

Received Date:

Revised Date:

Accepted Date:

Article Type: Original Article

Corresponding Author Email ID: linus@linustan.com

Abstract

This paper shows the importance and value of ambiguity to reveal opportunities hidden in problems and the manner in which ambiguity is removed from applications of design thinking. It describes the value of introducing, sustaining and using ambiguity and explains the different types of ambiguity. It follows up by describing the events when a designer encounters ambiguity. This paper proposes that an understanding of ambiguity is needed to harness its capabilities in finding innovative opportunities. To do so, design practitioners should consider 1) identifying the type of ambiguity needed to expand the scope of opportunity exploration and 2) becoming aware of and managing one's ability to work with ambiguity. Finally, it identifies the lack of literature on the impact of independent and collective experience on using ambiguity in design.

Keywords: Ambiguity, Design Value, Opportunity Identification, Innovation Opportunities

Introduction

Increasingly organisations use Design Thinking to innovate in their industry. It is presented as a unified framework for innovation (Cohen, 2014) described as a set of design principles

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/dmj.12045](https://doi.org/10.1111/dmj.12045)

This article is protected by copyright. All rights reserved

to realise ideas (Kolko, 2015). Design Thinking instructions are simple and clear for people without prior design knowledge to apply the methods. However, within the extensive literature on design thinking, the value and use of ambiguity remain a vital, and under-represented topic this paper aims to explore.

While the explicit guide to Design Thinking is easy to follow, its prescriptive flow hinders intentional and valuable misinterpretation of the design situation. When more than one interpretation can be made, ambiguity emerges. This ambiguity creates the space for speculation and provokes alternative views that are so important to creativity. These views serve as contextual information that reshapes the understanding and expands the scope of opportunities.

The explicit stages of Design Thinking methodologies also hinder the emergence of new interpretations. The methodologies urge people to select one idea to progress to the next stage, winnowing options for maximal efficiency. This selection determines the context and confines opportunity exploration within its contextual boundaries. When ambiguity is introduced, unresolved ideas are permitted to exist and to reveal their relevance to the opportunity later in the process.

There is increasing literature in recent years on using design concepts in innovation management (Boland & Collopy, 2004; Brown, 2008; Verganti, 2008). These literature present alternative approaches for organisations to address the unpredictable and rapidly changing environment and to maintain a competitive advantage (Jahnke, 2012). One of these approaches is to use trial-and-error learning to address ambiguity and find innovation opportunities (Loch, DeMeyer, & Pich, 2006). However, the usefulness and benefits of ambiguity are often ambiguous themselves, which creates additional uncertainties to the situation. Hence, some management practices seek out ambiguity to eliminate it (Koria & Karjalainen, 2012). A different response is using the knowledge of the found ambiguity to continue exploring opportunities for innovation. When it is used extensively, innovation opportunities become limitless. However, the full potential of design exploration, which ambiguity facilitates, in scoping out business opportunities are often not reached, and the research on such design strategies is also lacking (García, 2012).

Many design professionals approach ambiguity differently. While the Design Thinking process gradually eliminates ambiguity to reach a clear solution to an uncontested problem (Brown 2008), the architecture design process, for example, embraces ambiguity, seeking opportunity for value, to deliver innovative designs. An architectural case study that illustrates the importance of ambiguity in finding design opportunities is the Peter B Lewis Building (Case Western, Ohio). The architect incubated his ideas and transformed them into designs at the appropriate moment (Boland, Lytinen, & Yoo, 2007).

Although psychology literature has shown that ambiguity has been used to represent vagueness (Norton, 1975), this paper aligns itself with the understanding that ambiguity is created by our interpretative relationship between our experiences and the subject matter (Gaver, Beaver, & Benford, 2003). Ambiguity elicits and alludes multiple interpretations of the situation, permitting re-reading and hence unfetters us, whereas vagueness refrains the perceiver from forming useful interpretations. Hence, ambiguous ideas elicit and allude multiple possibilities whereas vague ideas obfuscate the perceiver to find useful applications.

This paper identifies the uses and values of ambiguity, describes the types of ambiguity and how to work with ambiguity. It offers organisations strategies to navigate through and benefit from ambiguity and to identify opportunities hidden in ambiguity.

Using and Values of Ambiguity

01 Introducing ambiguity to find opportunities

One of the ways architects reveal opportunity is to introduce ambiguity to the problem intentionally. They do so by exploring the problem and proposing ideas simultaneously. This engagement with ambiguity in the early stages of the design process differentiates the architectural design process from the Design Thinking methodology discussed in innovation management literature.

When the problem is made ambiguous, every idea proposed is a possible opportunity waiting to be realised. When a problem is defined, ideas proposed after that can be easily and prematurely judged on its suitability in addressing the identified problem. By

introducing ambiguity to the problem, ideas become a tool to scope for opportunities in the problem and to define the problem incrementally. Similarly, opportunities discovered through this process also become mechanisms to guide the trajectory and pursuit of ideas and to progressively refine the solution.

Design Thinking starts by exploring the problem to define the brief. It is followed by ideating, which suggests that ideas proposed are responses to the brief. However, exploring the problem and ideas simultaneously changes the seemingly logical sequence proposed in the Design Thinking process into a bidirectional relationship. Exploring the problem becomes an activity that identifies limitations and opportunities in the brief whereas designs are responses to the brief (Peña & Parshall, 2001). When the problem is ambiguous, and hence so is the brief, it removes the restriction for ideas to serve as direct responses. Secondly, the ambiguity presents the limitations as challenges for the ideas to overcome and not as rules the ideas must abide to. Thirdly, it gives ideas the freedom to help discover opportunities within the brief, similar to problem exploration. In this, we redefine the design process from *problem solving* (a closed ended process) to *opportunity seeking* (an open-ended process).

Opportunity identification has been recognised in the literature as a creative process (Long & McMullan, 1984) and has been proven difficult to document in research (Ward, Smith, & Vaid, 1997) and in industry (Rosenberg, 2010). It has been suggested that creativity becomes apparent in opportunity identification when entrepreneurs gather information to create new relationships and form new ideas (Kaish & Gilad, 1991).

02 Sustaining ambiguity to preserve dormant opportunities

Another way for architects to access dormant opportunities is to sustain ambiguity deliberately. Doing so protects unresolved ideas from being eliminated and gives them the chance to re-emerge as opportunities later in the design process. By iteratively defining the problem, the Design Thinking process eliminates any discovered ambiguity, which also limits the emergence of opportunities in the later stages of the process. Instead of defining the problem iteratively, some architecture design process reframes the problem continuously. This creates the conditions for unresolved ideas that were discovered in the early stages of

the design process to stay dormant until the circumstances become desirable for the idea to re-emerge as an opportunity.

Brown's 'Design Thinking' process leads designers towards a goal-orientated solution by iteratively defining the problem and validating the idea (Brown, 2008). Each iteration reduces the scope for novel ideas and discourages the pursuit of ideas that lie beyond the scope. Defining the problem motivates the designer to unintentionally create a definition derived from a limited perspective. This perspective is considered limited because it is developed from the designer's knowledge and experience (Schön, 1987). Hence the designer should analyse and reframe the problem from various perspectives to seek out opportunities that may be hidden from the designer's standard approach.

03 Using ambiguity to discover more opportunities

Keeping the brief ambiguous encourages designers to examine the brief from different perspectives. When the focus is shifted from finding a solution to exploring ideas, it expands the scope of opportunities.

During the industrial age, ideas of efficiency fostered a mindset that prioritised creating solutions over detailed examinations of the problem (Rittel & Webber, 1973). This ideology prevails in modern practices, with business managers analysing performance and trends for the purpose of finding and creating innovation (Boland et al., 2007). This goal-oriented focus limits ambiguity and restrains the opportunity for unexpected and innovative solutions.

An architectural case study that documents how ambiguity is used to find design opportunities is the Peter B Lewis Building which won multiple innovation awards. The architect consciously kept his design ideas malleable and used the fluid exchange of ideas and explorations to transform given limitations into new opportunities (Boland et al., 2007). One specific design opportunity that emerged through the process was the student lounge. It is a focal feature of the school that did not address the initial brief but was found when the architect's design ideas were used to explore the brief. The sequence of events that led to the innovative design demonstrated how design ideas can reveal hidden opportunities in the brief.

Since Design Thinking attempts to define the problem in the early stages and reduces the scope of opportunities as it progresses, the design process used in architecture offers a greater scope for opportunities and an alternative model to identifying entrepreneurial opportunities and innovation.

Types of Ambiguity

The following sections identify and explain ambiguity by using the linguistic model of ambiguity. It identifies the distinct characteristic of the different types of ambiguity and uses architectural case studies to explain how the ambiguity is applied in its design.

01 Ambiguity in the idea itself: Lexical ambiguity

Lexical ambiguity exists when a word has multiple meanings. It relies on the sentence, which is the contextual information, to ascertain its relevant meaning. One example is the word 'duck'. It could mean 1) a type of animal, or 2) the action of lowering oneself. Without context, both meanings are valid. When it is placed in context, for example "the duck laid an egg", the word is locked into one definition and loses the other.

An architectural example that uses lexical ambiguity is the design of banks in the 18th and 19th century. Banks of this time period, such as the Bank of England (Fig 1), used classical compositions to associate themselves with the prosperity and stability of ancient Greek civilizations (Fig 2). In architecture, columns serve a structural purpose. By imitating classical architecture, the banks use the columns to express another meaning; a sense of grandeur and prosperity portrayed by its scale and prominence at the entrance. This is also observed in its high walls. A wall primarily serves to divide a space, but the banks extended the height of the walls to demonstrate security and protection of its contents. Hence, the columns and walls in the Bank of England carry both structural and symbolic meaning.

<insert figure 1 here>

Figure 1 Main entrance of the Bank of England, originally built in 1818 and renovated in 1924, Retrieved from <https://www.flickr.com/photos/david-bank/10657975436/> Copyright 2013 by David Bank

<insert figure 2 here>

Figure 2 Parthenon in Athens, Greece built circa 435 BC, Retrieved from <https://www.flickr.com/photos/andazolamit/368794044> Copyright 2005 by Arturo Andazola

Lexical ambiguity can also be applied to visual arts and has been known to elevate the value of some artwork. Psychology literature shows that some value is derived from the ability to provoke and challenge the viewers' understanding and interpretation of the artwork (Kreitler & Kreitler, 1972). When used skilfully, deliberate ambiguity can evoke the feelings of mystery and curiosity through its artwork. A well-known artwork that exemplifies this feeling is Mona Lisa by Leonardo da Vinci. To evoke the emotional experience in his viewers, Leonardo employed ambiguity by blurring the outlines of her lips and eyes to hide the expression of Mona Lisa. This created a 'terrain for infinite variations' (Sassoon, 2001) and gives viewers the opportunity to form their own interpretation of the artwork. It also keeps the artwork an unresolved mystery.

02 Applied ambiguity: Syntactic ambiguity

Syntactic ambiguity occurs when multiple interpretations of a sentence exist. The words used may have a definite meaning, but their sequence in a sentence can present different situations. For example, "visiting relatives can be boring." It could mean 1) the act of visiting relatives can be boring, or 2) relatives who visit, can be boring.

An architectural example that uses syntactic ambiguity is Federation Square in Melbourne, Australia. Designed by Lab Architecture Studio and Bates Smart, it was completed in 2004 and has a civic space that can accommodate different functions. A design feature that has an ambiguous function is the different areas that were elevated deliberately from the ground. As they do not follow standard heights of a step or a seat, these areas end up serving as both (Fig 3). If the area is in a visitor's path towards the Federation Square Building, it functions as steps. If a visitor was waiting in the area, it becomes a seat. Another ambiguous design feature is the slope throughout the site, which is used by the visitors in many ways (Fig 4). It is gentle enough for visitors to traverse up to Federation Square Building without the need for stairs. It inclines enough for visitors to sit and lounge on the ground. It is wide enough for visitors to stop in their tracks without obstructing the pathway. Hence, Federation Square uses syntactic ambiguity to allow visitors to determine how the design is used.

<insert figure 3 here>

Figure 3 Elevated areas that are used as seats and steps simultaneously, Retrieved from <https://media-cdn.tripadvisor.com/media/photo-s/0a/14/cd/6b/federation-square.jpg> Copyright by TripAdvisor

<insert figure 4 here>

Figure 4 Slope in the open space are walked on, stood on and sat on by visitors simultaneously, Retrieved from <https://www.flickr.com/photos/avlxyz/4190003506/> Copyright 2009 by Alpha Lau

Syntactic ambiguity, along with lexical ambiguity, is used extensively in a designer's early sketch design phases. When a designer creates a rough sketch, it is non-contextual. To an outsider, it is a sketch that can belong to different design briefs. This rough sketch may also be perceived as vague, as the perceiver is unable to make sense of it. However, the intent of sketching at this stage is not to create ambiguous or vague drawings but to initiate a reflective dialogue between the design and her sketch (Schön, 1992). An ambiguous sketch facilitates, within the designer, the retrieval of design ideas associated with similar designs. Hence, the level of ambiguity in the sketch can affect how much ideas the designer can recall from her experience and knowledge. As the perception of ambiguity does not have a direct relationship with the amount of information provided (Boehner & Hancock, 2006), specific details can be selectively added to help the perceiver comprehend the idea itself and not how it would function in different contexts. For example, "visiting relatives that live far away can be boring", adds details to the situation, but both interpretations continue to exist.

Hence, syntactic ambiguity is useful in prolonging possible interpretations without compromising the precision of the idea. When sustained indefinitely, such as the design features in Federation Square, syntactic ambiguity can indicate that the overall idea is suitable for multiple situations.

03 Different perception of an idea: Semantic ambiguity

Semantic ambiguity occurs when the situation eludes different meanings. It can exist as a combination of lexical and syntactic ambiguities, for example, "He saw her duck". It is

difficult, but not impossible, to discern from syntactic ambiguity. Semantic ambiguity often draws on the perceivers' inferring abilities to make sense of and to accept the idea.

This kind of ambiguity is prevalent in verbal interactions that rely on communicative devices (Aoki & Woodruff, 2005). When a receiver of a phone call suddenly disconnects from a conversation on their mobile phone, there are two options the receiver can pursue to explain the situation. Firstly, the receiver can call back to clarify what had happened. Alternatively, the receiver can introduce ambiguity by assuming multiple scenarios such as the caller accidentally hung up, the device automatically switched off or bad reception. Subsequently, they can choose to avoid clarification by inferring from experience why it may have disconnected, e.g. high occurrence of bad reception, and accepting their assumption.

Many of Apple's retail stores benefit from semantic ambiguity; are they public spaces or sales targeted? The design is guided by the intent to create positive purchasing experiences, which steers the design away from conventional retail design while delivering the same functions as a store. Apple stores display many of the same product spaciouly for visitors to use comfortably (Fig 5). They keep the price tag displays subtle (Fig 6), similar to the design of, or the lack of, checkout areas. Despite these significant deviations from conventional retail design, they rely on the visitor's own awareness that they are in a store and that the products on display are for sale.

<insert figure 5 here>

Figure 5 Apple Store in Brussels with the same products displayed repeatedly at each table, Retrieved from <https://www.apple.com/befr/retail/brussels/> Copyright 2015 by Apple Inc.

<insert figure 6 here>

Figure 6 Apple Store in London and the product display of only iPhones, Retrieved from <https://www.dezeen.com/2016/10/13/apple> Copyright 2016 by Nigel Young/Fosters + Partners

Contrastingly, Apple's recent campaign to rebrand some of their stores as 'Town Squares' have been faced with public criticism (Madrigal, 2017) and highlights the dangers of using semantic ambiguity.

A new design direction to focus on gathering spaces for Apple's future stores was announced with the intent to continuously improve the customer's purchasing experience. To achieve this goal, prominent design features were added to serve as meeting points and floor areas were dedicated specifically for people to congregate (Fig 7). As many Apple stores are located on prominent sites in various cities, there was an opportunity for these gathering spaces to serve both the store and the neighbourhood. Although Apple used the name 'Town Squares' to represent the element of a gathering space, it was perceived differently by the public. It invited public debates on the definition of 'Town Squares', with many disapprovals of private enterprises claiming a share of public spaces. In this instance, semantic ambiguity exists in the name. When used inaccurately, it prompted disapprovals from the public. If Apple had branded itself differently, or perhaps not announce a rebrand, it could be suggested that their stores would be celebrated as designs that contribute positively to the city (Fig 8) and not perceived as an attempt to impinge on public spaces.

<insert figure 7 here>

Figure 7 Render of Apple Store Piazza Liberty in Milan designed by Foster + Partners, where the main area is dedicated to a public plaza and a waterfall entrance, Retrieved from <https://www.apple.com/it/retail/piazzaliberty/> Copyright 2017 by Apple Inc.

<insert figure 8 here>

Figure 8 Apple Store Michigan Avenue designed by Foster + Partners, completed in 2017, where most visible spaces are open areas, Retrieved from <https://www.archdaily.com/882147/> Copyright 2017 by Nigel Young/Fosters + Partners

Greater examination is required to expand the understanding of ambiguity as the sections above by no means capture the extent of ambiguities. However, it aims to help readers discern ambiguous ideas from vague ideas, prevent the abandonment of ambiguous ideas that appear vague and help to discover innovation opportunities that are often hidden by ambiguous ideas.

Encountering Ambiguity

The following sections describe five events a designer encounters with ambiguity: Finding, Embracing, Distinguishing, Approaching and Tolerating. These are not presented as a linear sequence of events but describe moments experienced during the design process.

01 Finding ambiguity by pursuing an idea

Persistence with an idea can become a motivation to find ambiguity in the brief. When an idea is prioritised over the brief, it becomes more resistant to change than the brief. The brief is challenged and different interpretations (i.e. ambiguity) are actively sought after. This is achievable in some architecture design process because the problem and idea are explored simultaneously. Not all interpretations are valid and so designers use a variety of design methods to filter out useful interpretations from the found ambiguity.

Design methods reveal the unity between an idea and the brief (Yuille, Varadarajan, & Vaughan, 2014). It can also be argued that such design methods can test the relevance of an interpretation to the pursued idea. However, different design methods reveal different aspects of the relevance (e.g. a site plan articulates a planning idea better than a perspective sketch). Hence, the designer uses a myriad of design methods to identify the link between the interpretation of the brief and the pursued idea. The designs from these design methods help the designer determine if the speculated interpretation works in the brief and with the idea.

02 Embracing ambiguity to exploit emerging opportunities

Embracing ambiguity enables unexpected opportunities, which often lie beyond our conception, to emerge and enter our scope (Leifer & Steinert, 2011). The hidden opportunities present themselves and give us the prospects to consider its value and alignment with the brief. When a newfound opportunity holds potential and considerable value to the designer/project, it provokes the designer to challenge the brief. The higher the opportunity is perceived to be valuable, the stronger the provocation to modify the brief.

One of the difficulties with embracing ambiguous ideas is the burden on resources to test for exploitable opportunities. Some designers counter this difficulty by prototyping

iteratively to test ambiguous ideas. A successful prototype helps to recognise an emerging opportunity, whereas an unsuccessful prototype may indicate shortcomings in the idea. Although a failed prototype may suggest wasted resources, its failure often provokes designers to re-explore the limitations of the brief and in its act, discover ideas to overcome the barrier (Leifer & Steinert, 2011). Hence, it can be suggested that prototyping any ambiguous idea will help the designer better understanding the brief. Rather than selecting ideas for prototyping based on limited resources, managing resources to pursue ambiguous ideas will help discover more opportunities.

03 Distinguishing uncertainty from ambiguity

Uncertainty is an emotional state when an individual is unsure of what actions to take. Uncertainty is commonly experienced when encountering ambiguity, but it cannot be attributed solely to ambiguity. When an individual lacks the information, experience or skills to determine appropriate actions required for the situation, they also experience the feeling of being unsure.

Working with uncertainty is different from working with ambiguity. An identified framework that reason with uncertainty is the Theory of Belief Functions (Dempster, 1967; Shafer, 1976). The theory proposes that an individual can decide on a proposition by gathering accessible information of the different propositions and by assessing the probability of the different hypotheses. It explains the individual's decision-making process to minimise uncertainty and is not limited to any specific situation. This suggests that it can be used to address uncertainty in ambiguous situations without affecting the use of ambiguity.

04 Approaching ambiguity with the right intent

Three approaches have been identified to addressing ambiguity in design; 1) pragmatic, 2) critical, and 3) enterprising (Yuille et al., 2014). The approach to ambiguity is determined by the individual's intent for the design.

In a pragmatic approach, ambiguity is eliminated to ensure the design meets its predetermined functions. This can be described as encountering lexical ambiguity and responding by selecting a more specific word. For example, *drake*, a male duck.

In a critical approach, ambiguity is seen as a mechanism to highlight and discuss how the design is used in its context. This can be described as approaching syntactic ambiguity and using it to provoke questions about the context. Using the example of “visiting relatives can be boring”, it seeks to provoke questions such as 1) Why are visiting relatives who visit considered boring; 2) Why is the act of visiting relatives considered boring; and even questions like 3) how is boring measured.

Finally, enterprising approach is critically examining ambiguity to eliminate it. This would be described as recognising and responding suitably to ambiguity. Using the example “visiting relatives can be boring”, the information provided is first made aware as ambiguous. The different yet valid interpretations are used to question and find a clearer definition, such as “relatives who visit can be boring”.

05 Tolerating ambiguity to develop hidden opportunities

Ambiguity tolerance is one’s ability to recognise ambiguity as either a resource or an obstacle (Budner, 1962). This ability influences a person’s behaviour when they encounter ambiguity (Tegano, 1990). An individual with a low tolerance for ambiguity prefers working in ‘black-and-white’ situations compared to individuals with a higher tolerance for ambiguity.

An aversive attitude towards ambiguity limits the scope for exploring opportunities. Research has shown that individuals with a low tolerance for ambiguity have led to judging ideas prematurely and rejecting alternative views (Frenkel-Brunswik, 1949). This behaviour often leads to a preference for defined ideas over other less-defined suggestions at the time of judgement.

An aversive attitude will also neglect opportunities that require more in-depth exploration to expose its hidden position under ambiguous ideas. Hence, it can be argued that a higher tolerance of ambiguity increases a person’s willingness to accept and investigate alternative opportunities.

Ambiguity in the thought and act of design

Ambiguity is difficult to articulate and expresses differently. Its ineffable nature makes it hard to extract from the design literature and even harder to use and benefit from. To elicit and emphasise its stealth, this section briefly elaborates on ambiguity in the context of thinking of and the act of design.

01 Ambiguity and divergent thinking

It is common to mistakenly assume that divergent thinking leads to ambiguous ideas and hence, to design with ambiguity. Divergent thinking helps designer explore ideas by encouraging creative and spontaneous ideas. It withholds judgement and aims to produce many ideas during a short time frame. It focuses on quantity over the quality of ideas before they are evaluated via convergent thinking. It is common at this stage to find the ideas both ambiguous and vague.

The creation of ambiguous ideas cannot be considered a defining characteristic of divergent thinking. Since divergent thinking is about generating ideas to address the brief, a designer is still considered to have thought divergently even when the generated ideas already exist as products and services in the market. Hence, it cannot be argued that divergent thinking introduces or will involve ambiguity.

Divergent thinking, however, does introduce uncertainty. When multiple options exist, the participant is unsure which option is the best solution, which creates a feeling of uncertainty.

02 Ambiguity and convergent thinking

Similarly, it is not uncommon to mistakenly assume that convergent thinking reduces ambiguity. Convergent thinking promotes logical decision-making to help designers focus on an idea. It uses research, data and facts to make logical conclusions and aims to find the 'single-best' solution, based on the brief. During this process, ideas with a clear problem-solution fit are kept. Conversely, ambiguous ideas, where the problem-solution fit is less known, are eliminated.

The reduction of ambiguity cannot be considered a defining characteristic of convergent thinking. Since convergent thinking is about finding a solution to the brief, a designer is still considered to have thought convergently by agglomerating all the ideas into a single solution. Ultimately, the found ambiguity is captured and maintained in this single solution. Hence, it cannot be argued that convergent thinking will eliminate ambiguity.

03 Ambiguity in the design process

When the design literature is observed on a macro scale, the design processes recorded seem to allude to the use of ambiguity, but there are insufficient works that address it directly. For example, in Lawson's (2005) *How Designers Think*, there is only one explicit reference of a designer who employed ambiguity in his design of a multifunctional and ambiguous sculpture. However, Lawson argues that designers appear to develop 'parallel lines of thought' (2005:297) in their projects and that the ability to sustain these thoughts allude to the designer's ability to maintain ambiguity. Sustaining these trajectories indefinitely also forces the creative reframing of the problem and the convergence of such segregated ideas into a single design. Authors describe and label ambiguity differently because it is challenging to express the topic clearly and uniformly across the design literature. Hence ambiguity of ambiguity obstructs researchers from gathering and examining its impact on design and undermines its value in the design process.

04 Ambiguity in a design technique

The observation on a micro scale also reveals a similar finding. Certain techniques in the designers' repertoire allude to the use of ambiguity, but seldom address it explicitly. The abstraction design technique was chosen for further investigation as abstraction and ambiguity have overlapping themes. However, abstraction is neither equivalent nor a superset of ambiguity. In abstraction, the designer takes a broader frame of reference to examine the brief. In Stricker's (2017) *Design Through Abstraction*, we observe the designer, through reflection, shows that the simplification process reveals innate qualities of the brief and initiate the designer with suggestive ideas. In this instance, abstraction introduces ambiguity by enabling the designer to create personal interpretations of the brief. Despite sharing similar characteristics to ambiguity (creating multiple interpretations of a brief), abstraction relies on the designers' proficiency in identifying potential and emerging ideas

(Kokotovich & Dorst, 2016). When the designer is not proficient, the abstraction technique may only suggest one interpretation of the brief.

Discussion

In seeking to explain and guide people through the Design Thinking process, the act of designing is made explicit and linear. Design, within such a context, is therefore widely understood to be a process of problem solving through reductionist progression and clarification. In contrast, designers speak to the uncertainty and ineffable nature of the design activity, celebrating the tentative and uncertain steps and those moments of realisation that an idea has emerged. Ambiguity is thus essential for ideas to emergence. The design solution then cannot be identified singularly as a solution to a problem. Instead, it might be described as recognition of an opportunity latent in the situation.

From a review of Design Thinking literature, we see the need to articulate the role and value of ambiguity in design. Since the designers' experience increases their capability to abstract (Kokotovich & Dorst, 2016), this suggests that the designers' experience may also influence their ability to ambiguate.

Collective design experience may also influence the ability of a design team to ambiguate the brief. A study identified that in certain situations, a group of problem solvers with a diverse set of experiences outperformed a homogenous team of expert problem solvers (Hong & Page, 2004). This suggests that a group's ability to create ambiguity from a diverse range of perspectives may compensate for the group's inexperience.

This paper has described the importance and value of ambiguity to reveal opportunities hidden in situations and the manner in which ambiguity is removed from descriptions and manuals of Design Thinking. We have described the value of introducing, sustaining and using ambiguity and explained the different types of ambiguity. This taxonomy of ambiguity is illustrated by architectural design examples to illustrate the practical application of ambiguity. We have also described the events when a designer encounters ambiguity, namely Finding, Embracing, Distinguishing, Approaching and Tolerating.

Ambiguity has a value in the design process that is denied by Design Thinking approaches. The challenges are to articulate this so that it can be applied productively.

Conclusions

Ambiguity contains an abundant source of ideas and often hides opportunities for innovation. But several aspects hinder the recognition and use of ambiguity in the design and innovation process. Early designs contain a mix of ambiguous and vague ideas, creating one of the first challenges in identifying ambiguity. A second challenge lies in knowing when and how ambiguity should be applied to benefit the design process. The third challenge lies in the designer, for the lack of positive experience with ambiguity often creates apprehension towards similar situations. Despite these challenges, designers are still encouraged to 'embrace the unknown' and to 'take risks'.

This paper has argued that an understanding of ambiguity is needed to harness its capabilities in finding innovative opportunities. To do so, design practitioners should consider 1) identifying the type of ambiguity needed to expand the scope of opportunity exploration and 2) becoming aware of and managing one's ability to work with ambiguity.

To that end, we have explored these 'unknowns' and 'risks' by framing them as ambiguity and examined the value of using ambiguity in the design process. Using architectural examples, we have explained three types of ambiguity, their associated traits and how to identify them. We have also described five types of encounters to help designers use ambiguity in their projects.

We have identified a lack of literature on the impact of independent and collective experience on using ambiguity in design. The role of ambiguity can be further investigated, in the management of ambiguity in a creative context. From this, appropriate management techniques can be developed to realise the value from teams working with ambiguity.

References

- Aoki, P. M., & Woodruff, A. (2005). Making space for stories: Ambiguity in the design of personal communication systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 181–190). Association for Computing Machinery.
- Boehner, K., & Hancock, J. T. (2006). Advancing ambiguity. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 103–106). Association for Computing Machinery.
- Boland, R. J., & Collopy, F. (2004). Design Matters for Management. In *Managing as Designing* (pp. 3–18). California: Stanford University Press.
- Boland, R. J., Lytinen, K., & Yoo, Y. (2007). Wakes of innovation in project networks: The case of digital 3-D representations in architecture, engineering, and construction. *Organization Science*, 18(4), pp. 631–647.
- Brown, T. (2008). Design thinking. *Harvard Business Review*, 86(June), pp. 84–92.
- Budner, S. (1962). Intolerance of ambiguity as a personality variable. *Journal of Personality*, 30(1), pp. 29–50.
- Cohen, R. (2014). Design Thinking: A Unified Framework for Innovation. Retrieved from <https://www.forbes.com/sites/reuvencohen/2014/03/31/design-thinking-a-unified-framework-for-innovation/>
- Dempster, A. P. (1967). Upper and Lower Probabilities Induced by a Multivalued Mapping Author. *The Annals of Mathematical Statistics*, 38(2), pp. 325–339.
- Frenkel-Brunswik, E. (1949). Intolerance of ambiguity as an emotional and perceptual personality variable. *Journal of Personality*, 8(3), pp. 58–91.
- García, L. M. (2012). Understanding Design Thinking, Exploration and Exploitation: Implications for Design Strategy. In T. Karjalainen (Ed.), *International Design Business Management Papers* (Vol. 2, pp. 152-161). Aalto: Aalto University.

Gaver, W. W., Beaver, J., & Benford, S. (2003). Ambiguity as a resource for design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 233–240). New York: Association for Computing Machinery.

Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. In *Proceedings of the National Academy of Sciences* (Vol. 101, pp. 16385–16389)

Jahnke, M. (2012). A Design Perspective on the Concept of Dynamic Capabilities. In T. Karjalainen (Ed.), *International Design Business Management Papers* (Vol. 2, pp. 140–149). Aalto: Aalto University.

Kaish, S., & Gilad, B. (1991). Characteristics of opportunities search of entrepreneurs versus executives: Sources, interests, general alertness. *Journal of Business Venturing*, 6(1), pp. 45–61.

Kokotovich, V., & Dorst, K. (2016). The art of “stepping back”: Studying levels of abstraction in a diverse design team. *Design Studies*, 46, pp. 79–94.

Kolko, J. (2015). Design Thinking Comes of Age. Retrieved from <https://hbr.org/2015/09/design-thinking-comes-of-age>

Koria, M., & Karjalainen, T. (2012). Learning in ecosystems: Design-intensive projects in the creative industries. In T. Karjalainen (Ed.), *International Design Business Management Papers* (Vol. 2, pp. 16–21). Aalto: Aalto University.

Kreitler, H., & Kreitler, S. (1972). *Psychology of the arts*. Durham, North Carolina: Duke University Press.

Lawson, B. (2005). *How Designers Think: The Design Process Demystified*. (4th ed.). Oxford: Architectural Press.

Leifer, L. J., & Steinert, M. (2011). Dancing with ambiguity: Causality behavior, design thinking, and triple-loop-learning. *Information Knowledge Systems Management* 10, 10(1–4), pp. 151–173.

Loch, C. H., DeMeyer, A., & Pich, M. (2006). *Managing the Unknown: A New Approach to Managing High Uncertainty and Risk in Projects*. Hoboken, NJ: Wiley & Sons.

Long, W. A., & McMullan, W. E. (1984). *Mapping the new venture opportunity identification process*. Calgary: University of Calgary, Faculty of Management.

Madrigal, A. C. (2017). The Great Thing About Apple Christening Their Stores “Town Squares.” Retrieved from <https://www.theatlantic.com/technology/archive/2017/09/the-great-thing-about-apple-christening-their-stores-town-squares/539667/>

Norton, R. W. (1975). Measurement of Ambiguity Tolerance Robert. *Journal of Personality Assessment*, 39(6), pp. 607–619.

Peña, W. M., & Parshall, S. A. (2001). *Problem Seeking: An Architectural Programming Primer*. New York: John Wiley & Sons, Ltd.

Rittel, H., & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), pp. 155–169.

Rosenberg, N. (2010). Uncertainty and technological change. In *Studies On Science And The Innovation Process: Selected Works of Nathan Rosenberg* (pp. 153–172). World Scientific Publishing Company.

Sassoon, D. (2001). *Mona Lisa: The History of the World’s Most Famous Painting*. London: HarperCollins.

Schön, D. A. (1992). Designing as reflective conversation with the materials of a design situation. *Knowledge-Based Systems*, 5(1), pp. 3–14.

Schön, D. A. (1987). *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions*. San Francisco: John Wiley & Sons, Ltd.

Shafer, G. (1976). *Mathematical Theory of Evidence*. Princeton: Princeton University Press.

Stricker, M. (2017). *Design through Abstraction, The Wright Source to Art & Architecture*. (P. Storrer, Ed.). CreateSpace Independent Publishing Platform.

Tegano, D. W. (1990). Relationship of tolerance of ambiguity and playfulness to creativity. *Psychological Reports*, 66(3), pp. 1047–1056.

Verganti, R. (2008). Design, meanings and radical innovation: A research agenda. *Journal of Product Innovation Management*, 25(5), pp. 436–456.

Ward, T. B., Smith, S. M., & Vaid, J. (1997). *Creative thought: An investigation of conceptual structures and processes*. Washington, DC: American Psychological Association.

Yuille, J., Varadarajan, S., & Vaughan, L. (2014). Affinity & Ambiguity in Designerly Leadership. In *19th DMI International Design Management Research Conference* (pp. 2937–2953). United States: Design Management Institute.



dmj_12045_f1.png



dmj_12045_f2.png



dmj_12045_f3.jpg

Author Manuscript



dmj_12045_f4.jpg



dmj_12045_f5.jpg

Author Manuscript



dmj_12045_f6.jpg

Author Manuscript



dmj_12045_f7.jpg



dmj_12045_f8.png



Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:

Tan, L;Kvan, T

Title:

Finding and Using Ambiguity to Search for Innovation Opportunities

Date:

2018-10

Citation:

Tan, L. & Kvan, T. (2018). Finding and Using Ambiguity to Search for Innovation Opportunities. *Design Management Journal*, 13 (1), pp.17-29. <https://doi.org/10.1111/dmj.12045>.

Persistent Link:

<http://hdl.handle.net/11343/261093>