkit of methods as a whole? ________________
What did you find particularly positive? ________________
What did you find particularly negative? ________________
Evaluation Results
In both workshops, a total number of seven people filled out a questionnaire, out of which three people participated in workshop A and four people participated in workshop B. At first, this section will jointly discuss the two workshops with respect to the feedback on the different components and scenarios. Subsequently, it will go into the specific details of each workshop separately.

In order to perform the evaluation mathematically, we used the following equivalent point system from 1 to 5:

1 - I disagree / Yes, 2 – I tend to disagree, 3 – I neither agree nor disagree, 4 – I tend to agree, 5 – I agree / No.

The questionnaire did explicitly not use a finer granulated Likert scale (e.g. a 7-point system), since the number of participants (n=7) was comparably low. By using a 5-point system it was ensured that the number of possible answers was at least lower than the number of participants. (Likert, 1932).

Overview
Figure 6 gives the results from the questionnaire for four exemplary questions from all three sections. The orange line marks the division between participants of workshop A (participants 1 to 3) and participants from workshop B (participants 4 to 7). The first and second graph (marked a) and b) in Figure 6) only include two people from workshop A rather than three, since one participant did not put a cross to rate the respective statement and therefore left no data to be evaluated.

![Figure 6](image)

*Figure 6  Answers on representative statements from all three categories*
**User Interface**

In the questionnaire, the great majority agreed that the user interface is beneficial and helps in getting an overview of the contents of the toolkit of methods (see Figure 6a). Regarding the comprehensibility, slightly more than half of the participants found that the user interface is comprehensible. Following up on this finding, more than two thirds of the participants found the division of the user interface beneficial, whereas slightly less than half found that all columns of the division of the user interface were actually beneficial for its usage.

Overall, the user interface was agreed to be comprehensible and beneficial. Only regarding the references, some participants wished to have additional, more general goals that in their view would help find methods in the toolkit more easily.

**Toolkit of Methods**

Regarding the toolkit of methods, the great majority agreed that the division into three different levels is beneficial (see Figure 6c). Additionally, the majority of the participants at least tended to agree that the division of the toolkit of methods and its subdivision are comprehensible and specifically beneficial for the documentation of methods (see Figure 6b). With respect to its applications, the opinions were quite diverse. Whereas most participants agreed that the toolkit of methods helps in applying new simulation methods correctly (see Figure 6d), slightly less than half agreed that methods could easily be found in the toolkit of methods. In contrast to the majority agreeing that the division of the toolkit of methods is beneficial, only few of the participants agreed that the application of the toolkit of methods leads to beneficial results. Furthermore, only a few agreed that the toolkit of methods helps with the integration of new simulation methods in the product development process.

In general, however, the toolkit of methods was agreed to be comprehensible and beneficial. Only concerning its application, the participants responded with less agreement. Especially the integration into the development process was regarded specifically beneficial by most participants. A possible explanation for this fact might be that the workshop only presented the concept in form of printed tables. Therefore, the integration into the development process that would be performed in form of an IT system is yet a completely different story.

**Benefits and Objectives**

The two strongest statements, which all participants agreed upon, were that in both companies, there indeed is a demand for knowledge management and that documentation of the available simulation methods is both important and reasonable. Furthermore, nearly all participants agreed that no comparable system to the toolkit of methods exists in their company or is at least not known to them. Merely one participant mentioned guidelines for the simulation department and checklists.

The strong agreement on the objectives and benefits of the framework underlines that there definitely is a strong demand for improved knowledge management in industry. The only comparable solutions mentioned were checklists and guidelines, which are not able to fulfill both the needs for expert users as well as inexperienced users, nor provide a holistic solution including various departments.
Figure 7 shows the median answers of all participants as well as their mean deviation from that median. It clearly stands out that with the exception of participants 1 and 7, all participants tended to agree to most statements. Furthermore, most participants stayed entirely within the range of agreeing answers and gave no clearly disagreeing answers to most statements.

\[
s = \frac{1}{n} \sum_{i=1}^{n} |x_{\text{Median}} - x_i|,
\]

where \(x_i\) represents the different point equivalents to the answers given by the participants, \(x_{\text{Median}}\) is the median value over all answers of the participant and \(n\) the total number of statements the participant answered.

**Separate Considerations for Workshop A and Workshop B**

In workshop A, the tendencies of the answers were a bit more diverse. Furthermore, six total statements were rated by at least one participant with disagreement, whereas there were only two in workshop B (see Figure 8).

To some extent, this might have been due to the fact that only three people participated in workshop A and the workshops included people that seemed to be less open to the idea in general. Particularly one participant seemed to disagree on many statements, along with leaving almost half of the boxes blank (participant 1 in Figure 7). Nonetheless, for some questions tendencies were also quite diverse in workshop B as shown in Figure 6a, but were overall less frequent. As opposed to workshop B, a lot less individual feedback was given in workshop A. In workshop B, most participants had already heard about the framework concept and due to an available process model, the application of the framework consisted of extracting simulation methods from their development process and transferring them to the framework. A significant part of workshop A was spent on documenting the process that was then used to identify sections where simulation methods of the exemplarily filled framework could appear.
Some of the more negative results from workshop A may be explained by the different workshop format. Due to the absence of a documented process model, a lot less time could actually be spent on applying the toolkit of methods as the participants from company A did not work on filling the framework with their own simulation contents. Furthermore, the application that was done was a lot less specific to the company, since they worked with the present contents of the toolkit of methods, rather than filling it with their own methods in most cases. Consequently, the results achieved in the workshop with company A were less specific to their own process and did not include the step of identifying own simulation methods along the process and transferring them into the framework. Therefore, their impression on the application was far less concrete than in workshop B. This might also explain the fact that none of the participants of workshop A agreed that an implementation of the toolkit of methods in his or her company is reasonable, whereas in workshop B most participants did agree. Furthermore, it underlined how important process knowledge is for the application of our method. In workshop B, most participants answered all questions and gave constructive individual feedback on what they thought was still missing or could be improved. For example, several participants wished the toolbox had more general goals or keywords that seemed to be more tailored for an inexperienced user. Most of the participants agreed that an implementation of the toolkit of methods in their company would be reasonable, although only one out of four agreed that an implementation is somewhat realistic. Some comment included that for making such a decision, a cost estimate would be necessary.

The differences in answers in the questionnaire relates to the very different behaviour of the participants in the two workshops. The distance to the actual application of
simulations methods in their daily working routines of the participants of workshop A was greater by far than to those of the participants in workshop B. Furthermore, the maturity level of software assistance in company A is higher than in company B, which also lowers the potential benefits of introducing such a system.

Figure 9 shows an extract of the documented process from workshop B in form of a model in Business Process Model Notation (BPMN). The legend gives an overview over the different elements, as well as the departments that correspond to the respective box coloring. The red dashed boxes mark methods from the toolkit that were identified within the respective process step, whereas the numbers next to the boxes mark the index of the method depicted in Table 1. As Figure 9 demonstrates, several methods from the framework were found in the documented process model, some even appearing several times throughout the process flow. Additionally, the participants were able to identify a method from their own process step called “Comparison Calculation and Test” that was then integrated into the toolkit of methods.

This different perspective in both workshops also roots from the level of cooperation prior to the workshop. Whereas there was an intense collaboration with the industry partner of workshop B that included monthly meetings and two publications (Schweigert et al., 2016; Carro et al. 2016), the evaluation workshop was the first meeting with the industry partner of workshop A in the last two years. As a result, one of the participants in workshop B, who is in the position of a department manager, was familiar with the toolkit and its development and acted as a moderator in some phases of the workshop. It can be concluded from this example that such an abstract topic needs profound knowledge and familiarity with the corresponding tool to use its potential.

The two workshops also cannot be seen as entirely independent. Workshop A proved the necessity for a deeper understanding of the framework and its concept. As a result, the introductory part was lengthened and intensified in workshop B. In combination with the higher familiarity with the topic of the industry partner of workshop B, the focus of the participants of the workshop was more on the actual topic – the concept of the toolkit of methods – and less on technical issues like implementability. Therefore, the authors believe the results of workshop B to be more profound and meaningful – regardless of their being more positive.
Conclusion
Most participants found that the toolkit of methods is both beneficial and comprehensible, although some of them did not believe it would improve the integration of simulation methods in the development process. This contradiction may be partly explained by the fact that no IT framework existed so far. Therefore, the general concept may have seemed more beneficial to them, whereas everything more closely related to applying the framework in the company, seemed far less beneficial in the absence of a real interface.

Regarding the initial question, both workshops showed that the framework concept is understandable in a short workshop. Nonetheless, the differences in the results between the two companies demonstrated how important prior process knowledge is in order to introduce the framework and transmit a more realistic experience of applying it in the company.

Therefore, especially workshop A showed that it is important to have a higher involvement in the project before the evaluation in order not to waste time on first documenting a process. One possibility to do so is to directly involve one of the industrial participants to be the moderator.

Furthermore, it could be beneficial to provide information material beforehand. Therefore, participants would start the workshop with prior knowledge about the framework concept, which might be beneficial. All these measures aim towards spending less time on explaining the toolbox and documenting processes and more time in the workshop on working with the actual toolbox.

Lastly, it could be important to tailor the workshops more to the needs of each participant. For that reason, it could be beneficial to gather information about each participant and put a focus on specific topic. For example, if a person from the manufacturing department is involved, it might be beneficial to put an emphasis on processes and methods related to manufacturing.

Especially when considering that most issues in the workshop were of formal nature, however, the results can be viewed as very positive and proof that it is worth continuing with further research on the concept. This encourages to continue the work on this holistic framework as it goes a step further than the current knowledge management and simulation management systems available on the market and discussed in the state of the art at the beginning of this paper.

Further Work
Individual feedback showed that the participants wished to have goals in the user interface that are more general. Therefore, the research group intends to thoroughly analyze and revise all goals in the user interface again, before moving on with further extensions and evaluations of the framework with its current exemplary contents.

After the positive resonance on the concept, the most important milestone of the future is the integration of the toolkit of methods into a web-interface. It would then be possible to start further evaluations, even with company-specific interfaces. A prerequisite for that, however, is an implantation concept that includes briefings of users as the workshop
results show that those with the most knowledge about the context are those that profit the most from the framework. By also briefing non-experts, expert knowledge and methods can be shared via the framework and its IT equivalent. At this stage, the toolkit would be advanced enough to integrate it into an actual development process. Therefore, it would be possible to evaluate the integration of actual methods from the development process, as in workshop B, but on a far broader level.

Furthermore, it would be possible to evaluate how it can help to support and document along the development process and how well the framework is integrated into the process structure. An additional aspect for evaluation then is also the usability of the web interface. The evaluation results could then serve as a basis for realizing the system in a software solution that is ready to be applied in an industrial environment or sold as part of a commercial solution.

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About the Authors

**Sebastian Schweigert** is a Research Associate with the Chair of Product Development. Since June 2015 he has been working on his PhD in the field of CAD-CAE coupling and the integration of simulations in product development processes.

**Nils Marahrens** is a master student in mechanical engineering at the Technical University of Munich, where he previously earned a B.Sc. in Engineering Science. His research interests include the improvement of development processes and the management of simulation knowledge.

**Prof. Udo Lindemann** was head of the Chair of Product Development until 2016. He was and is co-editor of several international journals and member of scientific societies. For many years he was in the scientific committee of the DSM conference.
Exploration in Knowledge Capital improvement through Social Media in Complex Product Design

QI Wen
Donghua University, Shanghai, China
design_wqi@sina.com
doi: 10.21606/dma.2017.71

Currently, Knowledge work is fundamentally different in character from physical labor. This new reality dramatically alters the methods by which a worker can manage, learn, represent knowledge, interact, solve problems, and act. In this paper, a knowledge-intensive company, who is characterized as such that a highly educated workforce engages in mainly intellectual work, has been studied. To realize effective knowledge management, a complete architecture is proposed to integrate different tools and methods (e.g. Wikis, and blog) that collect, store, categorize, present business and engineering knowledge. Storytelling is suggested to be used to engage, involve and inspire employees, represent tactic content in a more authentic and narrative form. All these efforts and approaches will greatly benefit the company in our case study for operating its business successfully. As a result, managing knowledge effectively for such company will offer itself the primary opportunity for achieving substantial savings, significant improvements in human performance, and competitive advantage.

keywords: knowledge management; product design; social media, design process

Introduction
As Baets describes (Baets, 2009), “knowledge is the potential of an individual to enact innovation.” Knowledge assets in a corporate context normally include processes, technologies, people, and many other aspects (see Figure 1). All knowledge can be classified according to its complexity on a continuum from explicit to tacit. Michael Polanyi
Polanyi, 1966) identified the distinction between two types of knowledge: *Explicit knowledge* (sometimes referred to as *formal knowledge*) can be articulated in language and transmitted among individuals; *Tacit knowledge* (also, *informal knowledge*) is personal knowledge that roots in individual experience and involves intangible factors, such as personal belief, instinct and values. Regarding the role of knowledge in any business organizations, *tacit knowledge* is often viewed as the real key to getting things done and creating new value. While tacit knowledge potentially can represent great value to any organization, it is, by its very nature, far more difficult to capture and diffuse.

The term of knowledge-intensive companies (Alvesson, 1995; Starbuck, 1992) refers to those where most work is said to be of an intellectual nature and where well-educated, qualified employees form the major part of the workforce (Alvesson, 2000). Typical examples of knowledge-intensive firms include management, engineering and computer consultancy companies, design agencies, research and development units and high-tech companies. High knowledge intensity within certain industries means that advances take place at such speed that cutting edge knowledge is rendered outdated within a short period. Now the life cycles of technologies and innovations are even shortening. In semiconductor industry, where time spans relevant to the development of smaller and faster chips are typically counted in a year (Moore’s Law). The demand for chips is directly related to the demand for electronics products by the end consumer and is, hence, extremely sensitive to market fluctuations and often unpredictable. Popular products such as iPhone, etc. may lead to an almost explosive demand for the most advanced equipment in chip manufacturing. In this paper, we select a company who designs, manufactures and produces lithography systems as example to examine how its knowledge sharing through social media during its complex product design process actually helps itself in maintaining its competitive advantage.

![Knowledge Assets in a Corporate](image)

**Figure 1** Knowledge assets in a corporate

**Knowledge Management in a Hi-Tech Organization**

The development, production and even marketing of any semiconductor manufacturing equipments are extremely complex and highly knowledge-intensive. For the company in this case study (it is called Company A in the following sections), it is well aware that the access to and/or the ability to share existing knowledge and create new knowledge has become a major source of competitive advantage (Teece, 2000; Nonaka et al., 2000; Brännback & Carsrud, 2002). Knowledge management (KM) is one of the keys of its success because of the growing importance of knowledge and becomes a new challenge in
current dynamic business environment. It has managed to be a people-oriented and knowledge-intensive organization from the beginning.

The company studied has several thousand employees. Most of employees have a scientific or technical background and the educational level is, as a whole, quite high (university and college graduate). The average age of its employees is 33. Its organization structure is shown in Figure 2. In this company, knowledge exists in different business units or departments in different forms. In the development and engineering department, knowledge is regarded as the know-how of the research and engineering (software, mechanical and electrical) processes. In the marketing department of the business support unit, the market trends and size of semiconductor industry are the important knowledge to implement correct marketing strategy. In the legal department, the patents owned by the company and its competitors, and the law of intellectual properties are relevant knowledge. In short, different forms of knowledge exist and are growing, which contributes to every aspect of the business. How to effectively manage and share these knowledges presents a big challenge in terms of KM.

![Figure 2: The Organizational structure of a High-Tech Company studied](image-url)
The Need of Knowledgement Management for Company A

A common definition of KM is “the collection of processes that govern the creation, dissemination and leveraging of knowledge to fulfill organizational objectives” (Lee and Yang, 2000). Davenport and Prusak (2000) define KM as: “to identify, manage, and value items that the organization knows or could know, including skills and experience of people, archives, documents, relations with clients, suppliers and other persons and materials, often contained in electronic databases.” Walter Baets defines KM as:

1. “Support of the networked act of ‘cognizing’ of the actors (employees, clients, ...);
2. Manage the empty spaces between functionalities (creativity resides in those empty spaces).”

Ann Macintosh (Macintosh, 1997) has identified several business factors that create demands on KM, including marketplaces, the reduction and mobility of work force and the change of corporate strategy. In Company A, those factors become even more apparent:

- The semiconductor industry and lithography equipment markets are extremely competitive and the rate of innovation is rising.
- After the burst of the Internet bubble, competitive pressures and financial constraints force Company A to reduce the size of the work force that holds valuable business knowledge. Company A has reduced the numbers of pay-roll employees through using contractors. Increasing mobility of the work force definitely leads to the loss of knowledge. Reductions in staffing create a need to replace informal knowledge with formal methods.
- The amount of time available to experience and acquire knowledge has diminished. The research and development cycle in Company A is forced to become shorter. Its customers often require shorter lead time.
- There is a need to manage increasing complexity in business operation process.
- Changes in strategic direction may result in the loss of knowledge in a specific area.

Figure 3  Knowledge management as processes

In addition, other factors also have created the needs for KM in Company A.
Modern organizations, especially high-tech industry, compete on the basis of knowledge. Most of the work in Company A is information based.

- Products in Company A become increasingly complex, endowing them with a significant information component.
- The need for life-long learning for employees become inevitable.

These aspects are embedded in different processes of KM (see Figure 3). In Company A, many aspects can be easily recognized, which include identifying and mapping intellectual assets, generating new knowledge of designing lithography system for competitive advantage, making vast amounts of corporate information accessible, sharing of best engineering practices, and implementing technology that enables all of the above, including groupware and intranets.

In Company A, many aspects can be easily recognized, which include identifying and mapping intellectual assets, generating new knowledge of designing lithography system for competitive advantage, making vast amounts of corporate information accessible, sharing of best engineering practices, and implementing technology that enables all of the above, including groupware and intranets.

![Figure 4](image)

*Figure 4 Standard knowledge infrastructure*

The current situation of KM in Company A was analyzed from four aspects of the standard knowledge infrastructure that is shown in Figure 4. It is recognized that the management team within the company indeed is aware of the importance of the knowledge ownership. Knowledge is remained with employees who need and use it. For particular knowledge, engineers or business professionals decide what to learn and keep. In company A, there is a culture of learning. Management team encourages learning and exchanging knowledge within the organization. There is also an ICT infrastructure that includes intranet, database to provide a KM platform. The problem with this infrastructure in company A is that it is technology driven rather than content driven. A lot of standard technologies are used without being customized to meet its special needs. And the existing platform is effective for managing explicit knowledge only. Explicit knowledge here, which includes engineering guidelines, marketing brochure and etc, is organized and stored in the database for employee’s usage. However, there is no effective means to deliver and share tacit knowledge that is pervasive within the company. In addition, because huge amount of information and documents exist, employees often encounter difficulties in searching and retrieve desired information. Hence, in the following sections, the existing problems are discussed in details and several tools and techniques are proposed to tackle those issues.

**Social Software for Knowledge Exchange and Sharing**

Knowledge-intensive firms like Company A need to share knowledge held by employees for triggering more innovation and engoucraging enhanced creativity in order to gain the most from their intellectual capital and compete effectively in the marketplace. There is growing recognition that sharing/transferring knowledge is essentially a social activity,
that knowledge has a social life and therefore operates often beyond formal organizational structures. The current KM system in Company A cannot meet this need because efforts were focused on the creation of central knowledge repositories, encouraging knowledge reuse and collaboration based on these repositories in a typical top-down approach where knowledge was seen as a separate entity.

Until recently, the growing phenomenon of Social Software offers a good chance to complement this traditional approach with tools that are simpler and more flexible. Social Software uses computing tools to support, extend, or derive added value from social activity. Sharing and integrating knowledge within an organization can benefit greatly from social activities through those social softwares. Typical applications of social software include social sharing, e.g. Flickr, social collaboration, e.g. Wikipedia, social bookmarking, e.g. del.icio.us, social communication, e.g. WhatsApp, and social networking, e.g. Linkedin.

What could Social Software do for Company A in KM? Knowledge emerges in conversations; actionable knowledge is mainly the result of collaboration. For example, testing and installation lithography machine in a clean room is a rather complex process. Senior engineers can share their experiences and lessons learned with junior employees. Social Software provides the necessary support for such conversations and collaborations, for knowledge creation, sharing and publication, for identifying experts and getting access to expert opinions worldwide. It leaves the control of knowledge with the individuals owning it. Each individual is able to maintain his own space for which he has complete control over the information/knowledge he chooses to share. This creates a bottom-up style of information sharing and collaboration, rather than an imposed or corporate top-down strategy (Fisher 2005).

There are several categories of Social Software (Boyd 2003), in which three kinds (weblogs, Wikis and social networking) are more relevant in connection with the core KM activities in Company A:

- **Weblogs** A weblog or simply a blog is a web application enabling periodic posts on a common webpage with public access. These posts are usually in reverse chronological order. Unlike an official web site, a weblog is highly subjective, reflecting the thoughts, opinions and preferences of its author(s). Most weblogs are written by individuals. These coexist on the World Wide Web with group weblogs, project weblogs and organizational weblogs. The blog from Prof Walter Baets in KM (http://euromed.blogs.com) is a good example. Weblogs is quite useful for senior engineers and experts to record and share their knowledge and expertise.

- **Wikis** A Wiki is a website (or other hypertext document collection) that allows users to add content, as on an Internet forum, but also allows anyone to edit the content. "Wiki" also refers to the collaborative software used to create such a website. A Wiki enables documents to be written collectively in a simple markup language using a web browser. For example, the development team members of one product line in Company A can use Wiki to share and edit information with each other easily, particularly when they are physically located in different places.

- **Social network services** The so-called “social networks” are circles in which people interact and connect with other people. They transcend strict delineation
between personal and business (there is often overlap between the two). Those popular social networks of web-sites are Facebook (www.facebook.com), and LinkedIn (www.linkedin.com). For a big organization with thousands of employees like Company A, social network can transcend organizational boundaries and hierarchies. It helps building network for business operation between different function units.

Introducing Social Software into the KM system in Company A leads to several benefits including low-cost, high bandwidth, coupled with self-motivated and gregarious employees. These tools give individuals a chance to network in online versions of real world social systems (Boyd 2002).

**Storytelling for Transferring Tactic knowledge**

It is generally acknowledged that knowledge, particularly tactic knowledge is not similar to information. Information can be canned into databases, papers, lists, guidelines. However, knowledge stays embodied, which means that experiences, insights, memories and judgments cannot be easily extracted from the bearer. Thus, most knowledge is uncodifiable, only pertinent at a given moment in time and often remains tacit. This presents organizations or corporates with a major challenge.

KM is essentially a teaching-learning interaction. Research indicates that the brain works by detecting patterns in information. “One of the brain’s best tricks is to extract meaningful patterns from confusion” (Liston, 1994). As one of the most prevailing forms of communication, storytelling is useful in the teaching-learning interaction and it possesses great potentials as a teaching-learning tool. Storytelling, as a tool to share knowledge within business organizations – especially when attempting to share tacit knowledge, is increasingly being recognized and deliberately used recently.

Current organizational communications in Company A are somewhat dry and lacking in inspiration. At the same time, tactic knowledge in Company A exists everywhere from research, development, engineering to production, marketing and sales. Tacit knowledge is regarded as “knowledge that we do not know that we know” (Hughes, 2002). Most of time, it is difficult to convey, and to acquire in Company A. The common way to acquire it is from those employees who have seniority and who have been with the company or in the lithography business for certain period.

“Storytelling is a way of capturing what is unique, and what is unique per individual is tacit knowledge” (Post, 2002). Storytelling is the right way of getting tacit knowledge out in Company A so others or inexperienced employees can use it and refer to it. Stories serve as metaphors because they make information more meaningful and understandable. Stories transfer the difficult-to-uncover tacit knowledge within Company A by appealing to the natural learning process of the brain. Stories of experiences during development or marketing, trials and errors during maintenance of the equipments, for example, would likely benefit young engineers or junior business professionals who have not had much opportunity to acquire tacit knowledge.

The final question is how to implement storytelling as a KM tool. Based on the suggestions from Reamy (Reamy, 2002), stories can be used in several ways in Company A:
1. **Use of stories for describing new generation lithography technology** – The use of storytelling in innovation and knowledge creation can encourage employees to move away from linear thinking towards a more multi-dimensional view, to see connections between old and new lithography methods, and also to invent new lithography technology with a more creative or intuitive approach.

2. **Storytellings to enhance communicating technical knowledge** – In *Company A*, employees often find it difficult to communicate about technology. Engineers sometime have trouble articulating their needs and expectations, while experts have difficulty in ‘talking in plain English’. Wherever there is a gap in language and understanding, storytelling can provide a bridge, by communicating the real essence of what each party is trying to get across.

3. **Storytelling to embody and transfer (tactic) knowledge** – A simple story can communicate a complex multi-dimensioned technical idea, not simply by transmitting information as a message, but by actively involving the listeners in co-creating that idea. Furthermore, as a story is told and retold, it changes. So the knowledge embodied in it is constantly being developed and built upon. For example, internal magazines with stories should be used in *Company A*. It encourages the senior engineers writing stories about their experiences and hopes that other teams will learn from their mistakes about “what not to do” by reading these stories.

4. **Storytelling to build team** – Stories can bring people together and foster a sense of team. Storytelling is non-hierarchical. It unlocks feelings and emotions as well as thought processes. Hence it helps to build relationships and trust among employees within *Company A*.

5. **Storytelling for individual growth** – Storytelling is a skill, and one that is mostly related to interpersonal communication. The development of such skill for young engineers is an important component of the KM program in *Company A*.

6. **Storytelling to ignite organisational change** – Experience has shown that storytelling can be highly effective as a change agent, even in change-resistant organisations. Telling an appropriate story can stimulate employees to think actively about the implications of change within the *company A* and to projecting themselves into visions of the future, enabling them to better understand what it will be like if doing things in a different way.

In short, when used effectively, storytelling offers *Company A* numerous advantages over traditional organisational communication techniques. Together with spurring change, storytelling can work to capture tacit knowledge; embody and transfer knowledge; innovate; build team; enhance technology; and contribute to individual growth.

**Implementation of an Integrated KM system**

In previous sections, issues in KM and tools and methods as solutions are discussed, including using social software to boost communications, using story telling to effectively transfer (tactic) knowledge.
In order to effectively and efficiently developing, transferring and applying important technical and business knowledge within Company A, a complete and integrated KM system that consists of all indispensable components is desirable. A proposed architecture of the KM system based on the example of OrganIK (Bibikas, 2008) is illustrated in Figure 5, which integrates different components mentioned above. As seen in the Client Interface Layer, the collaborative workspace is offered to employees, which comprises a wiki, a blog, a social bookmarking tool and a search interface. Every client interface corresponds to a server-side component in the Component Interface Layer of the architecture. The server-side building blocks include a recommender system, a semantic text analyzer, a collaborative filtering engine and a full-text indexer. They all locate at the Business Logic Layer. The Metadata Layer refers to repositories used for the persistence of syntactic and semantic metadata that support the functionality of all server-side components. The Data sources and Back-Office Integration Layer are business information systems and any form of resource container that Company A may depend on for its daily operations.

![Figure 5](image.png)

Figure 5  Integration of heterogeneous data sources in a knowledge architecture

The functionality of the main components in the component layer of the proposed architecture is envisaged as follows:

- The Wiki Component is a web-based authoring tool allowing engineers and business professionals to collaboratively create, edit, and share knowledge artifacts such as documents, diagrams, and etc. There can be a Wiki for software
development team. Marketing or sales unit can also establish their own Wikis to exchange marketing information and sales strategy.

- The Blog Component provides a simple content management tool enabling employees to build and maintain open project monitoring diaries, complete with links to relevant resources and user commentary. The blog component is particularly suitable for individual project/product management.

- The Social Bookmarking Component enables employees to organize and annotate resources (intranet documents, web resources, wiki entries, source code, blog posts, etc.) relevant to their own activities and share them with their co-workers.

- The Semantic Search Component provides supports for browsing, searching, retrieving and displaying knowledge/information resources, leveraging semantic annotation indexing.

The function blocks in the function layer are supported by the business logic layer that includes the following parts:

- The Recommender System focuses on the suggestion of tags and classifications for content added to the system (e.g. wiki entries, bookmarked documents, blog comments, etc.), and the suggestion of information items relevant to the search query or feed subscription of a user.

- The Semantic Text Analyzer uses linguistic and statistical processing functions to analyze the textual content of knowledge artifacts added to the system, in order to perform named entity recognition and term classification. The goal is to identify concepts of interest and establish relationships among resources that can be subsequently used by the Recommender System for suggesting tags and classifications with respect to a taxonomy.

- The Collaborative Filtering Engine enables individual employees to benefit from the collective experience built within groups of peers. An analysis of subjective views that are explicitly or implicitly expressed by other knowledge employees can assist in the selection and recommendation of resources, as well as influence the ranking of search results.

- The Full Text Indexer is an indispensable component of the architecture’s Business Logic Layer and complements the content retrieval techniques proposed.

Successful release and implementation of such proposed architecture within *Company A* also relies on the input of required content, including information, documents and materials that are relevant to its business operation. These materials can be in form of text, diagram and audio-video. Related stories will be particularly suggested because they allow employees to express and share (tacit) knowledge in rich and meaningful ways, instead of being forced to articulate it in more “structured” ways that can detract from its value. This proposed architecture of KM system has been implemented within Company A and positive feedbacks were received from employees of different business units.

**Conclusion**

In brief, knowledge and information have become the medium in which business problems occur. Currently, the nature of business in semiconductor industry has changed in at least two ways:
• Knowledge work is fundamentally different in character from physical labour.
• The knowledge worker in Company A is almost completely immersed in a computing environment. This new reality dramatically alters the methods by which its worker can manage, learn, represent knowledge, interact, solve problems, and act.

As a knowledge-intensive company, Company A is characterized as such that a highly educated workforce engages in mainly intellectual work. As a result, managing knowledge effectively for Company A represents the primary opportunity for achieving substantial savings, significant improvements in human performance, and competitive advantage. To implement an effective KM system, a customized architecture is proposed to integrate different social media tools and methods (e.g. Wikis, and blog) that collect, store, categorize, present business and engineer information and knowledge. A suggested method - storytelling is used to engage, involve and inspire employees, represent tactic content in a more authentic and narrative form. All these efforts and approaches will greatly benefit Company A for operating its business successfully.

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About the Author

Wen Qi is the Professor of Special Appointment (Eastern Scholar) at Shanghai Institutions of Higher Learning (No.TP2015029).
Application of a set of interdisciplinary quantitative methods on predicting a problem of vehicle design for elder drivers and assessing a design proposal

YANG Hao\textsuperscript{a} and WANG Yueran\textsuperscript{b}

\textsuperscript{a} North China University of Technology, China
\textsuperscript{b} Tsinghua University, China
* Corresponding author: hao-yang12@ncut.edu.cn
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Interdisciplinary research methods bring about more opportunities for designers to understand the users and predict some problems that hard to clarify by traditional methods. This study takes product design of the elder-friendly low-speed vehicles as an example, discussing the rationality of some quantitative methods introduced from other fields. The collected data include the subjects’ operations’ finishing time and finger moving times. By means of multiple linear regression and logistic regression, senior people’s driving behavioral model is built to clarify their operational characteristics. According to the results, a prototype design is proposed and then assessed by analytic hierarchy process. The set of feasible methods used in the research process is sorted out for solving other similar issues targeting relative product design.

keywords: design research techniques; behavioral research; driving behaviors; special users

Introduction
Contemporarily, more and more design researches make use of quantitative study. But in the academia, various opinions exist about whether quantitative study is suitable for design or not. Some designers hold the opinion that such an accurate and rigorous
method will encumber creative ideas. In fact, the quantitative study can be an excellent design research paradigm.

To understand users’ characteristics, designers need to analyze data obtained from field observation or surveys. In most cases, researches prefer to speculate essence of users’ behaviors or mental disposition by watching photos/videos or listening to conversations. But a great deal of information is omitted. In qualitative analysis process, researchers can observe users’ behaviors directly. But the accuracy of the data depends on the researchers’ knowledge and insight to a large extent. On the contrary, reliability of quantitative research originates in rigorous mathematical analysis. Qualitative methods are suited to interpret the reasons or the ways to solve certain problems, while quantitative methods fit to unveil numeral relationship (Fei, 2010).

Most of the data analysis methods and modelling methods are based on statistics, which involves descriptive and inferential statistical methods. In the process of design research, it is necessary to distinguish the two aims of research, Predicting and Knowing, from each other. It means researchers need to clarify that whether the purpose of the research is to obtain a general knowledge of the issue or to predict its future trend or developing tendency. Methods used to achieve the two goals are different, and follow different thinking paradigms. Researchers often make a prediction by causal and probabilistic relationship. In the study of Senior People’s Vehicle Design, we hope to identify the issues of reasonable driving style which is suited for the whole senior drivers, rather than problems of one or a group of senior people’s driving behavior or habits. Therefore, this is a predictive research and hard to clarify just by a simple description of data. The next part of the paper illustrates the application of quantitative methods led by statistics in design research, taking the research of senior drivers’ operational style as an example.

Research questions

Characteristics of senior drivers

In China, since the Ministry of public security relaxed the driving license applicants’ age limit to 70 in 2003, a large number of senior people are able to travel by driving and enjoy it. Driving behavior demands the behavioral agent have a high level of activities of daily living (ADL) and cognitive abilities, which can be seen as a challenge for senior people. According to Salthouse’s research, as the age increases, senior people present slower movement, lower operational speed and declining operational capacities. These changes impose a negative feedback which may lead to a mentally tension on senior drivers (McKenna, 1982). Some Chinese researchers also discover that there is a significant difference in behavioral reaction time between the elderly and the youth (including the middle-aged) in China. With the increasement of age, senior people’s perception time, decision time and moving time are all prolonged (Dianye et al, 2004).

With the increasement of age, limb moving abilities decline conspicuously. Compared with lower limbs, upper limbs’ muscle fibers decease more in quantity and shrink in a higher level. Thus senior people’s limb movement disorders first appear in leg movement (Ya, 2012). Some common diseases in the elderly, such as arthrophlogosis and rheumatosis, also make senior people’s lower limbs decline in function and capacity. Aging of lower
limbs’ function imposes a huge impact on senior drivers’ lower limbs’ operation, and proposes a special request for the function and layout of the motor vehicle’s operators. Such declination hampers hands-feet operation and makes it hard to coordinate. Reasonable driving style plays an important role in remedying the declination of senior people’s limb movement abilities.

Motor vehicles suited for senior people
There are various driving styles that can be chosen by senior people. In order to make an effective comparison, it is necessary to grasp the market and users’ preference. We analyzed a data of A Research for Urban Senior People’s Travelling Behavioral Pattern, which is collected by the industrial design department, Tsinghua University in 2013 (Sample quantity=323). One of the important data is to study The Vehicles Used in Travelling. It is discovered that besides the people travelling by bus and on foot, 16.8% of the subjects choose mini cars, 26.9% of them choose electric scooters and 11.7% choose motorized wheelchairs. Percentages of the three choices are much higher than the other travelling styles such as by bike, by motorbike or by self-balancing vehicle. In this way it can be assured that senior people have a high level of acceptance for the three driving styles, which can represent a higher research value.

Australian and Swedish researches demonstrate that senior people’s driving operational mistakes are much more than that of the youth, no matter automatic or manual cars (Selander et al, 2012). This reflects a situation that the mature driving style of modern cars is not suited for all drivers. With a reasonable driving style, mistakes made by senior drivers should not be significantly more than young drivers. The complexity of car driving makes the elderly feel hard to deal with and commit a blunder.

Therefore, research for senior people’s motor vehicles’ design should focus on electric scooters and motorized wheelchairs. Basically, a driving style includes 5 operations, which are Starting, Accelerating, Left-turning, Right-turning and Braking. Based on the movements to achieve the 5 operations, the operational feasibility of the two driving styles are analyzed.

Driving style
Driving style means the method and form of certain driving operational movements. Every vehicle’s operational circumstances correspond to a series of driving behaviors. An ordered combination of specific driving behaviors is a driving style. The research for rational driving style is to research the whole set of driving behaviors of a driving mission. Rather than rigidly adhering to a certain type of vehicle, such a research needs to abstract the method and form of these driving operational movements. That is because different vehicle type is designed according to different driving circumstances. And there will be some special features of the vehicle’s functions and design, not facing all the people. For instance, motorbikes’ high-speed and flexible mobility is not useful for senior people. Besides, because of the needs of driving indoors, motor wheelchairs have the function of rotating around its central line. While such a function is useless for common people without physical disabilities, and it is inconvenient. However, the driving style of these vehicles may be rational even though their mechanical functions are not suitable for certain group of people. Thus the research for driving style should not be confined to certain vehicle’s structure.
Guiding functions of behavior research for product design

Donald Schön's 1983 book The Reflective Practitioner introduced concepts such as reflection-on-action and reflection-in-action which explain how professionals meet the challenges of their work with a kind of improvisation that is improved through practice. For industrial design, each time when a new design appears, the product will impose an influence on people’s previous actions and behavioral style to some extent. Thus the research for behavior expectation is very important. To understand such an issue, creativity and guesswork of designers are incapable of functioning effectively. It is necessary to make product design action-led or behavior-led (Lixian et al, 2015).

Behavioral researches’ guiding role in design can make the product become easier to learn and be accepted by users. One embodiment is the work to grant a better responsiveness to the new product. This need the users can know the products’ situation and operational approaches as soon as seeing it. To achieve this goal, one efficient method is natural mapping. Natural signal can bring about an effective communication and reduce users’ study cost in the process of using a product (Donald, 2007). To build a match between natural signal and product’s operation, researchers need to analyze users’ behavior. Designs that done based on such a research will have a higher level of users’ acceptance.

Methodology of behavioral study

There are many similarities among design, fine arts and science. The Creativity which is necessary for design is also essential in fine arts. It depends on researchers’ shrewd perceptions. Meanwhile, designers need to understand human and human activities. The logicality, regularity and universality under these activities are opportunities of design, as well as designers’ and design researchers’ precious materials. Unveiling these materials is the core value of design research.

Compared with natural science research, design research has a closer connection with social science. Natural science is different in essence from social science (Yu, 2012). The aim of natural science is to discover concrete or abstract truths in the nature, which are always eternal, universal and abstract. While social science aims at understanding some temporary and specially appointed social phenomenon. Issues of design research can be universal, as well as being particular to study special groups. From this point of view, it is a necessary part of this study that absorbing useful methods from both natural and social science, and choosing appropriate ones to use in design research and analysis can be.

There are a variety of research methods. Experimentation, observation, investigation, personal experience methods, intuition study, introspective methods are all good methods to obtain a conclusion and have been used extensively in different fields. Results of a long period research demonstrate that these methods are reliable and able to give birth to effective conclusions, only if being used appropriately. Industrial design faces the needs of users. Analyzing and understanding the users play an important role in design. User research is not only investigation for preparation work, but also functions in every part of design process.

Take Senior People’s Vehicle Design as an example. It is hard for designers who are young and lack of senior experience to propose effective designs just by means of field work and interviewing. In order to describe and obtain the diversity and variation of the group of senior drivers, it is necessary to do experiments which are properly controlled. It is some
kind of positivistic approaches rather than transcendental or empirical methods. Quantitative data that embody the diversity and variation can be acquired. Besides, qualitative research is also requisite in the process of ascertaining experimental instruments and programs. For instance, observation which is a qualitative method is always needed to interpret quantitative results and discover the reasons behind the problems.

Data collection is the most commonly used work in industrial design as well as the most basic requirement. The representativeness, accuracy and chronergy of the data impose a significant influence to design location. It will bring about a resultant series of methods of subjects’ choice, inquiry and observation. Subjects’ choice methods include general investigation, sampling survey and typical case investigation. In the example of Senior People’s Vehicle Design, methods to choose appropriate subjects need to be deliberated circumspectly, rather than looking for someone casually and launching a survey hastily.

One of the most important aspects of quantitative research is statistics. Statistical methods are always based on some hypothesis. Analysis and conclusion of certain prediction are also based on the hypothesis. From this point of view, there must be some limitations of quantitative research methods. It demands researchers confirm that the data can meet the conditions of the hypothesis before practicing the methods. So it is necessary to choose analyzing methods rigorously to make the analysis reasonable and scientific under the condition of satisfying the hypothesis.

Methods

Subjects and experiment design
In terms of the two kinds of low-speed motor vehicles’ driving operations, researchers make a real-time collection of drivers’ data of operational behaviors, vehicles’ running status and traffic condition images. Based on previous analysis and theories, the research takes Reasonable Driving Styles Suited for Senior Drivers as a breakthrough point. The experiment is done in daytime. The aim is to compare the two kinds of vehicles (Figure 1) and clarify the advantages and disadvantages of the two driving styles. With a certain speed (10km/h) and in a certain distance (220m), real-time data of drivers’ operational behaviors, time to finish certain movement, swing times of the vehicle bodies and traffic condition images are collected to analyze these driving indexes’ change characteristics. By means of the analysis, regression model to reflect driving behavioral variations will be built and the two driving styles are compared.
Figure 1 The two experimental vehicles

According to the research aim, researchers in the experiment set up several typical route lines, including right-angled turning, straight driving, large radius turn and zigzag driving. 30 subjects are selected randomly. The age limitation is 60-80 years old for males and 55-75 for females. According to the statistics of Report on the Elderly Population Information and Aging Industry Development in Beijing in 2008, aging population (60 years of age or older) of male in Beijing is about 1044 thousand and population of female elderly is about 1136 thousand. Considering this male-female ratio, researchers selected 14 male subjects and 16 female subjects from various parts of Beijing and test in a real traffic environment.

In order to ensure a high stability and internal validity of the data, researchers take subjects’ cognitive level as a controlled variable. By means of two scales, SPMSQ and IADL, assessment was done. The senior people with a high level of cognition (SPMSQ scores > 9) and a complete self-care ability in daily life will be enrolled in the sample to test. Operational movements of the two experimental vehicles are listed as Table 1:

<table>
<thead>
<tr>
<th>Type</th>
<th>Brake</th>
<th>Directional Control</th>
<th>Go Forward</th>
<th>Draw Back</th>
<th>Auxiliary Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric scooter</td>
<td>Pinching</td>
<td>Gripping the two handlebars and rotating</td>
<td>Screwing</td>
<td>Screwing</td>
<td>Pressing the backing-up button before drawing back</td>
</tr>
<tr>
<td>Motorized wheelchair</td>
<td>Relinquishing the fingers</td>
<td>Pushing the direction stick with thumb</td>
<td>Pressing the direction stick forward</td>
<td>Pressing the direction stick backward</td>
<td>None</td>
</tr>
</tbody>
</table>

Table 1 Basic driving behaviors of the two experimental vehicles
A key point that need to be paid attention to is that the experiment focuses on operational behaviors rather than certain vehicle’s design. Thus the volume of the vehicle, transmission styles and influences of existing application environment on driving performance will not be put into the researched variables.

**Experimental instruments and data collection**

The whole experimental system is divided into 3 modules, which are operational behaviors collection module (GoPro Hero cameras), vehicles’ running situation collection module (Casio EXILIM digital cameras) and outside environment collection module (vehicle data recorder).

The Gopro Hero4 Silver camera has an ultra wide angle lens, which can record more information about the close-range user’s movements. Researchers designed a metal bracket system and fixed the camera onto the left rearview mirror (of the electric scooter) and the right foot plate (of the motorized wheelchair). In this way, drivers’ movements will not be hindered, and researchers can gain the largest field of vision from the videos. A set of tiny bracket was used to fix the Casio EXILIM cameras onto the right rearview mirror (of the electric scooter) and the left hand supporting-plate (of the motorized wheelchair). The brackets are reinforced by cellulose tape (Figure 2) to avoid slipping off from the vehicle caused by jolt. To guarantee the authenticity of the experiment, the fixed cameras’ spatial locations are based on the drivers’ visual and behavioral habits. So they will not hamper the drivers from finishing the experimental mission.

![Figure 2 Fixed method of the two camera equipments](image)

Researches of sports psychology demonstrate that human’s reaction time is related to movements accuracy (Jinhong, 2001). From the point of driving behaviors, reaction time means the time interval from when perception organs receive signals to that when the body reacts (Xiaohua, 2013). But collecting reaction time of driving operations will meet some problems. Conceptually, reaction time is the time that drivers spend to do a series of...
reactions including identification, judgment, taking actions and making the actions achieve the expected target after perceiving a signal (Xiaohua, 2013). But people’s abilities to identify and select external information are influenced by many factors such as road situation, environment and driving proficiency. So there is a high randomness in the abilities’ variation. Besides, from the point of driving, the time to make the actions happen is connected to the vehicle’s characteristic, such as the vehicles’ volume and transmission style, and not completely controlled by the driver. So the reaction time is less meaningful for this research. Therefore, researchers choose to collect the operation finishing time that can reflect the human-vehicle relationship, rather than the whole time of accepting signals, identification, judgment before the operations happen and the time that movements achieve the expected target after the operations happen.

Researchers use two digital cameras to collect driving operations, the vehicles’ swing times and driving stability in real time and synchronously. The method to obtain driving operation finishing time is to calculate every driving operational movement’s frame number and turned it into seconds, with an accuracy of 2 decimal points. To achieve this, researchers observe the video frame by frame and check out every movement’s beginning and finishing frame.

**Results**

*Descriptive analysis*

To analyze the driving operations of the two experimental vehicles, the first step is T-testing the variation of the two vehicles’ driving operational data collected from the subjects. The 30 subjects drive both of the two vehicles in the process of the experiment and so the researchers can obtain two groups of data. The analyzed variables include the driving operation finishing time and vehicles’ swing times. For the variables with a significant difference between the two groups, researchers compared the two groups’ mean values of the variable to clarify the more reasonable one. Results are listed as Table 2:

<table>
<thead>
<tr>
<th></th>
<th>Electric scooter</th>
<th>Motorized wheelchair</th>
<th>Sig.</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Braking</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X1***</td>
<td>1.82</td>
<td>0.725</td>
<td>0.74</td>
<td>0.322</td>
</tr>
<tr>
<td><strong>Left-turning</strong></td>
<td>2.97</td>
<td>1.129</td>
<td>2.09</td>
<td>1.057</td>
</tr>
<tr>
<td>(X2***</td>
<td>2.41</td>
<td>0.998</td>
<td>1.84</td>
<td>0.782</td>
</tr>
<tr>
<td><strong>Right-turning</strong></td>
<td>1.37</td>
<td>0.751</td>
<td>1.45</td>
<td>0.516</td>
</tr>
<tr>
<td><strong>Accelerating</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X4)</td>
<td>1.37</td>
<td>0.751</td>
<td>1.45</td>
<td>0.516</td>
</tr>
</tbody>
</table>
Table 2 shows that only the accelerating operations finishing time (X4) is not significantly different between the two groups. It means that no matter driving electric scooters or motorized vehicles, there is no significant variance between the time spent by senior drivers of the two vehicles on acceleration. The other variables all present a significant difference ($p < 0.01$) between the two groups, which demonstrate the change of driving styles has a significant influence on drivers’ operations.

**Analysis of vehicles’ stability**

According to psychological resource allocation theories, a shorter driving operation finishing time is more beneficial to the drivers’ performance. The whole driving process can be summarized as a Perception-Judgment-Operation model (Figure 3) (Xiaohua, 2013). Driving operation is the final step in the drivers’ information disposal process. A shorter operation finishing time is beneficial to allocate the driver’s psychological resource in a more reasonable way. So the driver can deal with and judge other information of roads and pedestrians better. From this point of view, operations of motorized wheelchairs, which need a shorter time to finish most of the movements, are more suited for senior people.

The next step is to clarify whether the operation finishing time’s variation of these movements is really effective to a better driving performance. The researchers take the swing times of the vehicles in the experiment process as the evaluation index to reflect the driver’s performance. Fewer swing times show a higher level of manoeuvrability. The driver controls the vehicle better, the vehicle runs more smoothly and seldom meets any accident. More swing times show that the driver is unable to fit in with the driving mission, which is very dangerous for the mission.

![Figure 3  Driving-information processing model](image)

According to the hypothesis, researchers take the swing times as the dependent variable and take the 5 operation finishing time as independent variables to build a linear regression model. The model reflects how much each operation of the motorized wheelchair influence the vehicle’s swing times. Results are listed as Table 3:

<table>
<thead>
<tr>
<th>Drawing back (X5***))</th>
<th>2.27</th>
<th>1.035</th>
<th>2.02</th>
<th>1.206</th>
<th>0.001</th>
<th>10.628</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swing times (X6***))</td>
<td>20.63</td>
<td>4.466</td>
<td>5.3</td>
<td>10.108</td>
<td>0.000</td>
<td>32.425</td>
</tr>
</tbody>
</table>

**Table 3  Linear regression analysis of motor wheelchairs’ driving operation**
<table>
<thead>
<tr>
<th>Criteria</th>
<th>B</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig.</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>18.729</td>
<td>0.477</td>
<td>39.24</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Braking (X1)</td>
<td>0.304</td>
<td>0.142</td>
<td>2.14</td>
<td>0.043</td>
<td>0.558</td>
</tr>
<tr>
<td>Left-turning (X2)</td>
<td>0.375</td>
<td>0.137</td>
<td>2.73</td>
<td>0.012</td>
<td>0.597</td>
</tr>
<tr>
<td>Right-turning (X3)</td>
<td>0.331</td>
<td>0.123</td>
<td>2.69</td>
<td>0.013</td>
<td>0.744</td>
</tr>
<tr>
<td>Accelerating (X4)</td>
<td>-0.011</td>
<td>0.011</td>
<td>-0.99</td>
<td>0.330</td>
<td>0.877</td>
</tr>
<tr>
<td>Drawing back (X5)</td>
<td>0.112</td>
<td>0.160</td>
<td>0.70</td>
<td>0.490</td>
<td>0.908</td>
</tr>
</tbody>
</table>

According to the results, the linear regression model can be written as:

\[ Y = 18.729 + 0.304X_1 + 0.375X_2 + 0.331X_3 - 0.011X_4 + 0.112X_5 \]

In the formula, \( Y \) refers to the swing times of the vehicle in the process of driving. Variables \( X1 \) to \( X5 \) respectively refer to the braking, left-turning, right-turning, accelerating and drawing-back operation finishing time. Among the 5 independent variables, \( X1 \) to \( X3 \) all significantly influence the swing times (\( p < 0.05 \)) while \( X4 \) and \( X5 \) are both insignificant variables (\( p > 0.05 \)). The result shows that braking and turning operations influence the vehicle’s stability significantly.

Industrial design is concerned about serving people, thus it is necessary to clarify the effectiveness of a design research. Only in this way designers can make decisions about how to use the results in solving problems of different user groups. The change of the 5 driving operations’ finishing time can interpret approximately 73% of the vehicle’s swing times change (\( R^2 = 0.7298 \)). The model’s goodness of fit is satisfactory. It demonstrates that driving operations’ finishing time really influence senior people’s driving performance. Tolerances of all the independent variables are above 0.1, and variance inflation factors (VIF) of them are all below 5. It shows that the model has no multicollinearity problem. The result of F-test shows the model’s linear relationship is significant, under a 95% confidence level (\( F = 15.97, \ p < 0.05 \)).

**Lane-keeping ability**

Driving operations influence not only the vehicle’s stability, but also influence the level of drivers’ lane-keeping ability. The lane-keeping ability is also an index to evaluate the driving performance. A reasonable driving style should be better manoeuvrable for the users and bring about a higher level of keeping the lane. In this step of the research, senior drivers’ lane-keeping ability is studied by means of logistic regression.

Tsuyoshi Moriyama and Takashi Yonekawa researched drivers’ operations to avoid obstacles in the process of changing lanes (1995). The research showed that there are two kinds of operations under this situation, one of which is controlling directions purely and the other is combining the operation of controlling directions with that of braking together. Any kind of lane-changing mission includes the accelerating operation, which is the first operation in the driving process. Thus it is needed to bring the three operations as independent variables into the analysis of lane-keeping ability. The operations’ finishing
time can reflect the interactivity between the driver and the vehicle. From the point of driving operations, the logistic equation can be built as:

$$\log\left(\frac{P}{1-P}\right) = \alpha + \beta_1 X_2 + \beta_2 X_3 + \beta_3 X_4$$

P refers to the probability that certain subject cannot keep the lane, while (1-P) means the probability that the subject keeps the lane. After fitting, results are listed as Table 4:

<table>
<thead>
<tr>
<th>Beta</th>
<th>S.E.</th>
<th>Wald</th>
<th>Sig.</th>
<th>OR值</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-turning (X2)</td>
<td>-0.888</td>
<td>0.322</td>
<td>7.607</td>
<td>0.006</td>
</tr>
<tr>
<td>Right-turning (X3)</td>
<td>-0.697</td>
<td>0.230</td>
<td>9.169</td>
<td>0.002</td>
</tr>
<tr>
<td>Accelerating (X4)</td>
<td>-1.297</td>
<td>0.624</td>
<td>4.326</td>
<td>0.038</td>
</tr>
<tr>
<td>Constant</td>
<td>4.713</td>
<td>1.243</td>
<td>14.381</td>
<td>0.000</td>
</tr>
</tbody>
</table>

From the results it can be known that for motor wheelchairs, the 3 independent variables all have a negative influence on logit P. Among them, acceleration finishing time (X4) has a larger influence (|β4| > 1). This illustrates that the change of acceleration finishing time can make the probability that senior people cannot keep the lane change more. This result may be caused by the natural mapping style of motor wheelchair’s operation. It means when the driver accelerates, direction of the operation lever movement is the direction that the vehicle moves towards. Because of the negative influence, the longer the finishing time is, the probability that senior people can keep the lane is higher. On the contrary, the shorter the finishing time is, the probability that senior people cannot keep the lane is higher. Lane-keeping is an accurate operation, so it should not be simply explained by theories of driving-information processing model. Sometimes a long period of time unlikely make some problems caused by psychological resource allocation. Oppositely, a longer finishing time can bring about a higher level of lane-keeping performance. This is consistent with the theory of motion accuracy.

**Discussion and assessment**

**Problem description**

The driving style of motor wheelchairs is more appropriate for the elder drivers. Moreover, the significant influential factors that make this driving style appropriate is the finishing time of braking, left-turning and right-turning operations. In future work of design for elderly-oriented low-speed motor vehicles, this driving style ought to be paid attention in the braking and turning manipulators’ design. But there is a problem existed in this style. We can know from Table 3 that the swing times of motor wheelchairs are significantly more than electric scooters. It shows that the elder drivers hardly control the motor wheelchair so well that the vehicle often swings.

For one thing, this may be caused by the vehicle’s mechanism. The wheelbase of motor wheelchairs, generally less than 600mm (Shengxue, 2007), is shorter than most motor
vehicles. There is no turning wheel on wheelchairs and the velocity variance of the two independently driven wheels is used to achieve the turning. Such a mechanical structure brings about a jolt and instability when the vehicle accelerates, brakes or climbs up to a slope. (Shengxue, 2007).

For another, it can be known from Table 4 that driving operations significantly influence the vehicle’s swing times. Therefore, the driving operational problem must be one of the factors that caused the situation of the overmany swing times. To clarify the solution of the instable driving, the method of observation is used. By means of observing and counting, it can be found that because of the operational stick is so short and small that drivers need to use two hands to hold the stick to avoid driving errors(Figure 4). In the process of driving, fingers are used to achieve two operations which are grasping and pushing. Thus the stick is easy to slip out from the drivers’ hands. Besides, the left hand always moves unconsciously, which may also hinder the operation.

![Holding and controlling problems of motor wheelchairs](image)

**Figure 4** Holding and controlling problems of motor wheelchairs

**Prototype and design proposal**

Based on the results, a prototype is proposed. It adopts motor wheelchairs’ driving style which controls the driving directions by pushing a stick, and brakes by relinquishing the fingers. But considering the swing problem existed on traditional motor wheelchairs, the
prototype’s operational stick is enlarged to a size as big as electric scooters’ steering column and the interactive parts are two handle bars. By means of holding the handle bars, both of the driver’s two arms are used to control the steering stick (Figure 5). This prototype maintains motor wheelchairs’ driving style so that the driver can have a better operational performance as well as reducing the possibility of incorrect operations caused by a small and short stick. Meanwhile, by such a style, senior people without driving experiences can easily learn to drive it. And it liberates senior people’s lower limbs, which is corresponding with senior people’s limb movement characteristics.

The prototype has a longer wheelbase and turns by the deflection of front wheels, just as the electric scooters’ swerving wheels. This mechanical structure is propitious to make the vehicle body keep balance better and not swing excessively. With the coordination of motor wheelchair’s driving style, such a structure can bring about a better driving experience.

![Figure 5](image)

**Assessment of the design proposal**

In order to assess the design proposal, researchers evaluate the three driving styles of the proposal, the electric scooter and the motor wheelchair by Analytic Hierarchy Process (AHP). As a method to process problems and make decisions, AHP integrates quantitative and qualitative analysis. Although the final result is generated by calculating, this method also takes full advantages of qualitative analysis and makes use of the evaluators’ experiences and knowledge more adequately. Thus compared with general quantitative research methods, AHP can analyze more detailed and deeper original data and bring about a more accurate result. In domestic field of industrial design research, especially in the assessment of designs, the application of AHP is also very popular. For the design proposal in this research, which is of fuzziness and nondeterminacy, such a method will bring about a more effective assessment.

By inviting experts in this field assess the driving style A (style of the design proposal), the driving style B (style of electric scooters) and the driving style C (style of motor
wheelchairs), an analytic hierarchy process model is set up to seek out the optimal choice for senior people. Then the next question is to find the appropriate experts. Because the aim of this research is to service innovative thinking and product design practice, senior people that have relative driving experiences are chosen to be the experts. They can evaluate the driving styles from the view of an expert driver as well as an user. What’s more, sorting the rationality of different driving styles from the point of elder drivers can support the effectiveness of the research achievement.

After setting up an analytic hierarchy model, constructing judgment matrices, calculating the eigenvectors and testing the consistency of the matrices, we can finally get the order of the three driving styles. Accessibility and Usability are used as reference indexes. 30 raters are invited to make an assessment to the three styles. Every rater’s judgment matrix is calculated to seek an ordering weight. All the raters’ ordering weight values are dealt with to produce the group decision. In this decision-making work, both arithmetical means and geometric means can work. But according to existing researches, when averaging a number of people’s judgment and decision, geometric means are superior to arithmetical means (Yanling, 2011). This is caused by the calculating method of GM and the property of the 9-scale assessment applied in AHP. The method to deal with different raters’ ordering weight values is (Yang, 2001):

\[ W_i = \prod_{k=1}^{n} W_{ki}^{\lambda_k} \]

\( \lambda_k \) means the weight of the kth rater. The sum of all the raters’ weight values is \( \sum_{k=1}^{n} \lambda_k = 1 \). Because the 30 experts are all elder drivers, an average weight was given to every rater’s assessment. So the 30 raters’ \( \lambda_k \)s are equal (\( \lambda_1 = \lambda_2 = \cdots = \lambda_k = \frac{1}{30} \)). \( W_{ki} \) means the ith element’s order weight of the kth rater’s judgment matrix. Multiplying all the raters’ order weight values (n=30) of certain element and then calculating the \( \lambda_k \)th (which is \( \frac{1}{30} \)th) power of the product, the result (\( W_i \)) is this element’s total order weight in the group decision.

Using the software yaahp 10.3, total order weight values of every rater’s judgment matrix are generated. C.I. Values of all the raters’ judgment matrices are less than 0.1, passing the consistency test. After dealing with the 30 raters’ total order weight, the group-decision results are listed as Table 5:

<table>
<thead>
<tr>
<th></th>
<th>Braking</th>
<th>Turning</th>
<th>Accelerating</th>
<th>Drawing Back</th>
<th>Weight of Total Order (( W_i ))</th>
<th>Total Order Sorting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prototype posture</td>
<td>0.4934</td>
<td>0.3196</td>
<td>0.2385</td>
<td>0.5396</td>
<td>0.4559</td>
<td>1</td>
</tr>
<tr>
<td>Scooter posture</td>
<td>0.3108</td>
<td>0.5584</td>
<td>0.1365</td>
<td>0.2970</td>
<td>0.3304</td>
<td>2</td>
</tr>
<tr>
<td>Wheelchair posture</td>
<td>0.1958</td>
<td>0.1220</td>
<td>0.6250</td>
<td>0.1634</td>
<td>0.2137</td>
<td>3</td>
</tr>
</tbody>
</table>
From the results, it can be seen that senior people have the best recognition to the driving style of the design proposal (W=0.4559). While among the various driving operations, braking functions best to the vehicle’s accessibility and usability (W=0.5215). And the proposal’s braking and drawing back operations get the most positive feedback from the elder drivers, better than the operations of the other driving styles.

**Conclusion**

Based on the operations’ finishing time, this study set up models for elder drivers’ driving ability. From the results, we can found that such quantitative methods is effective in clarifying the influential mechanism of actions in user-analysis. But the reliability and validity still need to be improved. The nonsignificant factors ought to be studied by testing a larger amount of subjects. In future researches, designers can use the methods discussed in this study to do rigorous experiments and consummate the designs step by step. Besides, in the next step of assessment work, experts from different levels could be invited to dig various design proposals further by AHP. Such as experts from universities, enterprises, or NGOs that engage in the elderly industry. Their multi-level knowledge and experiences can donate to reasonable designs that really meet the users’ needs.

Methods of design research are developing with each passing day. An increasing number of methods of other disciplines are introduced into design research field to solve various problems. The paper takes elder-oriented motor vehicles design as an example to discuss a set of methods to deal with data, such as descriptive analysis used to judge the significance of two operational postures' variation, multiple regression analysis used to understand the operations’ effects and influential mechanism, logistic regression used to clarify the relationship between lane-keeping capacity and operations, AHP used to evaluate different operational postures and sort them. From sorting out researching subjects, collecting data to setting up models and assessing design proposals, these methods solved a lot of problems that is hard to settle by traditional design research methods. These positivistic approaches bring about many information that is hard to obtain by traditional qualitative methods. Quantitative methods have been widely used in predicting problems and making decisions. But how to apply them in concrete themes and the application effects still need design practitioners to introspect constantly.

**References**


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**About the Authors**

**YANG Hao** is a lecturer of industrial design department, North China University of Technology, China. He got a Ph.D degree of design science in 2016. His research area is vehicles’ ergonomics and product design theories.

**WANG Yueran** is a post doctorate of the Academy of Arts and Design, Tsinghua University. She got a Ph.D degree of design science in 2016. Her research area is design research methods.
Design Management Knowledge: Identifying Learning Objectives of Various Stakeholders for Needs-Driven Learning

KIM Gye Young\textsuperscript{a}; NAM Ki-Young\textsuperscript{a}\textsuperscript{*} and BORJA DE MOZOTA Brigitte\textsuperscript{b}

\textsuperscript{a} Korea Advanced Institute Science and Technology (KAIST), Korea
\textsuperscript{b} University X Paris Ouest, Desigence, Think Lab on Design Management, France

* Corresponding author: knam@kaist.ac.kr

Design-management knowledge is of a cross-functional and multidisciplinary nature. Since the stakeholders’ realms of activities as well as their background are diverse, it is expected that their needs for knowledge-learning will also be diverse. In this context, this paper addresses a new way of learning design management knowledge. Content analysis about the learning of design-management stakeholders was conducted to identify learning objectives that can be used for developing learning approaches. The major findings of the research include: 1) 21 learning objectives with different learners in academia, business are identified; 2) understanding other fields, research, innovation, team communication, and strategic use of design were found to be the main goal in design management knowledge learning; and 3) a design criteria for needs-based learning platform was established.

keywords: design-management knowledge; learning objective; needs-based learning

Introduction

Design has been recognized to create a demand that has not yet been discovered, and it is being used in various ways throughout an enterprise's management beyond designing a product or service that meets user needs. Design management can be defined as a set of organizational management activities that are required to achieve the design process (Gorb & Dumas, 1987; Jevnaker, 2000; Joziasse, 2000).
The design process is a multifunctional process that integrates constraints from research and development, marketing, manufacturing, industrial design, and engineering design. The stakeholders of the process have knowledge and background in other fields, so that the design process has multidisciplinary characteristics. In addition, it is important for design management to include and link together other specializations, including areas such as design, marketing, engineering, and strategy. Design-management knowledge is being shared by design-management stakeholders from various specialized fields (O’Grady, 2012; Martin, 2009).

However, what can be useful design management knowledge may differ depending on the situation of various stakeholders. Designers, for example, have become more involved with unfamiliar business indicators and models, so the emphasis is on the their ability to share their sense of business and knowledge (O’Grady, 2012). Understanding the relationship between design and business issues is accepted as a way to engage the project as a whole. Likewise in the field of management, design thinking has been applied towards understanding the mind-sets of designers. Design is not only confined to the domain of design itself, but it is accepted as a mature capability of a company that can practice the various ways of thinking that designers use to solve problems (Gardien & Gilsing, 2013).

A variety of design-management stakeholders have been trained and acquired knowledge in a single field of expertise. The different stakeholders of design management are engaged in various design management activities in the enterprise, so it may be pointless for them to acquire the knowledge of design management in a single way. Since the stakeholders’ realms of activities as well as their backgrounds are diverse, it is expected that their needs for knowledge-learning will also be diverse. Therefore, it is necessary to take needs-based approaches to learning in design management to meet the very different needs of various stakeholders.

Ultimately, it may be necessary to design a learning platform that caters to the different needs of the stakeholders of design management. As a first step towards designing such a platform, this study attempts to identify why the various stakeholders of design management want to learn design management knowledge. It is expected that understanding the learning objectives of the stakeholders will contribute towards establishing appropriate design criteria for the needs-driven knowledge-learning platform, which will be the subsequent step in a series of research towards designing the platform.

A user-oriented design process can be used to provide a better appreciation of the challenge and a heightened sense of the range of possibilities for the new design management knowledge learning platform to be developed (Kim et al., 2016).

The research aims are:

- To establish impetus for understanding learning objectives of design management knowledge in view of needs-based learning;
- To establish a definition and scope of design-management knowledge; and
- To identify and structuralize learning objectives of various stakeholders for design management knowledge.

The research methodology includes a literature review and content analysis. The knowledge of design management is seldom dealt with in research. Thus, as a first step to
addressing design management knowledge, the definition and scope of design management knowledge are established from literature by firstly defining design management and contrasting design-management knowledge from design knowledge. Following the literature review in the fields of design, design management, and educational psychology, the research establishes the impetus for understanding learning objectives for design management knowledge in view of needs-based learning, ascertaining why learning objectives are important in designing a needs-driven learning platform.

Subsequently, learning objectives are extracted through content analysis on design management literature. The contents of the learning conditions of the design management stakeholders were collected using the verbs indicating learning. Finally, 21 learning objectives were analysed through the affinity diagram method.

The paper is divided into three sections. The first section presents a theoretical underpinning on design management knowledge and the importance of learner needs in knowledge learning. The second section identifies learning objectives and structure of learning objectives that could be ultimately used for designing needs-driven knowledge-learning platform. The third section presents the conclusions of this paper and recommendations for further study.

**Design-Management Knowledge and Learning Objectives**

*Definition and Scope of Design-Management Knowledge*

It is necessary to define what design management knowledge is before investigating the learning of it. Since there is no literature that expressly addresses the definition and scope of design-management knowledge, the research attempts to arrive at them by triangulating the definition of design management, the knowledge from the discipline, and the design knowledge.

The term *design management* emerged in the United Kingdom and the United States in the 1950s and has begun to be established as an academic field. Borja de Mozota (2003) defined design as not only a tangible dimension of the design paradigm but also an intangible dimension as an internal part of the management paradigm and enterprise process. She defined design management as design being integrated within a corporate organization to help a company’s developmental strategy in an operational, functional, and strategic levels.

Best (2006) defined design as an output or user-centred problem-solving process as products, services, interiors, buildings, and software processes and activities facing everyday life. In contrast, she defined design management as ‘to understand the role of design in achieving organizational strategic goals, and to develop the passions and aspirations, the conditions and tools necessary for planning and methods, and means to effectively put them in relevant position’.

McBride (2007) defined design management as the management of creative assets within a company to achieve strategic and sustainable strengths. In addition, design management provides support for processes that focus on value propositions used for the same
purpose from Design Management Institute. Examples of major definitions of design and design management are presented in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Definition of design</th>
<th>Definition of Design Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borja de Mozo (2003)</td>
<td>Creative activity whose aim is to establish the multifaceted qualities of objects, processes, services, and their systems in whole life cycle</td>
<td>Managing the integration of design in the corporate structure at the operational level (the project), the organizational level (the department), and the strategic level (the mission) Managing the design system within the company</td>
</tr>
<tr>
<td>Best (2006)</td>
<td>The outcome of a design project can be seen in the products, services, interiors, building and software processes that we come into contact with daily The activity of designing: user-centered, problem-solving process</td>
<td>The effective deployment by line managers of the design resource available to the organization in the pursuance of its corporate objectives The organization of the processes for developing new products and services</td>
</tr>
<tr>
<td>Design Management Institute</td>
<td>Identification and allocation of creative assets within an organization to create strategic, sustainable advantage</td>
<td>Design management encompasses the ongoing processes, business decisions, and strategies that enable innovation and create effectively-designed products, services, communications, environments, and brands that enhance our quality of life and provide organizational success.</td>
</tr>
</tbody>
</table>
The key points extracted from literature regarding design-management knowledge are as follows:

- **Organization**: Knowledge on the integration of design within a corporate organization that can help a company develop strategies at the project, departmental or headquarters levels, or strategic level;
- **Vision and strategy**: Knowledge on the establishment and implementation of vision and design strategy to meet organizational strategy;
- **Process**: Knowledge on the processes that achieve innovations for new environments and new user experiences within the company;
- **Environment**: Knowledge on the development of a creative work environment for design; and
- **Designer resource management**: Knowledge on the deployment of the design resource available to the organization.

Therefore, design-management knowledge is defined as ‘the knowledge related to design-related organizational issues, design vision and strategy, processes and environments for design, and designer resource management’ for the purpose of the research.

Design knowledge, as opposed to design-management knowledge, can be defined in a similar fashion: ‘knowledge about the nature of the object and material when designers design products and services’; ‘knowledge of various processes that realize a product that is actually designed and, knowledge of the characteristics of the design process that exploits process design’ (Van Aken, 2005). Some researchers defined design knowledge as ‘a way to solve problems, interact with others, work with others, knowledge of people, including understanding of people, companies and trends and societies’; ‘knowledge about artefacts, and an understanding of the environment’ (Friedman, 2000).

The discussions above illustrate that, despite the obvious commonalities, the main difference between design knowledge and design-management knowledge can be drawn: the former is needed by designers when designing, while the latter is related to the strategic use of design and designers in a company. This means that the stakeholder network in design management are much broader and more complex with widely varied needs for the knowledge than in design with more focused and relatively homogenous needs for the knowledge related to designing products and services. Further, there are many stakeholders in design management who do not necessarily understand design well or whose areas of expertise are not directly related to design. To establish how they should approach design management knowledge properly, it is important to understand why they want to learn design management knowledge in the first place.

**Importance of Objectives in Learning**

It is established that prior knowledge, interest, and motivation affect learners' knowledge learning. Many researchers in the field of educational psychology have found that prior knowledge has a great impact on knowledge learning. In addition, motivation and interest has been defined as an important factor influencing on learning behaviour. The factors that influence this knowledge learning can lead to specific learners' needs. These needs are important design factors for constructing a needs-based learning platform. In a similar context, knowledge management and learning management researchers have argued that past learning management schemes have failed because they focus on knowledge content.
and not on the learner’s special needs (Soloway et al., 1996). Learner needs are important because learners do not voluntarily participate in educational programs if their needs are not in the program (Wiltshire, 1973). In addition, Boone, Safrit, and Jones (2002) argued that learners have a drastic reduction in motivation to acquire knowledge if there is a gap between their interests and their learning outcomes. When an adult wants to acquire knowledge, the motivation of the learner is a unique essence that is drawn from the needs of individual growth, or is learned by social / environmental pressures.

In addition, knowledge management and learning management researchers argued that it is necessary to develop into a learner-centred model based on a content-centric model that focuses on content and provides certain knowledge contents to all (Soloway et al., 1996). The learner-centred model means that learners construct their own learning environment. The importance of learner needs has been emphasized as the changing learning environment gradually spreads. The system of e-learning can change depending on the degree of knowledge acquisition or the needs of learners such as beginners or experts (Childs, Blenkinsopp, Hall, & Walton, 2005). Knowledge content can be customized and configured according to needs, goals, interests, or other characteristics of learners within the e-learning system. (Barbara & Donna, 2005; Lee, Yoon, & Lee, 2009). Therefore, to provide knowledge based on learner needs, it is necessary to understand their needs and learning objectives.

Moreover, there are stakeholders with diverse backgrounds in design-management fields and activities appear at various levels in practice. Learner needs are likely to be different for each stakeholder because they are involved in different activities and different level. Even if design-management knowledge is provided on the basis of existing topics or issues without consideration of learner needs, there is a gap between needs and design management knowledge. Therefore, this study seeks to identify the learner needs in the context of design management knowledge based on the importance of learner needs to provide appropriate knowledge according to their needs.

**Learning Objective for Design-Management Knowledge**

*Contents Analysis*

*Design Management Journal* and *Design Management Review* were selected for content analysis. 159 papers published in the past five years were reviewed and 359 learning objectives for design-management knowledge (DMK) were extracted. Paragraphs containing the verbs related to learning such as ‘to learn’, ‘to understand’, ‘to know’, and ‘to think’ were collected.

Learners of DMK are generally classified by their roles, such as 'designer' and 'CEO', in the design management literature. Not only did the content analysis extract learning objectives, but it made it possible to establish the links between the learning context and stakeholder’s role by extracting learning objectives and the learner’s learning context together. In other words, learning objectives were connected with what kind of learners they were and why they wanted to learn the knowledge in their contexts. This presented a much more accurate picture of learners’ roles and needs than the conventional classification by discipline-based roles they play in the company, a requisite for designing a needs-driven learning platform.
Table 2 Example of content analysis

<table>
<thead>
<tr>
<th>Literature code</th>
<th>Learner</th>
<th>Contents on design management knowledge learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Researcher</td>
<td>In order to identify the strengths of a CEO has a design background and to create an organizational culture, the researchers organized cases that a CEO who has a design background created organizational culture</td>
</tr>
<tr>
<td>1</td>
<td>CEO</td>
<td>Understanding design principles, design values, and influences from traditional design concepts</td>
</tr>
<tr>
<td>1</td>
<td>Designer</td>
<td>Delivering design knowledge to non-design departments through life activities</td>
</tr>
</tbody>
</table>

Most design-management literature describes the design management activities associated with the design-management stakeholders in the corporate environment. It was found that additional content-extraction criteria were needed to find the learning objectives of the learners in academia as well.

To understand researchers’ knowledge learning, the literature on design knowledge accumulation process was reviewed (Owen, 1998). Knowledge is generated and accumulated by research (explicit knowledge) and practical activities (tacit knowledge), and the accumulated knowledge is used to create new knowledge, and the newly created knowledge is used again to create even newer knowledge (Owen, 1998; Nonaka, 2008). Design management research can also be understood in a similar context. Design management academics can create new knowledge based on existing knowledge. The knowledge is applied to design-management practice and newer knowledge is created by theorizing the practice or converting the tacit knowledge gained from the practice into explicit knowledge through research. Therefore, to extract researchers’ knowledge learning objectives, the introductions and the conclusions of literature were examined to mine directly their research objectives. The body of literature contained the learning objectives of the stakeholders in industry while the introduction and conclusion contained learning objectives of the researchers themselves in the form of research aims, rationales, approaches, and methods as well as how and why they conducted the study.

For the extraction of learning objectives, appropriate screening criteria are needed avoid extracting contents other than those directly associated with DMK learning. The verbs were used to extract learning objectives may have sufficiently broad meanings to extract contents associated with ‘knowledge’, but not necessarily ‘knowledge learning’, for example. This is important because literature is bound to contain knowledge as a result of the research. Also, it is necessary to exclude pieces on knowledge learning in areas other than design management. For example, the extracted sentence “most designers have experience in design education and some learned design in apprenticeship” were excluded because the learning is of design skills, not design management knowledge.
Similarly, if the verb ‘understand’ was written on understanding of the purpose and the result of the research, not design management knowledge, sentences and paragraphs were excluded. In addition, the verb ‘to think’ was often used to mean "design thinking", but this was also excluded if the design thinking was not described in connection with the DMK learning.

To summarize, the screening criteria used for extracting design-management-knowledge content are as follows:

1. Content should be excluded when it is not related with knowledge learning (e.g., content on acquiring new knowledge, such as guidelines or a results of research are not relevant to learning itself).
2. Content should be excluded when the contents are not related to design management knowledge, even if it is related to knowledge learning (e.g., most designers have experience in design education and some have learned design through apprenticeship).
3. Content should be excluded when the researcher does not understand the purpose of the study or learn it from the result of the research it is not design-management knowledge.
4. Content should be excluded when it is used to describe 'design thinking’, and not knowledge learning.

Learning Objective for Design-Management Knowledge
Since similar pieces were collected from different literature, the extracted content was grouped and categorized through the affinity diagram method for which four design-management researchers participated. All participants were familiar with affinity diagram activities and had an in-depth understanding of design management. In the categorization process, the extracted content was first simply placed without discussion, followed by content grouping through collective discussion and coordination. Finally, the grouped pieces were appropriately labelled.

![Figure 1 Example of affinity diagram](image)

Findings and Discussion
There were 21 DMK learning objectives that emerged through the affinity diagram process, in which the links between the roles of design-management stakeholders and their learning objectives were also identified. As part of the content analysis, a frequency
test was carried out on the extracted learning objectives to determine the significance of each learning objective. The 21 learning objectives for DMK finally obtained are presented in Table 3.

**Table 3  Learning Objectives**

<table>
<thead>
<tr>
<th>DMK Learning Objectives</th>
<th>Learners</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>To acquire knowledge about consumers</td>
<td>Researcher, company, design leader, CEO, executive director, brand team, designer, entrepreneurship, provider, marketer, engineer, designer, multidisciplinary team, student, senior management, design director, team, business stakeholder, organization</td>
<td>45</td>
</tr>
<tr>
<td>To learn integrated knowledge from other areas</td>
<td>Multidisciplinary team, transitional developer, design project team, educator, company, design manager, engineer, employee, researcher, business student, design leader, designer-entrepreneurs</td>
<td>25</td>
</tr>
<tr>
<td>To learn the skills and perspectives of the business</td>
<td>Social network, design leader, CEO, designer, leader, manager, business stakeholder, senior design staff, company, teacher, design student, design entrepreneur</td>
<td>22</td>
</tr>
<tr>
<td>To read opinions and stories from design management practitioners</td>
<td>Researcher</td>
<td>21</td>
</tr>
<tr>
<td>To strategically use designers and designs in the company:</td>
<td>Government, designer, manufacture, corporate, SMEs community, leader, manager, company, employee, researcher, Business student, manager, business stakeholder, business community</td>
<td>20</td>
</tr>
<tr>
<td>To use design knowledge in other areas</td>
<td>Design leader, leader, management and marketing community, designer, non-design colleague, design-process stakeholders, educator, engineering designer, firm, organization, manager, CEO, policy maker, project manager</td>
<td>20</td>
</tr>
<tr>
<td>To set and understand your project's direction for a seamless project</td>
<td>NPD team, team member, engineers, multidisciplinary team, transitional engineer, project leader, company, designer, leader</td>
<td>19</td>
</tr>
<tr>
<td>To find design opportunities for market changes</td>
<td>Design manager design leader, brand team, designer-entrepreneurs, design community, manufacturer, team, designer, researcher, company, design student</td>
<td>15</td>
</tr>
<tr>
<td>Objective</td>
<td>Target Stakeholders</td>
<td>Notes</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>To learn about organizational culture development direction</td>
<td>Leader, executive, designer, design leader, design manager, team</td>
<td>14</td>
</tr>
<tr>
<td>To take advantage of design at a strategic level</td>
<td>Human Resource, designer, business partner, government, engineer, researcher, design leader, firm, CEO, manager</td>
<td>14</td>
</tr>
<tr>
<td>To share knowledge in common for understanding work within the company</td>
<td>NPD team, designer, multi-disciplinary team, tactical level, operational level, design manager, project team, company</td>
<td>13</td>
</tr>
<tr>
<td>To refer to innovation cases to process in company</td>
<td>Start-up CEO, engineer, designer, business stakeholder, design project team, manager, researcher</td>
<td>13</td>
</tr>
<tr>
<td>To get motivation and utilization of research from case studies:</td>
<td>researcher</td>
<td>13</td>
</tr>
<tr>
<td>To understand the flow of academic theory and change</td>
<td>Researcher</td>
<td>13</td>
</tr>
<tr>
<td>To understand concepts in the field of design</td>
<td>Organization, employees, business student, business leader, manager</td>
<td>9</td>
</tr>
<tr>
<td>To understand the role of design and designers</td>
<td>Designer, clients, employees, marketer, researcher</td>
<td>9</td>
</tr>
<tr>
<td>To effectively communicate with managers and designers in the company</td>
<td>Designer, team, design manager multi-disciplinary team</td>
<td>8</td>
</tr>
<tr>
<td>To understand different perspectives in other fields.</td>
<td>Government, business and students, researcher</td>
<td>8</td>
</tr>
<tr>
<td>To understand the actual applied result of design management theory and applying the project</td>
<td>Student, business school, design leader, university, external stakeholder</td>
<td>7</td>
</tr>
<tr>
<td>To get tacit knowledge through design activities</td>
<td>Designer, leader, educator, business stakeholder, student</td>
<td>7</td>
</tr>
<tr>
<td>To understand theory of design management applicable to research:</td>
<td>Researcher</td>
<td>7</td>
</tr>
</tbody>
</table>
The learning objectives and their interpretation are as follows:

1. To acquire knowledge about consumers: This learning objective was most frequently found and many design-management stakeholders in academia and practice were found for this objective. The learning objective was to understand consumer needs and user experience and motivation.

2. To learn integrated knowledge from other areas: This means learning knowledge in marketing, design, service, and management to create organizational value, better leadership, and lower uncertainty.

3. To learn the skills and perspectives of a business: This included stakeholders such as designers and design managers with design backgrounds who wanted to gain business-related knowledge to communicate with people with management backgrounds or to understand the internal relations of the company or internal process.

4. To read opinions and stories from design-management practitioners: The objective was not only to hear the story experienced by actual designers but also to use those stories to establish research purpose through communication with practitioners.

5. To strategically use designers and design in the company: It means understanding how to use the design process, design organization, and understanding what designers are asking and what designers can do.

6. To use design knowledge in other areas: A variety of design-management stakeholders were found for the purpose. The designers were found to communicate their design knowledge to another department than the design department through daily activities.

7. To set and understand the direction for a seamless project: It means understanding the direction of the project within the team and understanding what to do next. It discusses about not only the purpose but also the constraints and the expected results, and includes the understanding of the same contents knowledge within the team.

8. To find design opportunities for market changes: It means that design management stakeholders want to respond quickly to market changes when trends, and cultural influences that change as circumstances arise.

9. To learn about direction of organizational culture development: Various stakeholders in design management academic field were found. It is included what factors should be considered to change the organization, or how to apply the design process to the organizational culture.

10. To take advantage of design at a strategic level: It means understanding the value of design and influence of design found from various stakeholders. Design is not merely a design concept or styling. This learning objective means an understanding of the true value of the process, and the process of using the design to achieve strategic outcomes.

11. To share knowledge in common for understanding work within the company: This objective included the sharing of frameworks to establish
standardized knowledge within the team and understand the business model and functions of the project.

12. To refer to innovation cases to process in company: The learning objectives were discovered from a variety of design management stakeholders, including designers, engineers, and start-up CEOs. It means learning how to design essential product development processes or new models from other companies, learning about the growth of business plans from other companies, or how others work.

13. To get motivation and utilization of research from case studies: There are cases for finding research opportunity is considered. Design management related cases can be used as ideas or motivation for research or for conducting research.

14. To understand the flow of academic theory and change: The objective was to find out the limitations of existing knowledge or to suggest a new model through the process of understanding the changing aspects of academic theories.

15. To understand concepts in the field of design: This learning objective was found from the design management stakeholders, most of whom had management background. Executives often look up design terms, so that they understand the terminology and use it correctly.

16. To understand the role of design and designers: This included how managers themselves are involved in the process, or other stakeholders understand the role of designers in the company to engage strategically in design management.

17. To effectively communicate with managers and designers in the company: This is included that experience of accepting, evaluating, and communicating with others in order to gain new ideas or understanding how the designer understands the market situation and the competitive environment and how to work with the right partners in the organization.

18. To understand different perspectives in other fields: It includes theoretical models based on understanding of the management area and the design domain. Many researchers identified the same research topic in both design and management fields in order to link both discipline.

19. To understand the actual results realized from design management theories and applying them to the project: The learning objective is to know and apply the elements of the theory in order to understand the actual practice. It also includes an understanding of how the theories and concepts learned appear in practice.

20. To acquire tacit knowledge through design activities: It is a learning opportunity through the practice, to experiment with the process, or to learn the new skill by actually training creatively through the project.

21. To understand theories of design management applicable to research: This includes other researchers' understanding or theories, or to be concerned about the research direction from the research by other researchers.
Structure of Learning Objectives

The learning objectives extracted through the content analysis are important elements to identify in designing a needs-based DMK platform. To provide knowledge according to learners' needs, learning objectives should be deployed as anchoring points through which appropriate knowledge content can be provided. It may not be appropriate to provide content by considering all the learning objectives extracted through content analysis. However, grouping the learning objectives could help to achieve the learners' goal of learning DMK. Therefore, in this study, the 21 learning objectives were grouped according to content similarity and summarized the final goals of the learners wanting to learn the knowledge.

Figure 2  Structure of Learning Objectives

1. Understanding of other fields
Understanding the other fields is a goal to see the convergent characteristics of design management knowledge. The learner with a design background wants to learn the skills and viewpoints of a business, and the learner in management or engineering field would want to experience design through design activities. Because learners with management backgrounds do not know much about the design field, it is important to understand the concept of design in the field of design so they can work with the designer or use the design at the enterprise level. Likewise, many learners with a design background wishing to learn 'skills and perspectives on business' were found. This means that not only executives but also designers and design leaders have learning objectives to gain business-related knowledge.

Research
The goal of studying the knowledge of researchers in academia is to accumulate new knowledge. Therefore, to use other knowledge, they tried to hear opinions from cases or design-management practitioners. It should be understood that the goal of learning DMK for researchers is different from that of other people, and that the pattern of knowledge use is also different.

2. Innovation
Innovation and design management are inextricably linked. Practitioners directly refer to examples of innovation that have been made to achieve innovation. However, understanding the consumer and finding a design opportunity to change the market can...
be interpreted as part of the activity to achieve innovation with a company's products and services. It is also an activity for the company to think about and learn about the organizational culture for creative ideas.

3. Communication within teams

The design process is working with various stakeholders, but their backgrounds are different. However, as they work on the same team, the goal is the same. They want to learn the knowledge to achieve the goal of enhancing communication within the team. This means not learning about other areas and understanding each other, but setting the direction of the project at the team level or sharing the same knowledge in common within the team. It is also within the team to learn how managers and designers who are very different from each other communicate effectively.

4. Strategic use of design

There may be learners who do not know the value of the design. They need to understand the value of design and the role of designers. However, they may not recognize their needs for learning DMK. Therefore, a needs-based learning platform should help them realize why they should acquire DMK in the first place. It is also an objective that is directly related to the goal of strategic use of design in the company.

**Design Criteria for Needs-Based Learning Platform**

As a first step towards designing a needs-based learning platform, this study identified DMK learning objectives. It is necessary to design the knowledge platform from the specific perspectives of the prospective learners rather than those of a general stakeholder. A need-based learning platform is needed to identify design-management stakeholders firstly and provide new knowledge based on their needs. Therefore, in this study, general design criteria for a needs-based learning platform were constructed with possible implications that can be derived from the research findings.

- Learner needs do not exist by themselves and need to be reorganized as a fictional character to design a needs-based learning platform. Personas should be constructed by combining the complex needs of learners in a comprehensive way. The persona should include various needs for knowledge acquisition as well as learning objectives.
- When a learner uses a learning platform, it should have a function that recognizes what type of learner is about to use the platform. If the learner corresponds to a persona, then he/she is led through a learning path appropriate for their needs and acquire the knowledge they need.
- DMK contents can be classified as learner needs and goals. The classification of the knowledge can be provided to a needs-based persona.
- The knowledge content will be able to provide based on the application of knowledge and their current design-management activities. The form and attributes of knowledge they want to learn differ when they acquire knowledge for research and when they actually do design management activities.
Conclusion
Design management is of a cross-functional and multidisciplinary nature. As such, design management has various domains as well as target learner groups with different needs for DMK. The research focused on the upstream research phase as a new way of learning DMK based on target learner needs, establishing a design criteria for a needs-based learning platform.

Major Findings
Firstly, a definition and scope of design management was found through the literature review. DMK is defined as knowledge related to the design-related organization, design vision and strategy, process-using design, environment for design, and designer resource management.

Secondly, it was found that learner attributes, such as prior knowledge, interest, and motivation, have impacts on learning, and these are constituted by different perspective on design management. The findings imply that learner needs in DMK are critical factors that need to be considered in developing DMK learning platforms.

Thirdly, learning objectives are identified as a first step in discovering their needs. 21 learning objectives with different learners in academia and industry are extracted and grouped through a content analysis from the design management literature.

Fourthly, understanding other fields, research, innovation, communication with team, and strategic use of design were found to be the main goals in DMK learning.

Lastly, the design criteria of a needs-based learning platform were proposed. Learner needs serves as a mechanism by which needs-based knowledge providing can be created.

This research makes a contribution by extracting and systemizing learning objectives to be used as a basis for a needs-based integrated knowledge platform. Understanding the learning objective is the first step in understanding how a learner learns DMK. Also, it is a new approach to understand design-management stakeholders from the perspective of learning. This will make a good case for adapting the platform for other multidisciplinary education in the future.

Limitations and Further Studies
For the purpose of this paper, learning objectives for DMK were extracted from design-management literature as a first step toward an understanding of learner needs. The learner needs could be further refined and identified in empirical studies such as interviews or user research. This will help provide special features to attract potential and unaware target-learners of DMK due to its multidisciplinary nature.

References


About the Authors
Gye Young Kim is a Master graduate of Designize Lab in ID KAIST. She received her master degree for the thesis about typology of learner needs for design management knowledge. She recently works for start-up as co-founder.

Dr. Ki-Young NAM is Associate Professor of Dept. of Industrial Design, KAIST and Director of Designize research lab bringing design values to areas beyond traditional boundaries of design including social innovation, policymaking, Product-Service Systems and Knowledge-learning. He disseminates research internationally.

Dr. Brigitte Borja de Mozota is emeritus professor in management science in Universite´ Paris X Nanterre. Her research specializes in design management. She is the founder of Designence consultancy in Paris.
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Increasing Knowledge Seeking Initiation based on Theories of Human Behaviour

CARRO SAAVEDRA Cristina*; OCON GALILEA Alicia and LINDEMANN Udo

Technical University of Munich, Germany
* Corresponding author: carrosaavedra@pe.mw.tum.de

This paper presents a model to understand the factors influencing the initiation of knowledge seeking by designers. The initiation of the knowledge seeking process is usually let to the will of designers, who most of the times do not come to the idea of looking into knowledge repositories or who decide not to do it. Understanding their motivations, practical actions to increase knowledge reuse can be derived. The model is based on theories of human behaviour and it considers factors from three main influent areas: social, technological and psychological. The paper discusses the implications of the model for the preparation of the phases of the Knowledge Reuse Cycle.

keywords: knowledge seeking; knowledge reuse; theories of human behaviour

Introduction
In the current dynamic economy, knowledge is considered a key resource, which organizations require in order to sustain strategic advantage in an increasingly competitive world (Davenport & Prusak, 1998). That is the reason why knowledge management has received much attention in practice and research. Effective leveraging of knowledge resources ensures that the right knowledge is available to the right people at the right time during product design, improving the quality of decision making and avoiding the tendency of organizations to repeat the same mistakes.

Knowledge reuse is the process by which individuals use knowledge generated by other individuals within their companies in order to be more effective and productive in their work (Alavi & Leidner, 1999). Although design companies are reasonably good acquiring knowledge, the application of the codified knowledge stored in companies’ repositories in
form of documents is complex, and just having a repository does not guarantee its reuse (Kankanhalli, Tan & Wei, 2001).

Previous studies in this field concentrate their efforts on how to acquire and document knowledge, forgetting the relevance of the moment of reusing, which is the last step to complete the cycle and give meaning to the whole process (Schacht & Maedche, 2016). The decision of using the content of a knowledge repository is usually let to designers, who most of the times do not come to the idea of using it or do not have the adequate support to do it efficiently. Therefore, the process of knowledge seeking is not initiated and knowledge repositories are scarcely used, which implies a poor utilization of the company’s resources.

Adopting a Design Thinking approach and thus focusing on the knowledge user and his/her requirements, knowledge reuse could be better supported. The goal of this paper is to gain understanding on designers’ motivations to initiate the action of knowledge seeking. In order to do that, we reviewed the main theories of human behaviour and based on them, we propose a model to understand the factors influencing knowledge seeking initiation. The implications of the model for the preparation of the phases of the Knowledge Reuse Cycle are discussed.

The paper is structured as follows. As initial situation, the concepts of knowledge management and reuse are defined, the design thinking perspective on knowledge management is discussed and the Worker-Centred-Model is presented. Then, the objectives of the paper and the research approach are introduced. Subsequently, the reviewed theories of human behaviour are described. Based on those, we propose a model of factors influencing knowledge seeking initiation. Then, we discuss the significance of the model for the Knowledge Reuse Cycle. The paper finishes with the conclusions and further work.

Initial situation

Knowledge Management, Reuse and Seeking

The discipline of Knowledge Management (KM) has the goal of “improving organizational capabilities through better use of the organization's individual and collective knowledge resources” (Probst, Raub, S. & Romhardt, 1999). Probst et al. define the eight as the main activities of KM: establishing the knowledge goals, knowledge identification, knowledge acquisition, knowledge development, knowledge distribution, knowledge usage, knowledge protection and knowledge evaluation.

Knowledge management can address two different types of knowledge. On one side, it allows to manage the codified knowledge which is contained in files and documents (codification approach). On the other side, it can support to manage the oral transfer of knowledge between persons in an organization (personalization approach). An organization can implement only one or both of the KM approaches combined.

The term knowledge reuse receives two interpretations in literature. It can be considered as one of the activities of KM, referring to the moment in which individuals perform reuse, or it can be considered as the complete process which is necessary to end up reusing. Markus (2001) depicts this paradox presenting the Knowledge Reuse Cycle of Figure 1,
which consists of four stages, in which one of the stages is called reusing: 1) capturing or documenting knowledge; 2) packaging knowledge; 3) distributing or disseminating knowledge (providing people access to it); and 4) reusing knowledge.

![Knowledge Reuse Cycle and the steps of the reusing phase. Source: Markus (2001)](image)

Knowledge seeking is the activity in which a designer during his work proceeds to search for knowledge in the organization. The designer can search for documented knowledge in the electronic repositories or for a contact person. The knowledge seeking embraces the steps “locating experts or expertise” and “selecting an appropriate expert or expertise” of the stage reusing of the Knowledge Reuse Cycle presented in Figure 1. Without knowledge seeking, knowledge application cannot take place.

**Design Thinking: another View of Knowledge Management**

The Design Thinking (DT) approach proposes the wide application of a design perspective as a potential source of sustainable competitive advantage (Martin 2010). Designers are used to solve open complex problems and still find the way to solve them. The key of DT is the understanding of the user and his/her requirements.

The successful implementation of knowledge management in industry is still a goal to achieve. Even if the KM structures and processes have been implement in the company, this does not assure that they will be used (Schacht & Maedche, 2016). The final decision on reusing knowledge depends of designers.

Adopting a DT approach to face the problem of KM implementation in organizations may help to understand better the reason for this phenomena and it will be possible to find solutions for it. The key is on understanding the designers’ motivations for knowledge seeking and understanding what can be done in the preparation of the stages of the Knowledge Reuse Cycle in order to motivate designers to seek for knowledge, which will lead to knowledge application.

**The Worker-Centred-Model**

Following the idea of placing the knowledge user in the centre, the Worker-Centred-Model (WCM) was developed. The WCM is a unified model, in which the knowledge worker is the centre of the knowledge processes (Carro Saavedra, Fernandez Miguel &
Lindemann, 2015). Under the term knowledge worker we understand an employee, whose main capital is its knowledge.

As it is shown in Figure 2, the model considers the three processes of knowledge transfer, integration and creation, and application, and presents the factors that affect each process (Fernandez Miguel, Carro Saavedra & Lindemann, 2016). Whereas knowledge transfer is influenced by factors related to the company’s infrastructure, knowledge creation and integration is influenced by factors related to the knowledge itself and knowledge application is influenced by psycho-social factors.

In particular, the psycho-social factors are directly related to human behaviour. It is the category covering the most number of them and where several aspects remain open for discussion. Twelve factors are identified, which are: perceived risk, perceived benefit, knowledge as power, commitment, trust, workload, personal relationships, culture, personality, social skills, mind openness and past experiences. Those factors influence knowledge application by influencing the user’s engagement and motivation to initiate the search for knowledge in the organization.

![Figure 2](image)

**Figure 2  Overview of the worker-centred model. Source: Fernandez Miguel, Carro Saavedra and Lindemann (2016)**

The WCM does not depict the relations between factors despite they are highly interrelated. It is unknown which factors influence in the first place creating a chain effect and which factors are a dependent of others. The identification of the initial influencing factors is a necessary step in order to derive practical actions for the company to modify them according to the interests for knowledge reuse.
Objectives and research approach

The aim of this research is to understand the designers’ motivations behind initiating the action of seeking for knowledge in company’s repositories and, based on the gained understanding, derive practical actions to increase knowledge seeking initiation. Three objectives are derived:

- Develop a model to understand the factors influencing the initiation of the search for documented knowledge. The model should depict the relations between factors.
- Determine which influencing factors are related to which stages of the Knowledge Reuse Cycle.
- Determine guidelines for the planning of the stages of the Knowledge Reuse Cycle in order to promote the knowledge seeking initiation.

Our research approach is to review well-established theories of human behaviour in order to collect the factors influencing individuals’ behaviour, considering the behaviour in this case, the initiation of the knowledge seeking process. The research procedure is structured in four phases, presented in Figure 3.

First (step 1), we searched for publications in Google Scholar and University Library between 2000 and 2016 that contained the combination of words “knowledge reuse” and “knowledge seeking behaviour”. The next step was to identify the most relevant ones as the core of this study, taking into account the following requirements:

1. Studies in the knowledge management field.
2. Studies which factors are related to human behaviour.
3. Studies that consider knowledge seeking behaviour.
4. Studies addressing explicit knowledge stored in knowledge management systems.
5. Studies that validated their results.

Seven publications fulfilled all the requirements and they were therefore selected.
The selected publications presented models to describe knowledge seeking behaviour based on several theories of human behaviour. We reviewed those theories in step 2 and we concluded that none of the models presented in the publications considered a combination of the theories. Therefore, in step 3, we developed a model based on the combination of the reviewed theories and finally (step 4) we define the contributions of the new model to plan the Knowledge Reuse Cycle.

Theories of human behaviour
The ten theories found can be classified in three categories. While all of them aim to represent influences on human behaviour, there are some differences among the three groups. The first group addresses the emotional and motivational characteristics of individuals, the second group is related to technology usage, and the last group places the individual as an element of a system. The theories and their classification are shown in Figure 4.

![Figure 4 - Overview of theories of human behaviour](image)

**Psychological theories**
These theories involve the study of human behaviour based on the hypothesis that humans are rational, so they try to predict their behaviour related to his attitude and beliefs, as the behaviour of individuals is influenced by its intention.

The theory of planned behaviour was developed in order to make some improvements to the theory of reasoned action -which only took into account the factors attitude toward behaviour and subjective norm- adding the factor perceived behavioural control. This explains that the specific behaviour of individuals is determined by their intention to perform the behaviour, and this intention is at the same time influenced by these three factors, as shown in Figure 5.

- **Attitude toward behaviour** is “the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behaviour in question” (Ajzen, 1991, p. 188).
- **Subjective norm** is “the perceived social pressure to perform or not to perform the behavior” (Ajzen, 1991, p. 188).
• Perceived behavioural control is “the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles” (Ajzen, 1991, p. 188).

![Figure 5](image)

*Figure 5  Theory of planned behaviour. Source: Ajzen (1985)*

The continuation of the theory of planned behaviour is the decomposed theory of planned behaviour. This theory divides the three antecedents of behavioural intention into a set of beliefs. The factors underlying human attitude toward behaviour are compatibility, perceived ease of use and perceived usefulness. The influence of the subjective norm is decomposed into superior and peer influence. While perceived behavioural control is divided into perceived personal ability, such as self-efficacy, and external source constrains and facilitators, such as technology and resource facilitating conditions.

In the expectancy theory the author introduces three variables — expectancy, instrumentality and valence — to explain why individuals choose one behavioural option over others since the motivation of the individual behaviour is determined by the desirability of the outcome. Expectancy is the belief that one’s effort will result in the achievement of a desired outcome; instrumentality is the belief that one will get something for achieving the outcome; and valence refers to the value the individual places upon the expected outcome.

**Techno-psychological theories**

This category attempts to address the factors underlying human attitude toward technology usage, modelling how users come to accept and use a technology system. The technology acceptance model adapts the theory of planned behaviour to explain the attitude toward information technology usage, which is the effect of the combination of two factors, as shown in Figure 6.

• Perceived ease of use is “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p. 320).
- Perceived usefulness is “the degree to which a person believes that using a particular system would enhance his or her job performance” (Davis, 1989, p. 320).

Figure 6  Technology acceptance model. Source: Davis (1989)

The technology acceptance model has been continuously studied and expanded. As a result, the technology acceptance models 2 and 3 have also been proposed. They focus on expanding the number of determinants that affect perceived usefulness and perceived ease of use. In the technology acceptance model 2 perceived usefulness is influenced by subjective norm, image, job relevance, output quality and result demonstrability; while experience and voluntariness act as modifiers of behavioural intention. In the technology acceptance model 3 perceived ease of use is influenced by anchor variables as computer self-efficacy, perceptions of external control, computer anxiety and computer playfulness, and adjustment variables, for example, perceived enjoyment and objective usability.

The unified theory of acceptance and use of technology is a technology acceptance model that combines four core determinants of usage and intention — performance expectancy, effort expectancy and social influence are direct determinants of the intention, while facilitating conditions is a direct determinant of usage behaviour — alongside with four moderators -gender, age, experience and voluntariness of use.

Social theories
They explain actions and organizational behaviour taking into account the individual within a society, and explore social relationships as an important factor in understanding how the individual behaves. In societies, the individual contributes out of free will to an organization or to another individual as a gesture of goodwill, either expecting that this contribution will be reciprocated in the future, or to fulfil a profit resulted from a past exchange.

The social exchange theory was introduced to explain social change and stability as a process of negotiated exchanges between different parts where the combination of rewards and costs drives individual decisions. Costs are the elements that have negative effect and can come in many forms such as time, money or effort. Rewards are the elements that have a positive effect and can be sense of acceptance, support or social recognition.

The social capital theory considers seven dimensions of social capital, which are: group characteristics, generalized norms, togetherness, everyday sociability, neighbourhood connections, volunteerism and trust. All these dimensions can be manifested in various combinations and they shape the interaction amongst the members of a group, organization or community. These social networks and the set of sources within it have a
high influence in the individual’s social behaviour, and this influence provides benefits that work to the advantage of the individual.

**Individual factors influencing knowledge seeking initiation**

This section presents a model as a basis for understanding and structuring the influencing factors collected from the literature review. Also to comprehend which are the factors that in the first instance affect human behaviour and that can be influenced, applying the appropriate methods, to modify the behaviour of the individuals.

The publications selected in step 1 of our research procedure do not address all possible factors related to human behaviour at the same time. As it can be observed in Table 1, none of the publications is based on theories from the three identified categories at the same time.

<table>
<thead>
<tr>
<th>Publication</th>
<th>Theories used</th>
<th>Category</th>
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<tbody>
<tr>
<td>Kankanhalli, Tan and Wei (2005)</td>
<td>Technology Acceptance Model</td>
<td>Techno-</td>
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<tr>
<td></td>
<td>Theory of Planned Behaviour</td>
<td>psychological</td>
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<tr>
<td>Sharma and Bock (2005)</td>
<td>Decomposed Theory of Planned Behaviour</td>
<td>Psychological</td>
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<tr>
<td>Watson and Hewett (2006)</td>
<td>Expectancy Theory</td>
<td>Psychological</td>
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<td></td>
<td>Social Exchange Theory</td>
<td>Psychological</td>
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<td></td>
<td>Decomposed Theory of Planned Behaviour</td>
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<td>Desouza, Awazu and Wan (2006)</td>
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<td>He and Wei (2009)</td>
<td>Theory of Reasoned Action</td>
<td>Psychological</td>
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<td>Theory of Planned Behaviour</td>
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<td></td>
<td>Unified Theory of Acceptance and Use of Technology</td>
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<td>psychological</td>
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<tr>
<td>Tsai, Zhu, Ho and Wu (2010)</td>
<td>Technology Acceptance Model 3</td>
<td>Techno-</td>
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<tr>
<td></td>
<td>Social Capital Theory</td>
<td>psychological</td>
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</table>

We propose the development of a model that combines factors from three identified influencing areas: social, technological and psychological. For the development of the model, we reviewed the influencing factors presented in the models of the seven literature papers and we proceeded as follows:
1. Identify duplicated factors with the same denomination and consider them only once.
2. Group similar factors taking into consideration their definitions (e.g. “organizational support” and “resource availability” were grouped under “facilitating conditions”).
3. Eliminate factors which influence has not been validated in the original source (e.g. “knowledge growth”). If the factor influence was validated in one source, but not in others, the factor is also considered.

Thus, we came up with 16 influencing factors. The factors and their sources, as well as the validation of their influences in the reviewed literature are presented in Figure 7.

Looking at the rows, it can be observed that the most complete models are proposed by Sharma and Bock (2005) and Tsai, Zhu, Ho and Wu (2010), since they are the ones that include a larger number of factors. Furthermore, most of their hypotheses are fulfilled, and that is why these papers are the ones that provide a larger number of relevant factors to develop our model.

Looking at the columns, the factors that most authors take into account are facilitating conditions, perceived ease of use and perceived usefulness. While facilitating conditions and perceived usefulness are always shown in all the papers as relevant, perceived ease of use does not fulfil the hypotheses in half of the papers. It is consistent with the results of the technology acceptance model study, where it is showed that perceived usefulness was the principal driver of intention while perceived ease of use proved less influential (Davis, 1989).

Habit only appears as a factor in one of the papers. But it is indirectly mentioned in several of them and will be treated as one of the most relevant factors influencing knowledge reuse. The lack of consideration of this term as a factor can be due to the fact that it does not appear in any of the theories on which are based the papers to extract their factors, since habit is not considered as behaviour but an automatic response. As it is argued by He and Wei (2009); “The more usage is performed out of habit, the less intentional behaviour is involved”.

Just like with the theories, we assigned the psychological, techno-psychological and social categories to the factors. All factors were allocated in one of these categories, except of the habit, which was considered as not belonging to any of them. As it is shown in Figure 8, the three categories indirectly affect the behaviour through the intention, except of the habit, which affects directly the behaviour, which is also a direct function of intention.

The theory of planned behaviour and the technology acceptance model are the core model of their correspondent categories. Therefore, we used these models as reference to allocate the influencing factors. Figure 9 shows the proposed model to represent individual factors influencing the initiation of knowledge seeking.
In our case, the behaviour is the initiation of knowledge seeking, i.e. the process of searching in the electronic knowledge repositories (EKR) of the company.

Based on the theory of planned behaviour, all the factors — except habit — are related to the intention through the attitude toward behaviour (attitude towards knowledge reuse), subjective norm and perceived behavioural control, so the combined effect of these three factors determine the individual intention to initiate knowledge seeking.

The model also adopts the factors of perceived ease of use and perceived usefulness from the technology acceptance model. In this particular case they are described as perceived ease of use of EKR and perceived usefulness of the EKR. They are considered determinants of the attitude towards knowledge reuse together with perceived relative advantage of reusing knowledge and perceived risk of reusing knowledge.

- **Perceived relative advantage of reusing knowledge** is “the gain one receives from accepting a new idea or innovation over what was previously conducted” (Desouza, Awazu & Wan, 2006, p. 39).

- **Perceived risk of reusing knowledge** is the feeling of uncertainty regarding possible negative consequences of using knowledge management systems (own definition based on Featherman & Pavlou, 2003).

At the same time, perceived output quality is included in the model as an antecedent of perceived usefulness of EKR, and perceived enjoyment and self-efficacy as predecessors of perceived ease of use of EKR.
• **Perceived quality of the knowledge** is the quality of the knowledge delivered by the system (own definition based on Tsai, Zhu, Ho & Wu, 2010). “Key dimensions of perceived output quality are the relevance, reliability, and timeliness of knowledge embedded in the output” (Kankanhalli, Tan & Wei, 2005, p. 1158). The quality can refer to the knowledge itself and how good it is documented, or it can refer to the ability of the system to provide the right knowledge for the user’s situation.

• **Perceived enjoyment using the EKR** is “the extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use” (Venkatesh, 2000, p. 351).

• **Self-efficacy** is one’s belief about his or her ability to perform a specific task using a computer (own definition based on Compeau & Higgins, 1995).

If designers perceive that they will be able to easily obtain useful knowledge that can enable them to accomplish their task more effectively, they are likely to be motivated to reuse knowledge from the system.

**Subjective norm** is influenced only by social factors presented in the Social Capital Theory. In this category are included collaborative norms, social relationship and trust.

• **Collaborative norms** is the degree of consensus in the social system, when the actions of people are influenced by the unified beliefs of the community to which they belong (own definition based on Kankanhalli, Tan & Wei, 2005).

• **Social relationship** is “an individual’s perception of other knowledge management system’s users with whom the person has social interactions” (He & Wei, 2009, p. 829).

• **Trust** is the extent to which a person believes in the good intent, competence and reliability of others (own definition based on Tsai, Zhu, Ho & Wu, 2010).

The actions of an individual are influenced by the unified beliefs of the members in the company. If people around are used to reusing knowledge and there is a culture in the organization that promotes it, the employee will see knowledge reuse as a regular practice and will be more likely to do the same and reuse knowledge.

**Perceived behavioural control** is determined by the factors of facilitating conditions and perceived knowledge asymmetry.

• **Facilitating conditions** “reflects the availability of resources needed to engage in a behaviour” (Taylor & Todd, 2005, p. 150). “Required resources that are likely to facilitate technology usage include time, availability of technology, training, and management support” (Bock, Kankanhalli & Sharma, 2006, p. 361).

• **Perceived knowledge asymmetry** is “an individual’s belief regarding their lack of information about the knowledge sought from the EKR” (Sharma & Bock, 2005, p. 10).

Both in the theory of planned behaviour and in the technology acceptance model, **intention** is defined as the only immediate antecedent of **behaviour**. But in this model, also habit is included in the model and presented as another determinant of behaviour. Therefore, behaviour is, according with this model, partly a function of the behavioural intention and partly of the frequency of past behaviour.
• Habit is “a recurrent, often unconscious pattern of behaviour that is acquired through frequent repetition” (The American Heritage Dictionary of the English Language, 2011, p. 787).

Discussion: significance of the new model for the Knowledge Reuse Cycle
The identification of the facilitators and inhibitors from an individual’s perspective is a key to understand the requirements for improved methods of knowledge management that support more extensive and efficient knowledge reuse. The proposed model provides an overview of which factors related to human behaviour should be taken into account in order to increase the initiation of the knowledge seeking, which will lead in the increase of the knowledge reuse.

The model has not been empirically validated, but we defend its validity, since it is based on a synthesis of empirically validated models. Furthermore, we do not attempt to have developed the ultimate model, but we see the model as a practical tool which shows a wide number of factors and which can be used as a base for the individual analysis of different individuals in different companies, which will be influenced by different factors of the model.

The presented influencing factors can be associated to the stages of the Knowledge Reuse Cycle. Taking into account the factors considered in the new model, guidelines to prepare the stages of the cycle can be derived.

As preparation the stage “Packaging”, the factor perceived ease of use of EKR is of high relevance. It can be guaranteed structuring the knowledge base in a comprehensible and organized form. Furthermore, the system should be stable, robust and available whenever it is needed, so that all the employees trust in the system and its reliability.

For the stage “Capturing and documenting”, it is important to take into account the factors perceived ease of use of EKR and perceived usefulness of EKR. Perceived ease of use of EKR can be enhanced by encouraging the employees to contribute to the process of filling the knowledge base with their own knowledge. This way, they will feel more satisfied and confident, which is positively related to perceived enjoyment of using the EKR, and also more comfortable using the system, which is positively related to self-efficacy. Perceived usefulness of EKR can also be intensified by ensuring that the output from the knowledge repository has a certain quality degree (increasing the factor perceived quality of the knowledge), trying to avoid the possible high quantity of outdated knowledge and by exercising strict quality controls. To assure the right update of the knowledge base by the employees it is also necessary to include the factor habit. To promote this, it is relevant to provide enough slack time and to avoid time pressure. To achieve this goal a measure that can be carried out is to integrate the update of the knowledge base in regular work practices, in a way that the time required to contribute with knowledge to the system can be built into daily work schedules.

The stage of “Reusing” is highly affected by facilitating conditions, that can be fostered through correctly and clearly defining the design situations. The number of design situations and types of knowledge in each reuse situation should be adequately dimensioned in order not to complicate and expand the time spent on the process. They also must be adapted to all the employees in the company to capture the particular
circumstances of each one. Furthermore, perceived ease of use of EKR should be increased, making the system easy to access, because employees will use them if they perceive that they will be able to easily obtain useful knowledge from them. In addition, if employees believe that the output from the knowledge base is of high quality, in terms of relevancy, reliability and time, they will be willing to reuse knowledge from the system and it will affect perceived usefulness positively. The goal is to increase the perceived relative advantage of reusing knowledge and to reduce the perceived risks. Possible perceived risks should be individually analysed and the means for overcoming such perceived risks for employees should be implemented.

In order to support the stage “Distributing” the social factors can be intensified by fostering the social ties between the employees within the organization; it will induce them to trust more not only their co-workers, but also the quality of the knowledge stored in the system reducing the perceived information asymmetry. Also the habit is here important because if employees are used to reuse knowledge, other co-workers unfamiliar with the usage of the knowledge base will be positively influenced in this practice and the likelihood of them using the system will increment. Facilitating conditions could be enhanced by management support, training and time availability, in order to inform employees about how to use efficiently the knowledge base, to provide the sufficient time to access and retrieve information and the benefits of reusing the knowledge stored.

Conclusion and further work
The main reason for individuals to be the centre of attention of knowledge management initiatives is that knowledge is not only originated by them, but also used by them. However, the factors influencing the designers’ decision towards the reuse of documented knowledge have not been extensively analysed.

The proposed model gives a clear overview of which factors related to individuals should be taken into account to increase the initiation of knowledge seeking during product design. Above all, it identifies the habit as the main factor influencing knowledge seeking behaviour. Secondly, it reveals the importance of the psychological and techno-psychological factors, highlighting the relevance of perceived ease of use, perceived usefulness and facilitating conditions, composed by management support, time availability and training. While social factors of collaborative norms, social relationship and trust appear as factors less relevant. By paying more attention to these factors in the design of the knowledge management systems in organizations, they will be able to obtain more benefits from knowledge reuse, a process that is becoming more important for firms in the growing number of companies related to engineering design.

Some limitations of the presented work, which derive in suggestions for further work, should be discussed. Firstly, the theories used to construct the model consider the individual’s behaviour as rationally intended. Factors other than those prescribed by these theories may also affect human decisions to use knowledge management systems. Although habit has already been included in our model in order to fulfil this concept, it is not the only factor, but there are more characteristics that contemplate this irrationality and inherent component. These characteristics could be examined in future research and also included in the model considering that being negligible does not mean being non-
existent. Secondly, for the success of knowledge transfer via knowledge management systems it is needed a combination of creating knowledge in the system and using the knowledge from the system to reuse it. In the study proposed by Watson and Hewett (2006), it is argued that knowledge contribution and knowledge reuse are two very different types of behaviour, and thus they should be studied separately. In this thesis we have focused only on the intention of reusing, not including knowledge contribution or the reuse itself. In order to obtain an integrated view of knowledge sharing through knowledge management systems, knowledge contribution and the process of reusing should also be studied.

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About the Authors

**Cristina Carro Saavedra** is a PhD candidate at the Chair of Product Development since 2013. She graduated in Mechanical Engineering at Universidade de Vigo in Spain. Her research focuses on knowledge management and reuse during product development.

**Alicia Ocón Galilea** is a graduate student at the Technical University of Munich who has just finished her master thesis at the Chair of Product Development. She studied Mechanical Engineering and Architecture at Polytechnic University of Catalonia.

**Udo Lindemann** is Professor emeritus of the Chair of Product Development, co-editor of several international journals and founding member and Fellow of the Design Society. He was the head of the Chair in 1995-2016. Research area is systematic product development.
An exploratory study of older customers’ holistic supermarket shopping experience in China

YIN Yuanyuan\textsuperscript{a}; SONG Qiu\textsuperscript{b} and RANCHHOD Ashoka\textsuperscript{a}

\textsuperscript{a} University of Southampton, United Kingdom
\textsuperscript{b} Tsinghua University, China

* Corresponding author: y.yin@soton.ac.uk
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This research investigated difficulties and challenges that older customers face in a supermarket environment in China, so as to understand the way in which the supermarket environment and service can improve older customers’ shopping experience. An ethnographic user study, which combines video-based direct observations, in-depth interviews and a cultural probe information gathering pack, has been employed to explore Chinese older customers’ supermarket shopping experience. 30 Chinese senior citizens above 65 years of age and able to undertake their own shopping at least once fortnightly participated this project. Research results show that a shopping experience design should not only concentrate on in-store shopping, but on a holistic shopping experience that includes shopping preparation, journey to store, in store shopping, journey back to home and after shopping at home. This flow and journey needs to be understood and addressed when designing a supermarket service for older customers. The supermarket shopping related issues that older Chinese customers face have been summarised, reported and discussed in the paper.

\textit{keywords:} supermarket service design; older Chinese customers; ethnographic user study
Introduction
The population of the world is ageing. The number of people classified as old in the world could rise to over 2 billion by 2050 (ONS, 2013). As the biggest economy in the world, it has been forecast that China will see an increase of 22% in the proportion of people aged 60 years and over, from 13% (185 million) to 35% (487 million) of the total population between 2012 to 2053 and this increase will be the fastest in the world (World Population Ageing Report, 2013).

Because of this substantial global demographic shift, numerous studies have been conducted to improve ageing people’s quality of life from multiple perspectives such as public service, transportation services, health and social care, product and service design, and the pension system (Stewart et al., 2014; Li et al., 2012; Kim et al., 2011). Among these studies, many researchers have highlighted the importance of shopping in older people’s day-to-day life and have discussed older customers’ shopping behaviour and retail needs (Yin et al, 2013; Thompson et al., 2011; Meneely et al., 2009). Several researchers have identified characteristics of older customers’ shopping habits that differentiate them from their younger counterparts, such as decreased price sensitivity, preferences for quality products, a tendency to make joint buying decisions and greater levels of store loyalty (Kohijoki, 2011). These factors play a significant role on their shopping experience and satisfaction. Thus a better understanding of consumer shopping habits and behaviour within and between age cohorts can be used to inform the best types of service provision for the ageing shopper (Angell et al, 2012).

Although the findings from previous research on older shoppers are notable, research gaps still remain. Existing studies have improved the knowledge of older shoppers’ needs, but previous work has mainly focused on America (Lu and Seock, 2008), Australia (Worsley et al., 2011), New Zealand (Goodwin and Mcelwee, 1999), UK (Omar et al, 2014; Yin et al, 2013) and other and European countries (Kohijoki, 2011), whilst research in developing countries, such as China, has been minimal (Liu, 2014). Chinese older customers’ shopping habits and behaviours tend to be different compared to customers in the West owing to cultural and other differences, such as fewer Chinese older customers drive to stores, the rituals of morning exercise as well as diverse supermarket formats in China (Maruyama & Wu, 2014). Thus, in order to serve this market effectively, retailers need to develop a good understanding of older Chinese customers’ shopping habits, unmet needs and requirements for supermarket service. Therefore, this research aimed to investigate what challenges and difficulties that elderly Chinese consumers currently face during their supermarket shopping process, and how to improve supermarket service and environment from a design viewpoint.

Literature review

Older people in China
In China, the challenge of population ageing is an emergent area of concern with significant implications as the country enters a period referred to by some as ‘super ageing’ (Liu, 2014). This has raised several challenges for the Chinese government. For instance, the cost of home and social care for this demographic group and public services that support their living independence has increased dramatically in the past decade (Sun...
et al, 2014). Researchers have also noted that ageing encompasses social changes that lead the elderly to have different requirements and preferences to public services in their day-to-day life (Park & Farr, 2007). For instance, older people need to be more independent and rely more on public services compared to previous generations due to changes in family structure and domestic migration in China (Flaberty et al., 2007; Biao, 2006). As a result, based on the 2010 Chinese Census, Liu et al. (2015) have highlighted that the number of ‘left-behind’ elderly has been increasing; 31.8% of older people do not live in families and within that 15.4% live with a spouse and 16.4% live alone. Consequently, these older people cannot rely on traditional family care any more, having to take care of themselves and be more independent. Much research has emphasised the importance of supermarket shopping in older people’s life (Omar et al., 2014). It not only contributes to health and wellbeing, but also determines the older peoples’ sense of independence that has been considered to be mentally important to consumers as they become older (Brennan & Ritch, 2010). As most of the existing literature on older shoppers is focused on Western countries, it is necessary to explore and understand older Chinese customers’ supermarket shopping experience and their unmet needs towards supermarket service. In this study, therefore, the older customers have been identified as Chinese customers who are aged over 65 years old.

Retail environment in China
Retail formats in China can be categorized into two groups, traditional retail format and modern retail format. The former includes wet market, traditional grocery stores and specialty food stores (e.g. butchers, staple food stores and general stores), and the latter includes, convenience chains, small stores, supermarkets and hypermarkets (Maruyama & Wu, 2014). Some researchers have highlighted that although traditional markets such as wet markets are perceived as offering superior freshness, low price and the chance to barter and bargain, the traditional markets are usually untidy and less organized, with weak regulations and poor food safety which is often a major concern for consumers (Gorton et al., 2011). In contrast, modern format stores are often better managed and under government regulation so product safety is more likely to be guaranteed (Goldman et al., 1999). Thus, despite traditional markets/stores providing unique value to customers in China, more and more older Chinese customers prefer to conduct their shopping in modern supermarket stores (Cui & Liu, 2000). Thus, this study focused on an exploration of older customers’ supermarket shopping experience.

Supermarket shopping related issues that older customers face
Much of the research into this area has taken place within the western context and investigation within China has been minimal (Liu, 2014). Based on current knowledge, older people’s shopping experience is directly influenced by supermarket design. For instance, layout, lighting, product information, shopping facilities, accessibility, location, temperature, service, smell and ambience all play an important role in the shopping experience (Woodliffe, 2007). Despite recognizing the importance of this customer segment, previous research indicates that most retailers fail to provide this group with a satisfying shopping experience (Brown et al., 2008). In the light of this shortfall, recent research by Yin et al (2013) indicate that important shopping related factors can be classified within six categories: trolleys and baskets, store layout and aisles, shelves and
freezer, product related issues, customer service and checkout. For example, studies by Goodwin and McElwee (1999) also revealed that short queues, access to discounts, good customer service and easy parking were important factors for them.

Methodology

In order to investigate the supermarket shopping related difficulties and challenges that older consumers face in China, an ethnographic user study approach that includes video-based direct observation, in-depth interviews and a cultural probes information gathering pack were employed. This methodology was chosen, as it would support the researchers in studying people’s behaviour within a natural setting over a relatively long period of time. It also represents a dynamic picture of the lifestyle of the targeted elderly consumer group (Burns, 2000). The key feature of an ethnographic study is its capacity to view a phenomenon through the eyes of the user so as to discover the user’s needs (Hughes et al., 2004). Thus, it is very useful in designing service to satisfy the end-user, the elderly consumer in this case.

1) A video-based direct observation method was chosen because it supports the researchers in discovering and discussing the real, indisputable actions of the elderly consumer’s shopping behaviour as they occur (Berg & Lune, 2012). It helps the researchers to capture and fix ‘reality’ contextually.

2) An in-depth interview approach was also chosen because it offers a great opportunity for the researcher to understand individuals more deeply and to open up new dimensions of the problem and secure vivid information that is based on personal experiences (Easterby-Smith et al., 2002). It supported the researchers in understanding older customers’ emotional feeling, satisfaction and thought processes during their shopping process. During the interview process, the shopping video was used as a supportive reminder for the participants in recalling their shopping experience when it was necessary. Combining direct observations and in-depth interviews allowed the researchers to not only capture older shoppers’ natural shopping behaviours but also understand the reasons behind their behaviour.

3) Cultural probes are tools for collecting (usually qualitative) data. Also known as ‘diary studies’, or ‘design probes’ in design research, cultural probes are helpful for collecting data about people’s everyday lives over a significant time period and when the researcher cannot be present. This method has been used widely in user-centred design research, and has potential for use in social science too (Gaver, B. Dunne, T. & Pacenti, 1999; Mattelmaki, 2006). In this study, a cultural probes box, that includes instruction book, diary, shopping experience evaluation cards and some post-it, has been applied to explore the shopping experience from the participant’s viewpoint.

- Instruction book: how to use the box for data collection
- Diary: to explore impact of shopping in people’s day-to-day life
- Supermarket evaluation cards: to examine participants’ shopping experience
- Post-it: for extra notes

The sample size for the ethnographic study is normally smaller and can be varied based on research objectives and practical factors. Many researchers have suggested that often only a relatively small sample is needed for an ethnographic study. This can be between 5
to 30 participants (Bernard, 2002; Brown & McCormack; 2005). For this study, participants had to be above 65 years old and able to undertake their own food shopping at least once fortnightly. This ensured that they were mentally and physically capable of completing the research experiment. Participant recruitment information was disseminated through local ageing related groups, such as elderly clubs and elderly dancing groups. In total, there were 30 participants in the user study. Nanjing, Qingdao and Chongqing were selected as research regions for the user study because they have a comparatively high proportion of people aged 65 and over in China (National Bureau of Statistics of China, 2011). 10 participants from each of the three research regions were invited.

The user study was designed to last six weeks in order to balance richness of data collection and feasibility/availability of participants’ engagement. After older shoppers agreed to participate the user study, the researchers gave them a cultural probes box and gave an explanation on how to use items in the box to record their shopping experience. The participants were required to complete at least 4 diaries per week to record their daily activities that included both shopping related and non-shopping related events. With the intention of collecting a balanced feedback that covered most components of a supermarket service, shopping evaluation cards were designed with six weekly-based focuses, probing areas such as: Layout, baskets and trolleys; Shelving and product display; Products and promotions; Comfort and services; Customer service; and Checkouts. Under each of the six focuses, there were three shopping evaluation cards: List It, Dream It and Rank It.

- List it: to list issues of supermarket service and design
- Dream it: to describe how supermarket service and design can be improved
- Rank it: to score the current supermarket service with 1-5 starts

During the 6-week user study period, apart from the cultural probes pack, the researchers visited the participants twice for shopping observations and in-depth interviews. The participants were asked to conduct their shopping in a natural way and they were observed from a distance. A small size video recorder was used for data collection to reduce the level of unavoidable disturbing of video recording to participants’ shopping process. Immediately after shopping observations, the participants were interviewed to elicit their feelings and satisfaction levels. The interviews were conducted at a quiet and safe space such as the participant’s house, store office or a quiet coffee area. The interview was based on the participant’s shopping journey and experiences within the supermarket, without any set sequence of discussion. All conversations were based on the participant’s shopping experience. The observations took between 30 minutes to 1.5 hours and the interviews were between 45 minutes to 2 hours. In some instances, some participants were only visited once due to unexpected issues such as illness. Overall, the results from the user study data collection were based on 42 store visits.

**Data analysis**

Content analysis was selected as an analytical method for this project because it emphasises natural and empirical content rather than interpretative arguments. It has been seen as one of the most objective methods for the study of consumer behaviour and culture (Seale, 2004). The principal strength of this approach lies in the clear and
systematic study of qualitative content as a basis for analysis and interpretation. This methodology helps to bring out some of the subtler nuances of the older customers’ shopping behaviour that cannot be captured easily such as personal values and physical discomforts. According to Blaxter et al. (2001), the process of analysing data involves reducing the size and scope of information, translating this into a more useful form for the study. This was achieved through coding where the data was simplified, standardised and reduced into groups. Selection was then used to identify significant clusters to illustrate key points emerging from the research (Miles & Huberman, 1994).

Key Findings

Participants’ background
Among the 30 older customer participants, there were 13 males and 17 females. 20% (N=30) of the participants aged between 65-69 years old, 46%(N=30) aged between 70-74 years old and 33%(N=30) aged over 85 years old. 27 of the participants have self-reported as very good and good with regards to their health in general, 13 of them selected fair to represent their health situation. 4 of the participants live alone and the rest of them live with either spouse, Children or together. Most of them (73%, N=30) do grocery shopping between 2-6 times per week. Their average weekly spending on grocery shopping are evenly distributed, 30% (N=30) of them spent less than £20 on grocery shopping per week, 23% (N=30) of them spent between £21 to £49 and 27% (N=30) of them spent between £50 to £99.

Reasons to shop at supermarkets
The 30 participants in this study indicated that they normally do their grocery shopping at supermarkets and open markets stores. 20 of the participants highlighted supermarkets stores are their main grocery shopping venue as they believe that supermarkets provide a better shopping environment, good quality of food in terms of freshness and safety, a wide range of product selection, easy access by walking or public transportation service, good promotion deals and loyalty card service for saving money. For example, some participants indicated that, for certain types of foods such as milk, cooking oil, rice and meat, they only purchase them from supermarkets due to food safety concerns. They believe that supermarkets have a stricter product check policy than open market sellers and local stores, so they have a higher level of trust with foods from supermarkets. Many of them highlighted the fact that although prices are still important to them, they prefer to pay more for high quality foods, which are more important to their health and well-being. Many of the participants appreciate benefits of their store loyalty cards that help them to save a good amount of money on grocery shopping than other types of retail formats. 10 participants who have supermarkets as their second tier shopping venue explained that as food prices at supermarkets are higher than the open market they prefer to shop more at open market. In addition, they think they can get fresher vegetables from morning open markets at a cheaper price. The results show the current older generation has inherited a good habit of thrift from the previous generations. However, they are more concerned about the health and safety issues regarding foods. This finding shows that the current food safety issues in China due to illegal food additives and contamination with environmental hazards have influenced older customers’ confidence of foods quality
from open markets and local stores (Lam et al., 2013). It also reflects that the current older generation has greater purchasing power and is less likely to shop at discount retailers in the future, especially as they prefer a ‘high quality product and pleasant shopping environment’ (Hare, 2003). Food safety has been rarely discussed older customers’ supermarket shopping experience in the western context in the last decade. This may be because trust in the food safety of supermarkets has been established over a long period of time, making it less of a research area to consider. Schutz and Bruhn (1999) stated that 86% (n=592) customers are either completely or somewhat confident about the safety of food from supermarket. However, food safety is reported to an important concern in Asia, in countries such as Vietnam and Malaysia (Wertheim-Heck & Spaargaren, 2015; Siow & Sani, 2011).

**Preparation for shopping**

In order to have a smoother shopping experience, older customers normally take several assistive items with them to stores. For example, some participants indicated reading glasses are very important for their shopping as it would be very difficult for them to read labelling and product information without it. Other items have been mentioned include shopping list, shopping bags, foldable shopping trolley with wheels, mobile phone, keys, cash/wallet, travel card, store loyalty cards, shopping cards/gift cards and medicine for emergency use. Bad weather could change people’s shopping plans. One participant mentioned that ‘If the weather is not good, and it is raining, I will not continue with my plan to shop’. Almost half of them do not plan for shopping. This could be because they normally visit supermarkets several times during the week, so a planned large shopping visit is unnecessary. However, in the western context, Meneely et al. (2009) indicated that more than 70% (n=791) older customers plan their shopping a week ahead. Many of the participants mentioned that they go to supermarket not only for shopping but also to exercise, by walking there and by walking around the store. Most older customers take shopping as one of the most important social activities in the west (Smith & Sparks, 2000), but, very few of them view shopping as a physical exercise. 10 of the participants said they do prepare a shopping list before they go shopping due to their memory problems. Most of them prefer to have fresh food rather than keep foods for too long. One participant said, ‘we normally buy foods based on the next day meal plans. I would not keep the food for too long, as it may turn bad quickly’. Budget has also been indicated as a part of shopping preparation. Participants indicated that they would only take a certain amount of money they need for shopping as they worry that they may lose the money. One participant said ‘I know what I need to buy, I usually take £10 or £20 with me for the shopping’. Comparing with the western older customers, Chinese older shoppers prefer to use cash or gift cards for payment and very few of them use credit cards at the checkout counter.

**Journey between home and store**

40% (N=30) of the participants go to supermarket mainly by walking, 40% (N=30) of them mainly by buses, and the rest mainly cycle to shop. Due to mobility and health issues, public transportation is one of the key elements older customer consider when selecting shopping stores. Many participants mentioned that they prefer to shop with supermarkets that are close to bus stations rather than the nearest store. Some participants felt that
buses are safer than walking or cycling and they can have a rest on the bus during the journey. Some complained about the traffic light system that does not offer enough time for older people to cross the road. Furthermore, public bus service is free or cheaper for people aged over 60 years old depends on regions in China, this encourages older shoppers to take buses for shopping. Some other participants indicated they prefer walking to store, as this is a good way of exercise. One participant said ‘It takes me around one hour to walk to the store that I normally go to. My children suggested that I take the bus, but I think this is good to my health’. Participants who selected cycling think riding a bike is very convenient and helpful for this shopping journey. However, it is not easy to ride a bicycle with all shopping items on the way back home. Thus, some participants indicated that they would hang the shopping bags on the bicycle and then push it on the journey back. Store accessibility has been discussed within the western context. In Hare et al’s (1999) study, they found that the majority of their older participants who responded to store accessibility questions indicated negative experiences with transport and support. All the 30 participants in this particular study do not drive for shopping as they don’t know how to drive or have no access to a car in the household. However, in the western context, most of the older people drive for shopping, including people aged over 80 years old. For example, Meneely et al (2009) claimed that 29% (n=143) of their 80+ years old participants drive to a store for shopping.

In-store shopping
Issues of in-store shopping focus on trolley, basket, shelf and layout, promotion, customer service and checkout. For example, the participants complained that trolleys were hard to control, too big and too deep. They suggested that it would be better if a smaller sized and better-designed trolley could be provided. Many of the participants think that a shopping basket is too heavy to carry around the store and they prefer a basket with wheels and handle. Regarding shelf and layout, many participants complained about the difficulties in finding products due to poor navigation signage design, picking up products from the top and bottom levels of shelf, products and labels on shelf are not consistent, labels were too small to read and product display that kept changing. One participant said that ‘the shelf is too high, around 2 meters. It is impossible for me to pick up items from the top shelf’. Other older shoppers suggested that ‘heavy products such as cooking oil should be allocated on easy access shelf’. Participants also suggested using colour coding for store layout. Regarding promotions, many of the participants felt that prices for promoted products were confused, dates for promotion period was not clear and the quality of the promoted product might not good. Also, some participants indicated promoted products were always in a big package that was too large and too heavy for older people. Feedback to customer service was mainly focused on over-selling by sale assistants, lack of staff on the floor, impatience when answering an older customer’s questions and indifferent staff who ignored older people’s needs. They also felt that a shuttle bus can be improved to extend its service catchment area so older people can gain benefit this service. Participants further explained that some brands hired sale assistants to promote their products in store. These sale assistant always over-sell products and do not care if the product is right for older customers according to their needs. Issues with checkout include long queues, narrow checkout aisles, lack of staff at checkout, lack of friendliness at the checkout (no smiles) and no packing service. Many in-store shopping related issues that
arose within this study have also been reported from existing studies, for example, difficulties of using trolleys, shelf is too high or too low and package related problems (Omar et al., 2014; Angell et al., 2012; Kohijoki, 2011). This could be a result of human factors and physical limitations and less to do with cultural differences.

After shopping at home
Most of the participant expressed tiredness once they arrived home from shopping. Thus, many of them suggested that a supermarket should provide a ‘deliver to home’ service for older people. During the unpacking process, some of the participants put all shopping items into the right places such as the storage cupboard and fridge in one go; some other participants normally put all foods in the kitchen first for cooking and then allocate the rest of shopping items to the right places after cooking. After unpacking, many of participants reused plastic shopping bags as bin bags.

Suggestions to improve supermarket service
Based on the cultural probes ‘Dream it’ cards, many suggestions for improving supermarket service for older customers have been given. Some participants indicated that the current trolley design was not very user friendly to people with different heights. Tall people find it difficult to push the trolley, whereas short people feel that the trolley is too deep for reaching items on the bottom. They proposed that a trolley should have adjustable height that would satisfy different types of customers. One participant highlighted the safety issues of leaving personal items within a trolley. She said ‘I would not leave my bag in the shopping trolley as my wallet was in my bag’. She recommended that a personal locker should be designed on a trolley. Another trolley related comment suggested the addition of a brake on the trolley so customers could stop a trolley effectively and easily when they needed to. Some other participants commented that on the wheelie/pull-along shopping basket, the handle was too thin and uncomfortable for holding. It would be better to have a wider designed holding position on the handle. For store layout design, some participants suggested that the fresh food zone should be close to a store entrance and navigation signage should be clearer. One participant suggested that the supermarket should redesign its layout based on a customer’s purchasing power and another advised that they should provide a special zone for older people similar as the current baby zone in the store. For multi-floors store, older customers would like to have grocery products on the ground floor so they do not have to go the different floors for shopping. For customer service, many participants have suggested staff training is essential for supermarket customer service quality. Supermarkets also should provide a reward system to acknowledge and encourage well-preformed staff so as to improve customer service quality.

Conclusions
This study explored Chinese older customers’ holistic supermarket shopping experience that include home preparation, travel to store, in-store shopping, travel back to home and after shopping at home. Some of the identified shopping issues have been reported in western-based literatures. For instance, trolleys can be difficult to use (Angell et al., 2012) but carrying baskets has been found to cause most difficulty when shopping (Leighton & Seaman, 1997), Hare et al. (1999) indicated that wider aisles are important to older
customers and Meneely et al. (2009) highlighted that older customers felt disadvantaged with multi-purchase promotions. However, most of the existing studies only focused on in-store shopping experience. Based on results from this research, it is clear that older customers’ shopping experience is not only related to in-store shopping but also the other parts of their shopping journey. A lack of preparation might cause a difficulty in shopping at a store, such as forgotten reading glasses. Bad weather may stop older peoples’ shopping plans and the public transport service may help the older customers to decide which store to visit. Therefore, retailers need to consider older customers’ holistic shopping journey so as to explore their unmet needs and then improve supermarket service to Chinese older customers accordingly, whose needs and wants differ from the normal supermarket shopping experience in the west, where many older shoppers will have access to cars. The study highlights many important aspects for designing the supermarkets of the future, when many of the shoppers are likely to be older than the normal population in China.

References


**About the Authors**

**Dr. Yuanyuan Yin** is a Lecturer at Winchester School of Art, University of Southampton. Her research concentrates on promoting business performance through developing design and brand strategies, understanding customers/users, supporting design collaboration, and product design innovation.

**Song Qiu** is a Professor in Design at Academy of Arts and Design, Tsinghua University, Supervisor of PhD students, Director of Basic Courses Teaching & Research Office and DMI member. His research focuses on innovation, design and branding strategies.

**Dr. Ashok Ranchhod** is Principal Teaching Fellow in Marketing Communications within Winchester School of Art at the University of Southampton. His research focuses on Branding, Serious Games Design and Marketing Communications, He has published extensively in these areas.
Section 6.c
Introduction: Design teams in the pursuit of innovation

GRAFF Daniela\textsuperscript{a}; CLARK Mark A\textsuperscript{b}; COMI Alice\textsuperscript{c} and FEI Fan\textsuperscript{d}

\textsuperscript{a} Loughborough University London, United Kingdom  
\textsuperscript{b} American University, United State of America  
\textsuperscript{c} Kingston University, United Kingdom  
\textsuperscript{d} Tongji University, China  

Introduction

Designers often work in teams to develop new services and products through leveraging the knowledge and ideas of multiple members (Ancona & Caldwell, 1992; Beckman & Barry, 2007). Design work requires teams to not only understand each other’s perspective, but also integrate their knowledge in an innovative outcome. Yet team members often struggle to process information across their different perspectives (Chiu, 2002); and ultimately fail to produce creative and sustainable products and services. Different epistemological beliefs, concerns, and languages make such process very difficult. And while information processing in design teams is acknowledged as a key mediator through which a team’s diversity of information, function, and work-related background influences team performance (Hinsz, Tindale, & Vollrath, 1997), the mechanism for integrating diverse knowledge is not clear (van Knippenberg, De Dreu, & Homan, 2004).

Research in this track explores how design teams engage in knowledge work as they pursue innovations (e.g., in products, services, or business models), or search for innovative solutions to problems of organizing, managing, or strategizing. The basis for research in this track includes previous work which has shown that the integration of knowledge in design teams poses considerable challenges, including a lack of clarity on how design features and performance are related (Stewart, 2006). The papers in this track improve our understanding of how design teams integrate knowledge and innovate in practice; and makes practical recommendations for design teams.

This track includes five papers, two of which are included in these proceedings (based on author permission, rather than editorial review). Two papers address visualization in design studies. The first, included in the proceedings, is “Exploring a Colored Linkography for Identifying the Member of Design Teams” by Xu, Chuai, & Gan. The authors modify
linkography, a tool for design cognition and performance (Goldschmidt, 1990), to visually analyse design team interaction, providing, and measure member design contributions. They validate their adapted tool on an industrial design student team. Comi & Bresciani’s presentation, “Design Thinking and Techniques in Management Teams: Understanding the Role of Visual Facilitation” also addresses visualization effects. They report an experimental study which finds that teams using visual templates – especially with software support – were better able to understand synergies between the alliance partners, and to design innovative opportunities for the alliance.

The second set of papers investigate the multiple perspectives present in design work and the means of linking the associated knowledge and capabilities. In “Analogies in Multidisciplinary Design Teams,” Graff and Clark discuss how specific modes of communicating knowledge can support integration of diverse team members’ unique perspectives, relating information processing and analogical research streams. Fei’s paper, “The Knowledge Boundaries of Cross-boundary Teaming in Design-driven Value Co-creation,” investigates how task and leadership characteristics moderate the relationship between localized, embedded and invested knowledge (Carlile, 2002, 2004) and cross-boundary teaming. The empirical data are collected from design-driven co-creative project teams in both public and private sector. In the second proceedings paper, “The Design Capabilities of Dynamic Teams Pursuing Innovation in an Academic Context,” authors Coulson and Woods examine the role of academia and design capabilities in the development of new businesses. By utilizing a mixed method case study design, the authors identify different design capabilities throughout the design-led innovation process and how these capabilities affect outcomes.

Together these papers and presentations pursue processes and tools which can improve our understanding of information processing in design teams in their quest for performance and innovation.

References
Fei, F. (2017, June). The knowledge boundaries of cross-boundary teaming in design-driven value co-creation. Design Management Academy Conference, Hong Kong, China.


About the Track Facilitators

**Daniel Graff** is a Lecturer of Design Innovation at Loughborough University London. His research interest lies in design at and across multiple levels of analysis with a focus on how design knowledge emerge from the individual to the organizational level.

**Mark A. Clark** is Associate Professor, Kogod School of Business, American University, Washington DC. His research centers on team performance contexts, investigating the effects of knowledge networks, leadership, culture, and strategic human capital practices in a variety of field settings.

**Alice Comi** is a Lecturer in Business Design in the Department of Strategy, Marketing and Innovation at Kingston Business School, Kingston University London. Her research explores the intersection of business and design, focusing on the role of visual and material artefacts (e.g., charts, drawings, and models) in processes of organizing and strategizing.

**Fan Fei** is a Lecturer in College of Design and Innovation, Tongji University. Her research interest focuses on cross-boundary teams in co-creative work and design-driven innovation. She also extends the research to the learning application in the interdisciplinary education.
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Exploring a colored linkography for identifying the members of design team

XU Jianga*; CHUAI Yinga and GAN Xiangb

a Tongji University, China
b Southeast University, China and Monash University, Australia
* Corresponding author: xujizju@163.com
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This paper introduces the colored linkography as a modified method for identifying members’ character in the interaction of design teams. Some indicators are raised and applied with a sample of postgraduate team. Result shows that the colored linkography and its following indicators contribute to evaluating and comparing the endeavor and interdependence of members. Consequently, the colored linkography is a feasible tool that has much more value for deeper researches.

keywords: colored linkography; design team; modified method; members’ character

Introduction

Researches on evaluating design teams usually focus broadly on four aspects: the person, the environment, the product and the process (Oman, Tumer, Wood & Seepersad, 2012). Just as other groups, each designer is the constituent part of a whole design team, so the attribute of one designer associates with the performance of the whole team (Foo, 2011). The members network is reported as one of the most reliable potentiality related to identifying the character of members in a design team (Guan, Luo, Peng, Wang, Sun & Qiu, 2013).

Different researching styles have already performed to reveal the individual impact on design teams. Applying the metaphorical thinking, Casakin and Miller (2008) explored the individual acquiring character in design reasoning and analyzed the design performance, which enables leaders to refer the special field that needs to put effort in. Goellner, Wakes and Shaw (2009) create a method on organizing, presenting and applying the interplay between consumers and product to determine whether designers’ achievement is of
success. Bouchard, Omhover, Mougenot, Aoussat and Westerman (2008) compiled an interactive software that retrieves the design information of designers in the team. Although these studies employed advanced methodology to identify designers, there is a lack of quantization that statistically measures and compares attributes of designers.

In another study of design teams, Goldschmidt (1990) originally established the technique of linkography to study designers’ cognition and performance. During decades of employing and evolution, however, researchers have changed the linkography into a tool to present the content and process of design reasoning. The linkography now is still a potential technique, which analyses the endeavor and capacity of members in design teams.

For the purpose of reusing the linkography to identify the members of design team, this paper concentrates on introducing a colored linkography as a revised method on analysing the interactive network of design teams. The generation and operation of this modified linkography is reported in this paper. A case study originated from a design of lock for bicycles is also performed to verify the feasibility of colored linkography.

Background

Design Cognition

As an important domain of design behavioristic, design cognition was synthesized by concrete thought and abstract thought. Theoretically speaking, design cognition is a part of the human cognitive process of gathering, recognizing, collecting, memorizing, recalling, and processing design information by designers (Chan, 1990; Chan, 2008). Asimow (1962) proposed that the structure of the design process consists of the vertical structure of the continuous behavior and the horizontal structure of the decision making cycle. Based on the logical analysis and artificial intelligence, Mitchell presented the Design Computing and Cognition in 1977, which models and computes the process and knowledge of design cognition (Hayes, Goel, Tumer, Agogino & Regli, 2011). Zeisel (1995) considered that the design process is the helical structure composed of concept, performance, and testing. This burgeoning multidisciplinary field has attracted increasingly more scholars to engage in this study from their own professions. Cross existing study, there were two typical theories of design cognition, one was the Symbolic Information Processing (SIP) raised by Simon, the other was the Situativity Theory (SIT) derived from Schon. Based on these theories, scholars established a series of models focusing on the course of design especially the use of algorithm simulation to generate the innovative design (Visser, 2006).

To sum up, the existing study in the Design Computing and Cognition has obtained huge achievement including cognition modeling, creation generation and individual cognition. However, studies have analyzed the role of personal knowledge in the design team using the linkography-design cognitive model is relatively lacking. From this perspective, interaction relating individual attributes to team achievement in the group network is regarded as the vital point to model the relationship and dependence between team and members.
Linkography

The linkography was first proposed by Goldschmidt (1990), which is an effective means to evaluate the level of thinking of designers and their team design. Based on the oral analysis experiment, it is based on spoken data to describe and analyze the temporal structure of design cognitive reasoning. Semantic link is the basis of multidimensional model realization. According to the degree of correlation between the evolution of design cognitive concept and the indexing of module indexing, the concept and intention of dynamic evolution are called "design node" in the design process. Designation of the correlation between nodes or not re-calibration It can be based on semantic link to judge, any link can be linked to the design of the connection, so as to establish the link shown in Figure 1.

![Figure 1 Linkography](image)

Design the cognitive language data by preprocessing, transforming the construction of structured semantic association link matrix. The matrix basically stores the link data at the bottom of the node to realize the mutual conversion of unstructured language data and structural data and is coded according to the degree of relevance of the design cognitive concept. If the correlation degree is high, it is related, Low, can be ignored, that is not relevant. On the basis of dividing the design node, the semantic relevance of the nodes is judged and coded, and the link matrix is established. For any design node i, denoted as Ni, its corresponding link vector can be encoded by 0 or 1 by associating with other nodes semantics, expressed as:

$$L_i = [l_{i1}, l_{i2}, ..., l_{in}]$$ (1)

Where $L_i$ is the link vector of $N_i$, $l_{in}$ is the semantically associated encoded values of $N_i$ and $N_n$ nodes. After the coding is completed, each node will form a link vector with the number of nodes as the number of nodes. Combine all the node link vectors to get the full link vector, where the node has no practical meaning from the link and will be zeroed.

Researchers have changed the linkography into a tool to present the content and process of design reasoning. However, the linkography now is still a potential technique, which is used to analyze the endeavor and capacity of members in design teams. Therefore, the research of the linked table in the research team needs to be further enhanced. Based on the classic design cognitive model and linkography, this paper reuses the linkography to identify the members of design team, and concentrates on introducing a colored...
linkography as a revised method on analyzing the interactive network of design teams, and explore the concept evolution law of the team design process.

**FBS Ontology**

As is proposed by Goldschmidt, the relationship of design moves was subjectively judged by elementary knowledge, so the generation of linkography was vague (Cai et al., 2009). For the purpose of improving the agreement and reliability for generating a linkography, Gero and Kan (2009) founded the function-behavior-structure (FBS) ontology modeling the framework of design process to segment and code the design moves in term of the purposeful nature of designing. The FBS framework encodes the design and design creativity through parsing the protocol within three categories:

1. Function represents the purposed requirement during the activity of ideation.
2. Structure that embodies the concept of an outcome.
3. Behavior that achieves from functions or structure (Gero, 2000).

After segmenting and coding, each category is linked semantically which builds a linkography embedded the FBS framework (Pourmohamadi, Gero & Saunders, 2011). Additionally, the Delphi method is employed to arbitrate reliability of FBS segmenting and the linkography (Gero, Pourmohamadi, & Williams, 2012). This study uses FBS ontology to ensure the reliability of segmentation and coding.

Furthermore, this study builds a new form for the linkography and extends the links index and critical moves for measuring the diversity of team members.

**Design Team Communication**

Teamwork is regarded as a more efficient form confronting tasks and challenges if the task requires a team. Meanwhile, design process often includes team behavior, in some cases, a synergistic team design inspires designers more ideation. One of the factors that make team operate effectively is communication. It is also an important aspect for identifying team network. Findings have been received by many studies that members’ shared mental models may reveal the interaction framework of effective design team (Chou, Wang, Wang, Huang & Cheng, 2008). To ensure the quality and productivity of design team, each member should preserve their sufficient interplay and communication (Guan et al., 2013). Andy Dong (2006) counted the amount of communication that represents the impact of concept between designers. This was an indicator to deduce the crucial member in a design team. However, there is a lack of comprehension of design course in this measurement. Therefore, this study concentrates on utilizing the FBS ontology and linkography to capture design issues deriving from members’ interaction, identify the individual character and evaluate the individual impact on design teams.

**Interaction Model of the Members in Design Team**

The fundamental of this interaction model is the FBS coding scheme which segments the design process strictly into three basic classes of variables: function, behavior and structure (Gero, 2000). In the model of teamwork interaction, the function represents the anticipant purposes of synectics and the structure contains the concept of the final outcome and their combination. The individuals construct their ideation from grasping
several emphases of the function. During communication, they may formulate different elements from others, which will cause comparisons and perfection involving citations and acquiring among team members. From the perspective of individual, the interplay involves two directionally converse behaviors, the acquiring behavior links the previous teammates and the cited behavior links the latter teammates. The citations and acquiring of interplay transform the individual issues and form the atmosphere of deliberation in teamwork. The structure is then integrated by parts of individual concept. Figure 2 show the model of interaction involving the relationships among team members and basic design variables.

![Figure 2: The model of interaction in design team](image)

To study this model, this study 1) apply the coding scheme on the basis of semantic analysis, 2) build the member set \( \{M_1, M_2, \ldots, M_n\} \) and the interplay set \( \{L_{R_Y}, L_{R_Y}, \ldots L_{B_Y}, L_{B_Y}\} \), \( L_{R_Y} \) represents the transform of concept from \( R \) to \( Y \) to identify the attributes of roles in the design team. From this model, this study expects to deduce some indicators for assessing the endeavor and activeness of group members and identifying the key member whose interdependence with others promote the interaction of teams.

**The Colored Linkography Methodology**

Concerning the members’ attributes and their communication and sharing, this study colors the distinct knowledge of members and applied quantitative methods to expose the source and inheritance of issues from the specific members. Furthermore, depending on the outcomes above, the attributes of roles and the individual impacts on synectics will be defined.

**Definition and Expression**

In order to distinguish different member and their issues along with the sequence of talking, this study refines the conventional linkography and colors individual design moves and the links tie them. Figure 3 is a typical example of colored linkography. The three letters R, B and Y represent three colors: red, blue, yellow, and corresponding to three
members in one design team. The following expressions and operations will be introduced through this example.

![Figure 3](image)

*Figure 3  A typical example of colored linkography*

In the colored linkography, one specific color of nodes corresponds to one specific member in the design team. Integrating the models of interaction, the distribution and relations among colored nodes embody the communication within members and the conveying and evolution of concept. Therefore, this colored linkography can both acquire information in the study of design protocol and re-exert the effect on assessing design productivity of an individual designer (Shah, Kulkarni, & Vargas-Hernandez, 2000).

To analyze the distributions of a wide variety of random nodes and their links, this study clusters them into data sets. First of all, the nodes (e.g. $R1$) are named with its color code (e.g. $R$ is the code of red, $B$ is the code of blue) and its sequence number. Each link connects two nodes, so one link is named by the nodes it ties (e.g. $R1B2$) and this code scheme contributes to recognize the forelink or backlink of one node, e.g. the $R1B2$ link is the forelink of $R1$ and the backlink of $B2$. Then this study let the node set (e.g. $N = \{R1, B2, R3, Y4\}$) contains the codes of nodes and the link set (e.g. $L = \{R1B2, B2R3, R3Y4, B2Y4\}$) contains the codes of links in order to cluster the data of the structure of colored linkography. In addition, this study defines the $x_i$ equals 1 if node $i$ is raised by the member who is represented by the color $x$. Otherwise, the $x_i$ equals 0. In this manner, the colored linkography could be encoded as a two-way color-node matrix, as is depicted in figure 4.
Figure 4  Two-way color-node matrix encoded from the colored linkography

**Operation**

In order to analysis the source and inheritance of each member’s concept elaborated in the model of interaction from the colored linkography, the study separates the nodes of each individual by letting the member’s node set (e.g. \( N_R = \{R1, R3\} \)) contains the codes of personal nodes and the individual link set (e.g. \( L_R = \{R1B2, B2R3, R3Y4\} \)) contains the codes of individual links. Moreover, the interaction between two members can be expressed by the mutual link set (e.g. \( L_{RB} = L_R \cap L_H = \{R1B2, B2R3\} \)) which collects the links tying two specific members.

**Identification of Roles**

**Issues Occurrence**

As the premise for identifying the character of the members in design team, issues occurrence should be measured from colored linkography, which relates to the amount of members’ concepts and reflects the activeness of each member. John (2010) calculates the cumulative occurrence of design, where any differences are indications of issues interaction, through the FBS coding scheme and the additive manner. In colored linkography, the issues occurrence could be calculated according to the color-node matrix. Through the matrix, the issues occurrence of the member who is represented by color \( x \), at node \( n \), will be

\[
I_x = \sum_{i=1}^{n} x_i
\]

(2)

and the mean of it is

\[
\bar{I}_x = \frac{I_x}{n} \times 100\%
\]

(3)

Because of this algorithm of accumulation, the issues occurrence reveals the respectively total quantity of concept of one member that assesses the personal contribution to the course of design, but not necessarily the merit of the final consensus. What’s more, the standard deviation of the issues occurrence is also an indicator for the activeness that
individual member has put into the course of design. Some indexes that reflect the interaction among team members are proposed as follow.

**Citation Index**

Team members are facilitated to integrate thoughts and determine schemes through interactive flow that involves interlaced citations and acquiring (J.F Interaction). The link index and critical moves in linkography are positive indicators to measure the productivity of design moves (Kan & Gero, 2008). Consequently, if these indicators of individual moves are integrated, then some derived indicators could be generated to identify the roles in design teams.

The individuals concentrate on anticipant purposes of design and construct their own reasoning. Members demonstrate their concept and this self-concept influence the atmosphere of deliberation and the external memory of the team. Through communication, the working memory of individuals will be referred and reconstruct, and, in turn, exchange with the external memory continuously. In the colored linkography, the forelinks of a node indicate that the concept embedded in the node has been cited by subsequence. In the links set $L$, specifically, if the node $i$ and $j$ tied by one link meet the requirement that $i < j$, node $i$ is proved to be cited by node $j$, which can be noted as $C_{ij}$

$$C_i = \sum_{j=1}^{L} C_{ij}$$

and $C_i$ means node $i$ has been cited for $C_i$ times in $L$. What’s more, the citations span of node $i$ measuring the interval of these interplays will be $CS_{ij} = j - i$ and $CS_i = \sum_{j=1}^{L} CS_{ij}$ shows its citations span in $L$. As a consequence, the number of citations of the member represented by color $x$ is defined by Eq. 3:

$$C_x = \sum_{i=1}^{N_x} C_i$$

(4)

where the $N_x$ is the member’s node set and the Eq. 4:

$$CS_x = \sum_{i=1}^{N_x} CS_i$$

(5)

calculates the total citations span. Furthermore, to evenly assess the impact of one member on the team, the citation index is expressed as:

$$CI_x = C_x / length(N_x)$$

(6)
and the citation span index will be:

\[ CSI_x = CS_x / \text{length}(N_x) \]  

(7)

where the \( \text{length}(N_x) \) indicates the amount of elements in the set \( N_x \). Although LI and critical moves have been integrated into individual, the relation to design performance is retained. In other words, a higher value of citation index and citation span index denotes that this member poses stronger impact on the design team than others.

**Acquiring Index**

Refereeing to the citation index, the backlinks of a node in the colored linkography indicate that the concept involved in the node has acquired from previous issues. In the links set \( L \), specifically, if the node \( i \) and \( j \) tied by one link meet the condition that \( i > j \), then the node \( i \) is proved to acquire from the node \( j \), which can be noted as \( A_{ij} \) and

\[ A_i = \sum_{j}^{L} A_{ij} \]

means node \( i \) has acquired for \( C_i \) times in \( L \). What’s more, the acquiring span of node \( i \) measuring the interval of these interplays will be

\[ AS_{ij} = j - i \]

and

\[ AS_i = \sum_{j}^{L} AS_{ij} \]

mediates its acquiring span in \( L \). As a consequence, the number of acquiring of the member represented by color \( x \) is defined by Eq. 7:

\[ A_x = \sum_{N_x} A_i \]  

(8)

where the \( N_x \) is the member’s node set and the Eq. 8:

\[ AS_x = \sum_{N_x} AS_i \]  

(9)

shows the total acquiring span. Furthermore, to asses the balanced capability of invoking the external memory of the teamwork, the acquiring index is expressed as:

\[ AI_x = A_x / \text{length}(N_x) \]  

(10)

and the acquiring span index will be:

\[ ASI_x = AS_x / \text{length}(N_x) \]  

(11)
where the $\text{length}(N_x)$ indicates the amount of elements in the set $N$. Because the relation to design performance is still retained from the model of LI and critical moves, the value of acquiring index and acquiring span index reveal the improvement of object-related abilities and satisfaction of the teamwork. In other word, the higher these two indexes denote the stronger dependence on the team.

**Experiments**

**Sample Design**

Textual data for the present studies were obtained from one design team contains 5 postgraduate students majoring in industrial design. However, they received distinct undergraduate course, so the preferences on design were different which contain structure design, appearance design and design valuation. Consequently, all the participants may raise issues based on their background of profession. The purpose of building this situation of team was that each member might construct special creation from the function and contribute different impacts on individuals and the outcome in this study. What’s more, there was no obvious supervisor in this team. Without known leadership in the team, this study can assess the capabilities of individuals and identify their attributes regardless the weight of anyone’s talking. The object of this design work was a bicycle lock design.

<table>
<thead>
<tr>
<th>No.</th>
<th>Utterance</th>
<th>Code</th>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Chen: diversify the lock, consider the extension of them</td>
<td>Bs</td>
<td>10 5 18</td>
</tr>
<tr>
<td>27</td>
<td>Zhou: one lock can protect more than one bike</td>
<td>Bs</td>
<td>26 10</td>
</tr>
<tr>
<td>28</td>
<td>Zhou: on the handle, achieve the locking action more fluently</td>
<td>S 5 20 3 25 10</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Li: solve the problem of space between two bikes</td>
<td>Bs</td>
<td>19</td>
</tr>
<tr>
<td>30</td>
<td>Chen: design a lock combining the plate on the back wheel</td>
<td>S 29 19 20</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Zhou: used on public bikes</td>
<td>S</td>
<td>9</td>
</tr>
</tbody>
</table>

**Table 1** Partial segmentation and code encoded from textual data in this sample

**Coding within FBS and Building The Colored Linkography**

This study used the FBS coding scheme to segment and code the textual record by two separate coders. The agreement of these two coders’ result was 92.8, which could regard as be reliable. An example of the segmentation and code of the design protocol is posted in table 1. Here during the coding process, the study notes the backlinks of each node after of the Code row in this table, which is following the operation principle of the linkographer, an open-source design protocol analysis tool (Pourmohamadi & Gero, 2011).
In order to avoid ambiguities and perform further studies, part of the forelinks and backlinks are presented in figure 5 and 6 separately. In the whole colored linkography, there are 245 links tying 122 segments, so on average each segment has 2.01 links and each member has 22.6 segments and 49 links. However, some members in the teamwork have more segments and link the others.

![Part of the forelinks in the resultant colored linkography are assembled](image1)

![Part of the backlinks in the resultant colored linkography are assembled](image2)

**Calculation of Indicators**

Figure 7 plots the results of equation 1, where the X-axis is node numbers and the Y-axis is the issues occurrence. This index reveals the respectively total quantity of concept of one member that assesses the personal effort to the course of design. The result in the figure qualitatively infers the contribution of each member in the sample to the process of design. In addition, the mean and standard deviation of issues occurrences figured in table 2 enable the comparison of the originality of each member. Li has the most issues occurrences with the mean of 32.73%, and is more active in the middle and later periods. In other word, Li has put into the most effort for the design team in the sample. On the other hand, the distribution of issues raised by Jia is 0.090, so he is much more active during the whole reasoning process. As a consequence, the devotion of Li and Jia in this
interaction is much higher than others', especially Wang whose graph line climbs a small scale and the SD is only 0.019.

Figure 7  Issues occurrence for the design team

<table>
<thead>
<tr>
<th></th>
<th>Chen</th>
<th>Jia</th>
<th>Li</th>
<th>Wang</th>
<th>Zou</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{I} )</td>
<td>18.85</td>
<td>23.77</td>
<td>32.73</td>
<td>7.38</td>
<td>17.21</td>
</tr>
<tr>
<td>SD</td>
<td>0.055</td>
<td>0.090</td>
<td>0.074</td>
<td>0.019</td>
<td>0.045</td>
</tr>
</tbody>
</table>

Table 2  The means and standard deviations of issues of the design team

Table 3 and 4 figure out the outcomes of equations 3, 4, 7 and 8 and figure 8 and 9 is the result of equations 5, 6, 9 and 10. These data evaluate the attributes of roles in the interaction. The citations index (CI) and acquiring index (AI) contribute to relatively assess the frequency of interplay of roles during the process of design. In order to compare the individual CI and AI distinctly, these two indexes are enlarged in figures. In addition, the CSI and ASI indicate the popularity of individual moves in the colored linkography. Figure 8 shows that Wang's CI and Chen's CSI is the highest, that is, their standpoints are more widely accepted among this design team. Combining the indicators above, Chen has not proposed the most issues during the design reasoning, but Chen invokes the external memory more deeply and activates it more dynamic. In turn, Chen’s originality poses stronger impact on external memory as well as others’ working memory and invoke to their reasoning. Combining the indicators above, Chen has not proposed the most issues during the design reasoning, but Chen invokes the external memory more deeply and activates it more dynamic. In turn, Chen’s originality poses stronger impact on external
memory and individual work memory. Figure 11 presents Chen's colored linkography annotated with Chen's ideas and identification. Comprehensively, the model of this sampled design team could be summarized as figure 12, where, during this teamwork of design, the interdependence between Chen and other members is the key factor that develops this team's interaction.

Table 3  The amount of citations and citation span of individual design issues

<table>
<thead>
<tr>
<th></th>
<th>Chen</th>
<th>Jia</th>
<th>Li</th>
<th>Wang</th>
<th>Zou</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>56</td>
<td>47</td>
<td>78</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td>CS</td>
<td>1076</td>
<td>835</td>
<td>1449</td>
<td>412</td>
<td>576</td>
</tr>
</tbody>
</table>

Figure 8  The citation index (CI) and citation span index (CSI) of individual design issues

Table 4  The amount of acquiring and acquiring span of design issues

<table>
<thead>
<tr>
<th></th>
<th>Chen</th>
<th>Jia</th>
<th>Li</th>
<th>Wang</th>
<th>Zou</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>38</td>
<td>65</td>
<td>53</td>
<td>14</td>
<td>38</td>
</tr>
<tr>
<td>AS</td>
<td>926</td>
<td>992</td>
<td>1008</td>
<td>189</td>
<td>679</td>
</tr>
</tbody>
</table>
Figure 9  The acquiring index (AI) and acquiring span index (ASI) of individual design issues
Figure 10  Wang’s colored linkography annotated with Wang’s ideas and identification
Most of long-span links
Retrieve and acquiring
are both profound, which
means the strong
interdependence between
Chen and other members.

The rest of utterances here

102. Chen: integrate the
lock with gears
106. Chen: the key can
be symmetric
107. Chen: aiming at the
hole of keys easily
108. Chen: change the
shape of keys and locks
110. Chen: the costing
will be too high
120. Chen: lock the skid

1. Chen: operate by one
hand
16. Chen: use the
luminous material
17. Chen: identify the
right side of key
23. Chen: set an inductor
to find bike easily
26. Chen: design
diversely to extend
existing locks
30. Chen: design a lock
combining the plate on
the back wheel
34. Chen: accomplish the
behavior fluently
50. Chen: set up a
fixation on spokes
55. Chen: the wheel will
break down after
removing spokes
57. Chen: the spokes
sustain the weight
62. Chen: just lock the
spokes
63. Chen: three spokes
are enough
81. Chen: combine the
lock with skid
82. Chen: lock bikes
without stoop
83. Chen: lock the
derailluer
85. Chen: they do not
operate as the same
direction
87. Chen: distinguish
with the skid
93. Chen: set the lock on
the handle
98. Chen: take out of a
gear

Figure 11 Chen’s colored linkography annotated with Chen’s ideas and identification
6. Discussion
Successful teamwork relies upon synergism existing between all team members creating an environment where they are all willing to contribute and participate in order to promote and nurture a positive, effective team environment. Team members must be flexible enough to adapt to cooperative working environments where goals are achieved through collaboration and social interdependence rather than individualized, competitive goals (Luca & Tarricone, 2001). So the analysis of the designers in the design team’s personal attributes and contribution, is to help the team to conduct a thorough analysis, a good division of labor, improve the design team management and cooperation.

In this study, we use a color linkography model and encode the color node matrix according to the distribution of the members’ design actions, so as to analyze the individual indexes of the members. Through the color link and the matrix algorithm, we can show the evolution of the individual concept and evaluate the individual attributes, the breadth of the personal concept in the design phase. Dong (2006) identified the existence of central designer who has the ability to connect with and integrate concept from others by accounting the amount utterances in textual record in terms of assessing the relationship in the interaction. This study interprets this attribute in assembling concepts as “the interdependence between key member and other members”. In this study, through the color linkgraphy model and matrix calculation, reveals the total number of each member of the concept, and get the citations index (CI) and acquiring index (AI), which contribute to relatively assess the frequency of interplay of roles during the process of design. The higher the CI and CSI, indicating that the designers’ positions are more widely accepted in this design team. Therefore, this model can be used to show the most important designers in the interaction. Then this study also evaluates how profound the individual concepts are in design synectics.

The FBS ontology and Delphi method employed in this study enhance the reliability of parsing and segmenting, as is proposed in previous research by Gero et al. (2012), which is a pre-configuration step of structuring the colored linkography. Then, comparing with Dong (2006), this study additionally assesses how profoundly the individual concepts develop in design reasoning. In other word, the content of communication is also an
essential index for identify the character of roles in the model of interaction. Colored linkography contains the distribution of individual nodes and the span of links implying the generation and evolution of concepts, so it is a more thorough methodology for identifying the members of design team.

7. Conclusion
This study proposes the generation of the colored linkography on the foundation of previous researches on linkography. This modified linkography differentiates individual design moves and interaction with others distinctly. What’s more, to analyze the character of members from the colored linkography, a color-node matrix is encoded according to the distribution of design moves. Then, the algorithm of five indicators following with the colored linkography and matrix is presented to embody the evolution of individual concept and evaluate different aspects of individual attribute. Therefore, this linkography is considered as a method to compute the interaction model and identify the members in design team. After that, a case originated from a design of lock for bicycles is performed to verify the feasibility of colored linkography. In the case, this study reveals the respectively total quantity of concept of each member and shows the most important designer in the interaction, which achieves the purpose on identifying the members in design team. Consequently, the colored linkography is feasible and reliable. In the future work, the researches expect to develop a measurable approach to represent the links in colored linkography so that the analysis of interaction in design teams can be refined.

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About the Authors

**XU Jiang** researches for the national design strategy and design management. Host and participate in a number of major consulting projects of Chinese Academy of Engineering Innovative Design - development strategy research and the National Natural Science Foundation.

**CHUAI Ying** researches for design management and design cognition computing. Participated in the National Natural Science Foundation of China and a number of design management research projects.

**GAN Xiang** researches for industrial design and design cognition computing.
The design capabilities of dynamic teams pursuing innovation in an academic context

COULSON Saskia and WOODS Mel*

University of Dundee, United Kingdom
* Corresponding author: S.M.Coulson@dundee.ac.uk
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Design research is moving beyond the study of industry based practices and towards the stewardship of design-led innovation for business development and economic growth. To this end, it is now required to evidence the benefits it creates. To examine these notions further this paper presents an approach for design-led innovation within an academic context. The authors build on the concept of design capabilities to develop a framework of evaluation that provides a platform for which the impact and value of design to industry and the formation of diverse teams can be critically discussed. Furthermore, this study contributes to the burgeoning cognisance of design capabilities as a means to understand value, by indicating potential pathways towards yet further application of design research in the industry context. It closes with reflections and reveals how lessons from this study can contribute to future of university-industry partnership working.

keywords: design in action; design capabilities; knowledge exchange; university-industry partnership

Introduction
The relationship between higher-level research institutions and industry are undergoing a period of transformation, and the Knowledge Exchange Hub Design in Action (DiA)\(^1\) is both

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\(^1\) Design in Action (DiA) was a £5m Arts and Humanities Research Council (AHRC), Knowledge Exchange Hub for the Creative Economy. The project was also awarded £400k from Creative Scotland to support small and medium enterprises to utilize design as a strategy for innovation, within and beyond the creative economy.
reflective and an active part of this change. The shifting backdrop is a landscape of new complex demands and challenges for higher-level education institutions, where impact is now deemed critical to the success of research. In the UK, this is evidenced by the recently published Dowling Review (2015), which has outlined the government’s role in fostering further business-university research collaborations, namely, to provide academia with the groundwork to allow for wider impact for research, allow companies to enhance organizational activity through new technologies and processes, and further the capabilities of businesses and de-risk research investment.

This relationship between design-led business development and the academic environment is often thought of as a beneficial pairing in itself, and as such, is of growing attention to institutions across the world (e.g. d.school, USA; Business & Design Lab, Sweden; PolyU Design, Hong Kong). New challenges are revealed in this circumstance as the juxtaposition between long term planning in academic research and emergent and spontaneous nature of small businesses and entrepreneurship, are some of many elements that demonstrate the complicated relationship between these endeavours. It has been argued that design research is uniquely placed to tend to the complexities and exploit the potential of interdisciplinary knowledge exchange within a university environment (Davis, 2008). However, the capture and analysis of these new hybrid models of research and practice with a high industry impact agendas presents an ongoing challenge for academia. In this context, research is moving beyond the capture and analysis of industry based practices and towards the facilitation of design-led innovation for business development and economic growth, and it is now a requirement to evidence the benefits it creates, both in regards to tangible and intangible value. Responding to this contextual shift, and ever expanding challenges, this paper seeks to consider the following research question:

RQ: Taking a holistic approach and with attention to the academic context and a process of design-led innovation: How do those from diverse backgrounds (academics, designers, businesses, entrepreneurs, NGOs, policy makers and wild cards) form teams and which design capabilities are evident as they mobilize innovative ideas?

To examine these notions further, this paper presents the DiA approach for design-led innovation within an academic context and the authors apply the concept of design capabilities to investigate the role of design in the process and delivering project outcomes. Using a case study methodology, a design capabilities framework is employed as a means to analyze the activities and impact from the DiA project. This includes an evaluation role of design in both the formation of design-led businesses and the wider design advocacy programme led by the project.

Explicating Design Capabilities

Design capabilities are gaining ground in scholarship surrounding areas of design leadership in enterprise performance. It follows a rise in the specific use of design to address the indeterminate nature of decision-making and problem-solving in management, which has been described as a “paradigm of design as general capability” (Cooper & Junginger, 2011). Evolving alongside the transformations in design, the concept of design capabilities was initially employed to describe the leadership activities of a business (Jevnaker, 2000) but has since expanded to tend to the complex nature of
organizations and systems, as it can be used to study design at multiple levels within systems and between organizations and the wider environment (Mortati, Villari & Maffei, 2014). Further to this, some use the concept of design capabilities as a method for analyzing the value of design in systems extending from production innovation (Fernandez-Mesa, Alegre Vidal, Chiva & Gutierrez-Gracia, 2013), or as a means to investigate the absorption of design in SMEs (Acklin, 2013), and even as a way to uncover design in public sector services (Malmberg & Wetter-Edman, 2016).

The etymology of design capability rooted in the strategic management concept “dynamic capability”, which describes an organization’s capacity to develop, embed, and adapt in highly transformative contexts (Teece, Pisano & Shuen, 1997). Furthermore, dynamic capabilities are important in entrepreneurial activities within businesses that equip organizations with the tools, processes, and systems to scope and adapt for sustainable growth and high performance (Eisenhardt & Martin, 2000; Teece, 2007). Dynamic capabilities share components with theories in management strategy, i.e. resource-based view and minimizing competitive threats (Teece, et al., 1997). Taking a resource-based view, Eisenhardt and Martin (2000) describe dynamic capabilities through the categorization of key characteristics within successful businesses. These characteristics include the processes for innovative product development, strategic planning and action, and enhance existing resources to develop and sustain competitive advantage (Ibid.). Indeed, this may be achieved by using this concept as a way to understand the needs of stakeholders and clients.

Dynamic capabilities within organizations assist in the effective identification and reaction to the external industrial environments and shape those environments through innovation and leading market change (Teece, 2007; Teece & Pisano, 1994). Much of the rhetoric around dynamic capabilities has resonance with the emerging landscape of design management and has been noted in several studies which aim to develop ideas on design capabilities (Malmberg & Wetter-Edman, 2016; Mortati et al., 2014; Acklin, 2013; Fernández-Mesa et al., 2013; Jevnaker, 2000).

Building on the notion of dynamic capabilities, design capabilities are also perceived to support competitive advantage and form flexible and effective organizational practices (Acklin, 2013). Furthermore, it has been argued that design capabilities are important to achieve innovation and should be embedded in the overall learning capacity of an organization (Fernández-Mesa, et al., 2013). Acklin (2013) contends that where a resource-based view of an organization examines assets, processes, information, a design capability framework can extend further to illustrate the sustained competitive advantage of the business.

Furthermore, Mortati et al. (2014) state that the main obstacles in measuring the value of design are: the lack of frameworks for the capture and analysis of design capabilities in a business; the lack of appropriate metrics which would demonstrate design’s impact on organizational performance; and, the ability to translate an appropriate metric system into an approach for measuring design as an intellectual capital. They assert that design capabilities can capture the skills, capacities and resources of a business, in addition to demonstrating the outcomes of knowledge exchange between human resources and intellectual capital (Ibid.).
Jevnaker (2000) sought to explore the strategic use of design capabilities as an approach to design advocacy and describing the leadership activities that design has in wider value creation. From this research, they develop a framework of six-themes to illustrate the leadership actions which describe these organizational design capabilities [Table 1].

<table>
<thead>
<tr>
<th>Organizing Design Capability</th>
<th>Leadership Action Involved</th>
</tr>
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<tbody>
<tr>
<td>Design resourcing</td>
<td>Starting-up design or development initiatives. Accessing best suitable design and business expertise. Resourcing money, time, projects, and facilities without detrimental overload of capacity.</td>
</tr>
<tr>
<td>Design combinative capability</td>
<td>Configuring design resources. Tapping and connecting to firm-specific resources, strategic assets, or otherwise distinctive resources. Creating interaction of design resources and the firm’s core competent people.</td>
</tr>
<tr>
<td>Design learning capability</td>
<td>Communicating design with ethos repeatedly to multiple stakeholders. Exposing and testing design within a reciprocal and acknowledged design relationship. Inaugurating design experiences to key stakeholders. Debriefing design building memory.</td>
</tr>
<tr>
<td>Design innovation capability</td>
<td>Adopting new knowledge and ideas. Fostering creative design developments. Nurturing open exchange and taking advantage of creative abrasion.</td>
</tr>
<tr>
<td>Design-strategic capability</td>
<td>Providing a strategic focus while allowing out-of-the box discovery. Anchoring design developments in business and strategy and strategists. Implementing strategy stretch.</td>
</tr>
<tr>
<td>Design advantage-protecting capability</td>
<td>Protecting new design designs by patents, licensing, and pattern protection. Capturing design-based value and sharing risks through legal agreements, royalties and relational contracting. Sustaining design capabilities through design alliancing, R&amp;D partnering.</td>
</tr>
</tbody>
</table>

The Design Management Absorption Model (DMAM), which describes the capacity of a SME with little previous design experience to absorb design knowledge into the business,
also denotes a distinction between design management and design leadership capabilities (Acklin, 2013). Through the process and the socialization of design knowledge, design leadership capabilities, which acquire and assimilate design knowledge, are a precursor to those more affiliated to design management capabilities, which transform and exploit design knowledge. This has great significance in this study, as in this context there is a similar delineation of capabilities through the DiA process. To further understand the importance of design capabilities in the design-led process of innovation in an academic context, this paper presents a case study of DiA and the research approach to building and evaluating this case study is discussed below.

**Research Approach**

This paper seeks to understand the value of design in the development of new businesses by examining the design capabilities that underpin the innovation process. Using the existing literature and existing frameworks on the design capabilities, the activities of DiA are evaluated through a longitudinal case study methodology (Bryman & Bell, 2007). The case study format is selected not for methodological preference but as the object of focus, what is being studied takes precedence, it is a study about ‘both the process of learning about the case and the product of our learning’ (Stake, 1998, p. 87). Therefore, it is proposed that case study methodology in this context is a way of creating a strategic research process, one which is able to define and achieve the aim of this study: namely, the presentation of new knowledge in the design-led innovation of business within an academic environment. Crucial to this research is the notion that only case study can adequately attend to the complexities of undertaking research in design, in that it enables a holistic view, and allows the interlaced relationship between them to be captured and analyzed.

**Methods**

The collection of data in this research is reflective of the diverse nature of the project. The mixed-methods applied in this study include; surveys with participants of DiA events, semi-structured interviews with individuals who led on successful businesses, document analysis of funded business proposals, and the interim and final business reports. In addition, the DiA process model was developed through a co-design approach incorporating the perspectives of both the operations and research teams of DiA. Analysis of this data was considered in relation to the research question and positioned in the design capabilities framework. Table 2 provides an overview of the methods, participants, data collection tools, and frameworks for analysis in the study.

<table>
<thead>
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<th>Table 2  Research Methods</th>
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<tbody>
<tr>
<td>Methods</td>
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<tr>
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<tr>
<td>Post-ideation event surveys</td>
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<tr>
<td>End of project survey</td>
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<td>-----------------------</td>
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<tr>
<td>Semi-structured interviews</td>
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<tr>
<td>Document analysis</td>
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</table>

**Case Study: Design in Action (DiA)**

DiA was a knowledge exchange hub that brought together the arts, technology and business communities to work with academia around common themes or problems. Initially based out of six Scottish universities, DiA grew an expansive network of businesses, academics, designers, and creatives who wanted to make new connections and find new pathways for exploration and innovation.

The priority was to bring innovation capacity to Scottish SMEs, as it forms 99% of the country’s businesses. DiA was a research project, with the research occurring in real-time. It examined the process of business formation, the diverse requirements of each one, support mechanisms and the issues that require action for sustainable businesses to emerge.

For DiA, knowledge exchange was a crucial component in the design-led innovation process. DiA initially delivered its activities across five sectors (food, sport, rural economies, ICT and health and wellbeing) because the government recognized these areas as having high growth potential. However, due to externally commissioned partnerships and contracts, the project widened its focus to include legal services, digital imaging crypto-currencies and the circular economy.

This unique opportunity for knowledge exchange highlights the commercial potential for design in the Scottish economy and also the relevance of design-led business innovation, and capitalizing and amplifying academic research in the humanities, in a variety of sectors where it might not be immediately associated.

**Chiasma and teams in the pursuit of innovation**

Chiasma was the term used to describe a method of ideation and collaborative innovation engineered and coordinated by DiA. In science, “chiasma” refers to a biological term meaning the overlap of two chromatids in the process of meiosis. DiA appropriated the term to describe ideas meeting at the point of creation and used it as the title for the ideation events the project produced. The approach endeavoured small groups of individuals from different walks of life, to solve complex problems by generating new
ideas and business models in a fast-paced, design-led environment. Some of the ideas were funded to take the concepts to prototype and business formation stage. The chiasma events were simultaneously creative and focused to catalyze the design process by bringing together the right mix of participant skills, interests and experience. The resultant new companies and developments have led to new near-to-market products and provided valuable insights into how design can assist businesses from their genesis.

During the chiasma events, participants from a variety of backgrounds form teams (ideally of five people, or less, including at least one professional designer) to create ideas around a specific sectoral problem. Through specifically created design-led innovative techniques, devised by the academic team leading the research, the teams combined their knowledge and skills over the course of the event to create a commercially-viable ideas that were then presented to an expert panel on the final day. The intellectual property that was generated and demonstrated in the final presentation was then held centrally at the DiA hub for the protection of all participants (further discussion in findings section below).

Six-weeks after ideation, all participants had the opportunity to apply for up to £20k grant funding which secured them the exclusive rights to further explore the commercial viability of the idea and generate a prototype. All applications were considered by the DiA grant funding panel who decided which teams are funded to business formation stage and received additional support on securing patents, design, consultancy, testing, materials, and additional time costs along the way. One of the benefits of being a DiA member is that any idea resulting during chiasma that was not awarded Grant Funding could eventually be accessible for development by the wider DiA network.

*Design in Action Key Performance Indicators*

Throughout the project, DiA involved over 630 businesses in its programme of; seminars, workshops, annual design summits and fifteen residential Chiasma. These events lead to the formation of 17 design-led businesses, with a collective turnover in excess of £3 million, and with a total of 76 new jobs created.

*Table 3  Design in Action Key Performance Indicators*

<table>
<thead>
<tr>
<th>Operational</th>
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<tbody>
<tr>
<td>5172 organisations and individuals engaged with Design in Action</td>
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<tr>
<td>3762 attendees at 25 Design in Action events</td>
</tr>
<tr>
<td>633 SME’s attended Design in Action events</td>
</tr>
<tr>
<td>300 Ideation event participants from business, academia and design</td>
</tr>
<tr>
<td>14 Ideation events</td>
</tr>
<tr>
<td>£318,937 of DiA grant funding approved for projects</td>
</tr>
<tr>
<td>£672,400 of partnership funding/support raised by DiA for the projects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-Operational</th>
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<tbody>
<tr>
<td>17 funded projects, with 13 (76%) predicted to launch</td>
</tr>
<tr>
<td>£1,121,000 of additional funding raised by the projects</td>
</tr>
<tr>
<td>£3,068,000 annual turnover of the funded businesses (2015)</td>
</tr>
<tr>
<td>£3.44 leveraged by the businesses for every £1 invested by DiA (+70%)</td>
</tr>
<tr>
<td>113 products, processes and services developed</td>
</tr>
</tbody>
</table>
113 jobs created (81 by the funded projects and 32 at Design in Action)
7 trademarks; 2 RSE Fellowships; 1 patent filed

Research
£11,616,207 of additional research grants and funding awarded
101 research papers, publications and conference presentations
298 Arts & Humanities researchers engaged with DiA
242 Multidisciplinary researchers engaged with DiA

However, the activities of DiA did not always result in direct or immediate commercial benefits. It was recognized that the project supported various constructs of knowledge exchange between many different groups of individuals. The benefits of which may only come to fruition in the long-term and could include economic and societal impacts over varying timescales. Some of this was captured through the collection of key performance indicators (KPIs) gathered by the project over the course of four-years [Table 3]. However, a need to understand the role of design in the process led to an exploration in the wider DiA process, including an examination of the approach for developing the ideation events and the subsequent support in the formation of the businesses.

Design in Action Knowledge Exchange Process Model for Innovation
Over the course of the research project, DiA developed a way to communicate how knowledge exchange is critical to a design-led innovation process. In design, models are often used to explain the use and application of design to its context (e.g. Design Council's Double Diamond, IDEA Design Thinking Process Model and the Danish Design Centre's Design Ladder). The Design in Action Knowledge Exchange Process Model explores the different forms of knowledge exchange and whether the instance requires internal or external engagement and participation (Woods, Marra & Coulson, 2015).
The Design in Action Knowledge Exchange Process Model [Figure 1] illustrates five stages of design-led innovation, brought about by processes of external and internal participation. The boundary between these different modes of knowledge exchange is represented by the “knowledge exchange horizon” line. Above the horizon are the activities mediated through, broadly, processes of external engagement with an open uptake of individuals from the arts, business and technology sectors. Below the horizon are the internal activities which mobilize innovation through curated teams, and selected individuals who contribute additional knowledge and expertise. The model demonstrates that team formation crosses back and forth across the horizon, to maximise the potential of these varying, but crucial, forms of knowledge exchange.

The phases of the design-led innovation process, are defined through the areas of knowledge exchange. Each phase has been identified by the Design in Action team as varying and important stages in understanding the process.

**Scoping - Discover**

This stage is one centralized on participation which aims at identifying critical challenges and the key stakeholders that may contribute to near future innovation opportunities in specific sectors. More than a traditional review, scoping is an active and open process of
discovery using methods of co-operative inquiry (Heron & Reason, 2008) to collectively question and position the gaps in the sector.

Participants include; academics, businesses, communities, non-governmental organizations and government.

**Interpretation - Framing**

Driven by academics and peer reviewed by invited external experts, this is the stage where material gathered on the sector is synthesized with existing literature. The aim is to define three to four key challenge areas for an industry sector and support a narrative for the innovation call to prospective participants for the ideation event. This stage includes the creation of appropriate design methods and tools to support ideation with potential participants and identifies a more extensive network of potential participants to ensure that certain skills and knowledge are brought to the ideation phase.

Participants include; research team, academics and industry experts.

**Ideation – Concept Generating**

Ideation begins with a sector call for applicants for the ideation event (Chiasma), which frames the event through three to four key challenge areas for an industry sector and supports a narrative for future innovation possibilities. Here, design as strategy for business development underpins the process which facilitates and supports ideation. The event enables collaboration between the assorted group of participants and leverages knowledge exchange to for the inception of novel business ideas.

Participants include; designers, entrepreneurs, businesses, academics, and wild cards.

**Formation – Business Modelling, Prototyping**

Ideas are brought forth from the ideation phase, and teams move into a stage of research and development to form a business model that meets, or creates, a need and tends to an innovation challenge. Teams work within an internal network, with information coming from selected experts as facilitated by business support staff based with the academic environment. It is a stage driven by design-led prototyping, feedback, and refinement to prepare the product or service for market through funding and design expertise.

Participants include; business teams, designers, academics, external experts and prospective users.

**Evolution – Market Feedback**

The final stage of the DiA process is the launch of the product or service into the market, this public introduction allows the business to evolve. The business does so by evaluating targets and gathering insight on general success and from customers to evolve and move forward. The new business does this independently, but still receives support on critical business issues from the DiA hub. Businesses are also further involved through mentoring and showcasing opportunities delivered by the hub.

Participation is wide open.

The DiA process model enabled a way to articulate a wider approach to supporting innovation within an academic environment. However, there was still a need to develop further understanding on the various design capabilities that existed in the process. Therefore, the following discussion engages both the DiA process model and the design
capabilities framework, using the data gathered through the mixed methods approach to discover where and what capabilities are evident in the innovation process, and the teams that enabled these capabilities.

**Discussion: design capabilities in the DiA process**

DiA developed a process of design-led innovation between arts, technology and business, by creating platforms to overcome cultural and infrastructural silos that were thought to restrict business development. This was achieved in a number of ways. Firstly, it engaged the specific sectors through a scoping process; listening to the challenges and issues which were stifling progress and development and responding by creating tools and approaches to overcome these barriers. It developed a process that considered the holistic needs of design in every aspect of delivery, including the design of the physical spaces for ideation, bringing in the right stimulus from key speakers and advisors, building scaffolds for co-creation with specifically developed methods and tools. It provided a programme and educational and engagement activities that advocated for design practices and articulated and advanced design knowledge and use, to help develop insights into the opportunity offered by strategically building design into core business processes. It built the confidence in the academy to support the SME sector and advance their opportunities, by providing access to knowledge, introducing SMEs to experts in support of their ideas, helping teams make the transition from idea into a viable and sustainable business.

Through the analysis of the data collected throughout the project, this study examined the role of design capabilities in the DiA process and considered how these capabilities might change as the phases and the groups involved and adapted to the needs of the process.
As can be seen in Figure 2, differing design capabilities are more evident in certain phases than others. Similar to the Design Management Absorption Model (Ackin, 2013) design leadership capabilities; such as resourcing, combinative, and learning were more evident in the early stages of the innovation process. Phases which required high levels of design capabilities existing in the ideation and formation phases of the innovation process. Furthermore, there is an interesting relationship between who is involved in each phase and which design capabilities were required to mobilize the process. Scoping and interpretation were primarily led by the DiA academic research team, and they also led on the ideation phase and Chiasma events. During the ideation phase the teams that were formed at the event became the drivers of innovation and concept development. These teams received business support during the formation and evolution phases from the DiA operations team and external experts. Although there was interest from the DiA academic staff to assist more of the later phases of development, they often did not have much contact with the teams during this time.

In addition, although many design capabilities exists across the DiA process, the indicators and outcomes of these activities facilitated by knowledge exchange and design capabilities varied. In some instances the demands on certain design capabilities were higher than others. The capabilities that came through in each stage are discussed below.
Scoping
The in-depth sector awareness that was required during the scoping phase demanded appropriate resources for facilitating and harnessing the outcomes of knowledge exchange (Coulson & Woods, 2016). Therefore, the teams that were leading on scoping had to access and connect with specific resources. This was both research and human-resource based, i.e. the identification and building a network of sector experts which can collaborate to identify the gaps and opportunities for innovation. As much of scoping is done with experts from various backgrounds, many did not have a previous understanding of design, and DiA advocated and educated these participants in the enabling multifaceted value of design.

Interpretation
Interpretation seeks for the best and most suitable expertise to feed into the development of sector understanding, and to help form and articulate the critical challenges that were used for the call for the ideation events. This is also the phase when the teams developed the tools for successful innovation in the subsequent ideation phase. For this, the appropriate resources were sought and pulled together from various subject areas and sector experts. This included the methods developed that combined existing design methods and other areas of research. For instance, DiA developed a Likert scale method, an approach from psychology, but tailored it so it became a collective activity and a way to share opinions and preferences around a certain theme or topic.

Ideation
For the ideation phase (Chiasma), the DiA team held responsibility for creating the appropriate scaffolds to stimulate idea generation. There was also much preparation done in terms of bringing the right skills and knowledge into the room, and the DiA team took a lot of time and care in selecting the right participants for the ideation events. As one participant noted:

It’s one of the main opportunities of chiasma to be put together with people from those different perspectives and coming up with an idea together. Starting collectively...and coming up with it together. You get the chance to meet someone who has a problem and you figure it out. It’s really rare to get that opportunity (Chiasma Participant, Funded project).

Furthermore, the ideation phase was as much about advocating design as it was about initiating new products and services. The intent was to build on the pre-existing knowledge and skills brought in by the participants and form a common platform with design. The methods and tools, and other activities such as presentations and talks from renowned individuals were embedded into these events to educate people about the value of design.

It made me realize how design runs through the business, not just in branding but also business models/strategies (Chiasma Participant, Survey).

Design as strategy was a core concept at the forefront of this learning agenda. This was in part due to the lack of common understanding of design in this role. However, the
activities supported teams in thinking about how design can be built into the business from the very early start of idea generation.

The lean start-up approach and the design process are not incompatible, but it takes hard work for them to be complimentary. Bringing the design process into start-up will ultimately lead to better user experience and therefore better business (Chiasma Participant, Survey)

Design capability of advantage protecting, which is the preservation of new ideas, was embedded into the DiA process from the beginning of the ideation phase. As DiA was founded on a knowledge exchange innovation model, questions were raised early in the project regarding intellectual property in collaborative settings. Therefore, the project developed a concept for intellectual property called the “IP Shelter” which allowed DiA to address and incentivise collaborative practices and build a framework of working in this highly collaborative area [Figure 3].

![Design in Action IP Shelter](image)

This was created within the specific needs of the project and the IP Shelter provides a framework for an approach to protecting innovation in co-creation and co-design. It allows for ideas to be shared freely amongst teams. It signifies way that academic institutions can develop pathways for building ‘safe-spaces’ for knowledge exchange and platforms for initial ideas to be test and verified without putting potentially profitable IP at risk.
**Formation**

Design as resourcing capability within the formation phase is of high importance. The DiA Hub supported the teams in developing the concept into a tangible product, service, and business. The DiA operations team at the Hub worked with the innovation teams to access best suitable business expertise, and find the resources (i.e. money, time, and facilities) for the teams, without overburdening them.

> *It’s been an iterative process because you don’t quite know where things are going to go and what it’s going to look like at the end. You’re moving forward without knowing exactly how you’re going to get to that end result and there are big blanks, which could be difficult for someone who isn’t familiar with design process. The iterative process is the key in design. A lot of projects or new product developments fail because that process hasn’t been followed. You need to bring in all different elements – engineering, market priming – that come together for one proposition and because design is multi-faceted, it enables that.* (Chiasma participant, funded project)

The above quote not only touches upon a resourcing capability, but also the design combinative capability through the many forms that design is used. Again, this is a crucial part of advocating the scope and possibilities of design-led innovation in the project. For many it was the first time they discovered, and indeed used, design in this way.

> *Up until that point I hadn’t done anything involving design and now everything is all about that completely. If you get it right, it can add a ton of value to what you’re doing and it separates you from your competitors. It adds to the experience and adds real value.* (Chiasma participant, funded project)

The IP Shelter, discussed above continued to provide support in the formation of the businesses, and the operations team sought out further support and advice in this area for the burgeoning businesses during this phase.

**Evolution**

Once the new business launched into market, there was a continued relationship between the teams and the DiA Hub. This continued support focused on effective use and development from the feedback that was gathered from initial market review. Moreover, the IP Shelter assisted new businesses in maintaining their USP once the product was out in the public sphere.

**Limitations and further research**

DiA did not set out to discover the nuances in the design capabilities, or understand those different requirements, which were more evident in some phases of the innovation process over others. Therefore, the methods for data capture and evaluation of the full scope of process delivery focused heavily on the ideation events and the formation of the businesses. This is noted in the strong qualitative evidence given in this study to the phases of ideation and formation. Data gathered on scoping and interpretation was collected through systematic document analysis in the project archives, but further
research into the application of this process would build a more robust system for the
collection of information and evaluation in the earlier stages.

Concluding Remarks
The role of support within an academic institution for the development of new businesses
is a new and unexplored area. This paper addresses the rising interest in the diversification
of academic institutions activities, with noted hubs that form relationships between the
university and the third party organizations from industry.

Further to this, the research specifically examines the role of design capabilities in team
formation and the mobilization of innovative business models, and products and services.
Although this paper is focussed on the innovation pipeline driven from within an academic
institution, the work is also applicable to team capabilities and the support of the same in
comparable innovation events e.g. hackathons, design-sprints and co-creation events
(Trainer, Kalyanasundaram, Chaihirunkarn & Herbsleb, 2016). Academics already
participate in these spaces, particularly from the fields of design, computing and the
creative industries. Although potential novel products, services or start-ups are developed,
these events have not explicitly sought to support post-sprint business development. We
have highlighted the importance in bringing the right skills into the different phases of
design-led innovation and to support knowledge exchange. Recognizing that it is not just
designers that are required, but bringing in those from the arts, technology and business
sectors to encourage knowledge exchange and design-led innovation. However,
facilitating knowledge exchange through a common platform enabled by design
capabilities.

By revealing key design capabilities that are commonly required by teams at different
stages of a design led innovation process, we can further support these by more easily
identifying gaps and tailoring advice. This may overcome common roadblocks and provide
opportunities for a more targeted, streamlined approach to university-business
entrepreneurial efforts as well as scaffolding university-industry partnership working. This
is an ongoing consideration for further research in this area.

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About the Authors

Saskia Coulson is a postdoctoral researcher on Making Sense (H2020), previously on Design in Action (AHRC) focusing on value of design in new business development. Her doctoral research was funded by ESRC and sponsored by V&A Museum of Design Dundee.

Mel Woods is a Reader in Creative Intelligence at University of Dundee, focusing on supporting people with knowledge and information exchange for change making. She is lead investigator for AHRC Design in Action, H2020 Making Sense and H2020 GROW Observatory.
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Erik Bohemia is the Programme Director in the Institute for Design Innovation at Loughborough University London. He is interested in Design as a cultural practice and the material effects of design.

Cees de Bont is dean of School of Design, Hong Kong Polytechnic University. His research interests are in the areas of early concept testing of consumer acceptance, branding, networked innovation and design education.

Lisbeth Svengren Holm is professor in Design Management at Gothenburg University, Director of Business & Design Lab. Her research interests include design management, design & strategy, design & innovation, and the interaction between design and other functions.