UNIVERSITY OF TECHNOLOGY SYDNEY

Inside the Creative Leap:

Understanding Metaphorical Thinking in Design

By

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Pee Suat Hoon declare that this thesis is submitted in fulfilment of the requirements for the award of the degree of Doctor of Philosophy, in the Faculty of Design, Architecture and Building at the University of Technology Sydney.

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Suat Hoon Pee

Date: 13 Nov 2018

To God be the glory!

The Lord is my strength and my shield; in him my heart trusts,
and I am helped; my heart exults and with my song I give thanks to him. Psalm 28:7

"but they who wait for the Lord shall renew their strength;
they shall mount up with wings like eagles; they shall run and not be weary;
they shall walk and not faint."
Isaiah 40:31

*"…*He gives wisdom to the wise and knowledge
to those who have understanding**…"** Daniel 2:21

Abstract

In order to understand design and design thinking, it is necessary to understand what lies at the *core of what designers do* in their creative practice. Literature reveals that the creative leap is recognised as an important aspect of design thinking (Archer 1965; Cross 2006), the kernel of design (Roozenburg 1993), and even the *real crux of the act of designing* (Archer 1965). This study is motivated by the need to gain insight into the creative leap, and to provide at least a partial answer to the question of where originality in design comes from.

Many researchers talk about the leap as the heart of abductive thinking (Taylor, Torugsa & Arundel 2017). Therefore, an improved understanding of abductive thinking could illuminate the steps underlying the creative leap. In design thinking, the creation of frames is powered by abductive thinking (Dorst 2011). As metaphors are used as frames in design practice, a focus on the use of metaphors in framing could shed valuable light on how the creative leap is carried out in design thinking. However, metaphor creation is a topic that is not well researched, according to Cila (2013). Therefore, it needs to be strengthened with empirical research.

The guiding question that directs this project is: "What are the creative processes present in metaphor creation?" The research questions developed in this study are:

> Research Question 1: *"Which types of creation processes of metaphors that help produce frames can be identified?"* and
> Research Question 2: *"How can the logical representations of these respective creation processes identified in RQ1 be described?"*

From literature investigation, it is found that there are various types of metaphors in existence and they are likely to be created in different ways. Since a *general* understanding of the creation process will not reveal how different metaphors are created, a *typology* approach is needed.

Three studies are conducted in this research project to answer the research questions. The findings reveal two types of creation processes: *Explicit Thinking Type (ET)* and *Perceptual Intuition Type (PI)*. In the creation of ET metaphors, designers use propositional symbols and logical inferences such as categorisation. For creating PI metaphors, designers make use of the gestalts of the design situations to trigger the metaphorical sources.

Findings from the single case analysis reveal that PI metaphors are often intuitively created. In order to gain an improved understanding of this process, the knowledge of image schema is applied in the analysis to illuminate how PI metaphors and the mysterious leap are conducted. This close description of the use of *image schemas* contributes significant insights into how originality is achieved in creative practice.

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1 Introduction

Kings Cross, the entertainment quarter in the City of Sydney used to attract 30,000 people over the weekends. Much of the crowd activity was concentrated in a narrow 500-meter stretch of road. This influx of people into the small space led to a number of issues that included drunkenness, fights, theft and drug dealing. Problems escalated as intoxication increased late into the night and sporadic violence occurred. The problem was not new. Over the years, the local government had increased police presence, added more security personnel and installed more CCTVs. But the problem stubbornly persisted.

In 2008, the Kings Cross problem was presented to the Designing Out Crime research centre (DOC). DOC was jointly established in 2007 by the University Technology of Sydney (UTS) and the New South Wales government's Department of Justice, Police and Attorney General. Designers at DOC apply design practices to generate innovative ideas to create a safe and protected environment.

Designers at DOC found that most of the young people who visited Kings Cross simply wanted to have a good time, but some get into trouble. Instead of looking at the situation as an obvious *law and order* crime prevention problem, designers at DOC used a broader lens (Dorst & Tomkin 2011) and reframed the context as a large-scale *musical festival*. The resulting solutions related to event management: transportation to bring the young people out of Kings Cross, especially late in the night; crowd control to facilitate the flow of people moving around; ensuring safety of people hanging out at Kings Cross. Approaching the problem through a design perspective produced non-traditional and innovative solutions.

In contrast, the conventional intervention with more policemen, security and CCTVs turned Kings Cross into a sterile place that no longer appealed to partygoers. Many shops closed down or were on the verge of closing down after the lockout law

implementation in February 2014. The Sydney Morning Herald announced the “death of Kings Cross” on 22 Sep 2014.

1.1 Importance of design thinking

The Kings Cross case study illustrates how using design thinking as a different approach to a problem can generate very different solutions. Design thinking is increasingly indispensable, as today’s problems become more “open, complex, dynamic and networked” (Dorst 2015b, p. 12). This requires us to step back and view them in radically different ways before moving to solutions (Beckman & Barry 2012; Dorst 2015b; Getzels 1964).

The Kings Cross case study also demonstrates the usefulness of design thinking for a non-design field like criminology, resulting in a rising interest in design thinking among professionals from other fields (Andrews 2015; Müller & Thoring 2012; Ward, Runcie & Morris 2009). Design approaches are now being used to address issues from solving global problems to running organisations (Maeda 2013). They have entered science, education, business, politics, policy making. Specific uses highlighted in the research of Johansson-Sköldberg, Woodilla & Çetinkaya (2013) include administration and management of libraries, hospitals, legal practices, human resources. Design thinking is considered an inspiring paradigm for handling complex problems (Dorst 2011).

However, this demand of design thinking in these disparate and wide ranging fields requires the identification of the core of what designers do in their creative practice. This understanding is useful to guide non-designers and design practitioners who are interested in applying design thinking.

1.2 What is design thinking?

Design thinking is usually perceived as “what designers do” and is regarded as synonymous with design. It is defined by design practitioners as a way to identify

human needs and then using what is technically feasible to create value to satisfy users' desires in a strategically viable manner (Brown 2008, 2009; Kelley & Kelley 2013). This definition reflects the *management discourse* of design thinking (Johansson-Sköldberg, Woodilla & Çetinkaya 2013). It regards design thinking as a prescriptive, replicable process comprising toolboxes and methods to help companies understand user needs in order to develop innovative solutions (Dong, Garbuio & Lovallo 2016). This discourse focuses on success stories and how everyone can think like a designer. The development of design thinking in this discourse is drawn from design practices which is independent of design research and this resulted in criticisms for its lack of a scholarly base (Johansson-Sköldberg, Woodilla & Çetinkaya 2013).

A second discourse that is more academic and scholarly focusses on 'designerly ways of knowing' (Cross 2006) or *designerly thinking* to understand what designers do and how designers think to create new concepts. In contrast to the management discourse which takes a practice-based and process view of design thinking, the designerly discourse takes a cognitive perspective of design thinking (Dong, Garbuio & Lovallo 2016).

This thesis can be seen as taking the designerly approach and focuses on the cognitive skills that enable designers to develop original solutions. The research interests in adopting this approach centres on how designers generate original ideas, the moments in making the creative leap and sudden illumination present in creative practices (Cross 2006). Even though the creative leap is recognised as an important aspect of design thinking (Archer 1965; Cross 2006) in being the *kernel* of design (Roozenburg 1993) and the *real crux of the act of designing* (Archer 1965), these creative moments in the leap remain unpredictable and mysterious (Wang & Ilhan 2009).

1.3 The creative leap in design thinking

The creative leap often appears in creativity stories: Archimedes leaping from his bath, Kekule seeing the snake biting its tail, Fleming discovering penicillin after finding the dirty agar-plate (Boden 2004). These stories fascinate, but provide no clue on how the leap happens. A functional understanding of the creative leap begins with its definition: "a mental creative moment that results in a new design idea or the re-structuring and development of an existing idea" (Alhusban 2012). The creative leap has been described as a "flash of insight" - the sudden discovery of a solution to a problem (Bowden et al. 2005). The insight may come from a novel way of *seeing* or *representing* the observed data (Klag & Langley 2013) or from a new understanding of the problem situation (Luo & Knoblich 2007).

While scientific disciplines use analytical deductive or inductive thinking in rational problem-solving, chance discoveries (Magnani 2007) as described above and designers use fundamentally different *abductive* thinking to produce the creative leap in creative problem-solving. Abductive thinking offers a mechanism of discovery through *logical reasoning* (Dong, Garbuio & Lovallo 2016) and is recognised as a core element of design thinking (Dorst 2010). In the abductive thinking process, designers *see* patterns and uncover relationships among various sources of information that facilitate the creative leap. Uncovering how the creative leap is triggered during abductive thinking would illuminate how designers think creatively.

In design, abductive thinking is applied to create new *frames* to tackle design problems (Dorst 2011). Frames provide ways of 'seeing' the problem situations and addressing problem issues. For this investigation, the definition of framing is taken from Dorst: "*Framing refers to the creation of a novel standpoint from which a problem situation can be tackled. This includes perceiving the situation in a certain way, adopting certain concepts to describe the situation, patterns of reasoning and problem solving that are associated with that way of seeing, leading to the possibility to act within the situation"* (Dorst 2010, p. 134).

A *problem frame* looks at the problem situation, organises the knowledge and reconstructs it to give new meanings or realities that guide further actions (Schön 1993). A *solution frame* defines potential solutions in broad strokes that lead designers to relevant knowledge and processes for producing solution ideas (Duncan 2007). The example in the introduction of this chapter shows how the DOC designers created novel solutions for Kings Cross by reformulating or *reframing* the problem as a music festival, thus creating a new solution frame and setting a different direction for solutions.

An interesting way to view the creative leap in framing is provided by Cross (2006) who considers it as the construction of a bridge that links design problem to solution. It has been empirically shown that expert designers explore unstable problem and solution spaces until they are connected by an emergent bridge identifying a "problem-solution pair" (Lawson & Dorst 2009). The creative leap is not necessarily the sudden dawning of a completely new way of seeing the problem situation, or a radical shift in design solutions. From empirical data, Dorst & Cross (2001a) demonstrate that the bridge is gradually built using partial structures of the problem and solution spaces. The creation of this bridge requires a high level of design skill and is commonly known as *co-evolution* in design literature (Dorst & Cross 2001a; Wiltschnig, Christensen & Ball 2013).

To build bridges between design problems and solutions, designers have to *see* and *use* patterns across disparate disciplines and contexts to bring together situations that are usually not related together (Reichertz 2007). For example, the designers at DOC linked the law and order problem to a seemingly unrelated music festival. To make such connections, designers have to recognise implicit patterns and establish relationships (Dew 2007). Kolko (2010) attributes this ability to perceive patterns in design situations to intuition where intuition is generally considered as a gut feeling or instinctive impulse that guides decisions (Blackler & Popovic 2015; Fischer, Itoh & Inagaki 2015). For the purpose of this project investigation, the definition of intuition is taken from Zander, Öllinger & Volz (2016) to mean an *experience-based perception in terms of a sensitisation toward the detection of hidden patterns whose structure*

cannot be immediately verbalised. The work of Bowers et al. (1990) elaborates the process over two stages. In the first stage, clues are accumulated from information that are not consciously represented and synthesized into a pattern. In the second stage, the implicit activation becomes consciously available and is explicitly represented. This description highlights the use of patterns and initial non-conscious processing in intuition. It has been reported that past experiences inform intuitive processing (Blackler 2008) that is based on tacit knowledge. The outcome of intuition is holistic (Gobet & Chassy 2008) of the situation and is often referred to as a gestalt (Zander, Öllinger & Volz 2016).

Another way to find out how bridges are built between design problems and solutions is by tapping on metaphor knowledge. As part of the framing process, metaphors offer structure, facilitate understanding of unfamiliar design situations and contribute directions for actions. In this framing process, the designer's *imagination* first bridges the gap between what is experienced in the design situation and the abstract thought expressed in a metaphor. Thereafter, this metaphor that is the basis of a frame helps the designer carry out unconventional thinking to generate innovative design solutions (Casakin 2007; Schön 1967). The discussion in this section leads to the decision to focus on the application of metaphors in framing to investigate the creative leap in design thinking.

1.4 Understanding metaphor creation in design

In this doctoral thesis, an understanding of how metaphors are created will be used to find out more about the creative leap in design. Before stating the research objective of this thesis, a definition and framework for the creation of metaphors in design will first be introduced. Additional discourse of metaphor will be discussed in Chapter 2.

Metaphors bring together two objects or ideas that appear different. They are used to provide a better understanding of an abstract or unstructured situation, known as "target", in terms of something more concrete and structured, known as "source"

(Lakoff 1993). In the Kings Cross case study described in the introduction of this chapter, the target is the Kings Cross design situation which is abstract and unstructured, while the source is the "musical festival" which is more concrete and structured, as shown in Figure 1.1.

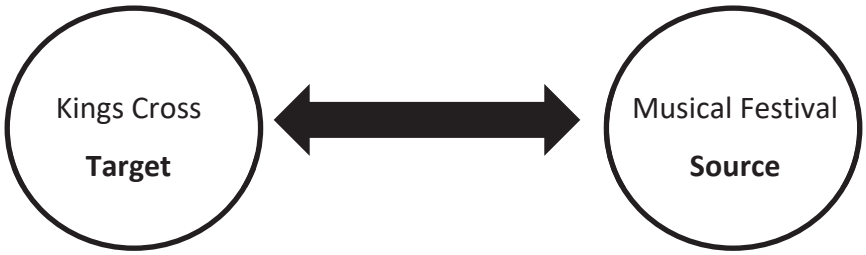


Figure 1.1 KINGS CROSS AS A MUSICAL FESTIVAL metaphor

A new understanding of Kings Cross is obtained through tapping on what is commonly known of a musical festival such as the common elements, properties and relations that exist in a musical festival. The common elements in a musical festival include attendees, event manager, program etc. Parallels between the musical festival and Kings Cross may be drawn once the link is established. For example, the element of 'musical festival attendees' may be linked to 'visitors to Kings Cross'. In addition, the mapping also reveals the missing elements in Kings Cross. For example, the event manager or organiser element existing in the musical festival concept is not found in Kings Cross. This missing role of event manager at Kings Cross opens up new design solutions. In addition, the well-defined relation between the scheduled program, main musical event, fringe events and transport arrangements in a musical festival contributes to design ideas for facilitating the circulation of visitors in Kings Cross. The organisation of entertainment and fun for the musical festival attendees are used to inspire new ideas to organise entertainment in Kings Cross. This includes the curation of an enjoyable experience for the musical festival attendees, provision of different services and the availability of guides when help is needed. When this pattern of inference is imported from musical festival to Kings Cross, it becomes apparent that there are only policemen available to assist the visitors at Kings Cross. In short, the musical festival source offers a new way to understand the experiences encountered in

Kings Cross. Through a better understood set of elements, properties and relations in a musical festival, new design directions could be generated for Kings Cross.

The above example reveals some reasons behind the wide use of metaphors in design and its important role in design practices. Metaphors influence how designers perceive, conceptualise and organise their knowledge (Casakin 2006b). This makes metaphors useful as problem solving tools in design tasks. Design fields that make extensive use of metaphors include human-computer interaction design, games design (Khaled, Nelson & Barr 2013), systems design (Carroll, Kellogg & Mack 1987; Hammond & Allinson 1987), urban design and product design (Antoniades 1990; Blackwell 2006; Cila 2013; Pickett, Cadenasso & Grove 2004; Saffer 2005). In these and other design fields, metaphors help designers understand design situations in new ways, clarify and structure design problems, identify and explore a variety of concepts, and restrict the number of probable design solutions (Casakin 2013; Casakin 2006b).

Among the various functions highlighted, the use of metaphors for framing a problem situation is of specific interest in this investigation. To frame the design problem in a novel way, there is a need to reformulate the design situation and change the representation of the problem structure by looking for unusual and unique relationships (Casakin 2012).

The creation of a metaphor in design

Schön's description of the creation of the PAINTBRUSH AS A PUMP metaphor is chosen to describe the metaphor creation process. The case study is selected because Schön provides detailed descriptions and insightful comments (Schön 1967, 1993). In addition, many researchers have analysed the case study and shared their understanding of the metaphor creation process (Clancey 1997, 1999; Indurkhya 1992, 1994, 2007). The case study will be used again in Chapter 4 for a closer examination of what and how connections are made between the painting and pumping process, and how the pump metaphorical source is triggered.

In the case study, a team of product researchers tried to enhance the performance of paintbrushes that are manufactured using synthetic bristles. The investigation is triggered by their observation that the new synthetic brushes deliver paint in an uneven "gloppy" finish compared to the smooth finish of the original natural bristle brushes. These attempts to enhance the wall finish led to the creation of a PUMP metaphor.

Schön describes how painting is seen initially as a smearing process: paint on the brush is smeared on the wall as the brush moves across its surface. Using this understanding of the painting process, the product researchers are puzzled when the synthetic fibre brushes produce very different results from the natural fibre brushes. As the product researchers continue to immerse themselves in the painting experience, they begin to *see* the painting process differently. They observe that paint is forced to flow in between the bristles when a paintbrush is pressed against a surface. A sharp bend *forces* all the paint out suddenly in both natural and synthetic fibre brushes. One of the product researchers notices that to facilitate a better flow of paint, some painters attempt to *vibrate a brush* as they apply paint onto a wall.

A breakthrough occurs when one of the product researchers experiences a flash of insight (Indurkhya 1994) arising from the unarticulated perception of similarity between painting and pumping. This perception is initially expressed by the product researchers using the activity of painting and inviting others to watch and using terms such as 'squeezing' or 'forcing' to convey the pump-like nature. This eventually leads to the "paintbrush is a kind of pump" explicit comment by one of the product researchers. It is useful to highlight that Schön attributes the generation of metaphor to the concrete situation in which the product researchers are able to experience the painting act in the problem situation and to reflect on the problem simultaneously. The significant role of this immersive environment to create metaphors is discussed in Chapter 4.

It is useful to observe that the product researchers are unable to explicitly state exactly what is similar when the metaphor is first created (Schön 1967, 1993). Schön assesses

that the PAINTBRUSH AS A PUMP metaphor is generated based on a pre-analytic detection of similarity between the paintbrush and pump (Schön 1967). On the other hand, Clancey (1999) deduces that the metaphor is triggered by perceptual correlation between paint flowing through the bristle space in the paintbrush and fluid flowing through the channels in the pump. Details of correlation is given in Section 2.3 (Dimension 1: Basis of connection).

After the creation of the PAINTBRUSH AS A PUMP metaphor, features of the new painting experience are regrouped and reordered to correspond to the *pumping concept*. For instance, instead of seeing paint on the bristles being smeared onto the walls, paint is seen as *flowing* through *channels* between the bristles onto the wall. This transforms the concept of painting and the role of paintbrush. It leads Indurkhya (1994) to conclude that the PAINTBRUSH AS A PUMP metaphor is not triggered by *existing* similarities between painting and pumping. The similarities are produced by the metaphor in this case study as highlighted by Indurkhya (1992). This view that *metaphor can create similarity between target and source* is also supported by various researchers (Black 1954; Lakoff & Johnson 2003).

Development of a framework for understanding metaphor creation in framing

A framework for understanding metaphor creation in framing is developed using the work of Schön & Martin (1995) and the analysis of the PAINTBRUSH AS A PUMP metaphor creation process. This framework is applied to carry out analysis in later chapters. According to Schön & Martin (1995), the framing process consists of three steps. First, a situation or experience is problematised or interpreted as problematic. Second, a frame is created for the experience or situation where A is seen as B. Third, solutions are generated using the newly created frame. The first two steps may be considered as the s*ee* phase of the metaphor creation process following the work of Pee S. H., Dorst & Van der Bijl - Brouwer (2015) where framing is found to comprise *seeing, thinking* and *acting*.

In the PAINTBRUSH AS A PUMP case study, designers try to improve their understanding of the problem through "seeing" the issues in a novel way (Schön 1985; Seevinck & Lenigas 2013). They then "structure and formulate the problem" (Visser 2009) by determining the features of the problem that they want to focus on (Rein & Schön 1977). By seeing the design situation in a certain way (Schön 1985) and bringing together salient features of the situation, the designers can then adopt certain concepts to describe the design situation (Dorst 2010) which trigger the metaphorical source.

The framing process changes the meaning of the original problem situation and leads to a new interpretation with a different set of relationships. Framing facilitates non-standard and innovative responses to the problem (Dorst 2010; Seevinck & Lenigas 2013). The mapping of target to source is considered as the *think phase* which is not explicitly reflected in the three steps described by Schön & Martin (1995).

This pumping frame not only provides coherence and a way to grasp the painting situation, it also enables the designers to *act* by generating moves towards a solution (Dorst 2010). The *act* phase refers to the production of design ideas to tackle the problem issues in design projects. This *see, think and act* framework shown in Table 1.1 will be used for analysing the empirical data obtained from metaphor creation case studies in Study 2.

Table 1.1 *See-think-act* framework of metaphor creation

Analysis of PAINTBRUSH AS A PUMP metaphor creation process.	**See-think-act**
Structuring the immersive painting experience	**SEE**
Associating painting experiences with pumping experiences	
Projecting/mapping of pumping concept onto painting experience	**THINK**
Generation of initial design ideas	**ACT**

1.5 Research objective

The previous sections show that the creative leap is central to the design process (Cross 2006). As some researchers consider the creative leap as the heart of abductive thinking (Taylor, Torugsa & Arundel 2017), an improved understanding of abductive thinking could illuminate the cognitive steps underlying the creative leap.

In design thinking, the creation of frames is powered by abductive thinking (Dorst 2011). Metaphors are often used as frames to provide structure to enable the comprehension of unfamiliar situations and then generate links to action (Cornelissen, Holt & Zundel 2011; Pee S. H., Dorst & Van der Bijl - Brouwer 2015). A focus on the use of metaphors in framing could contribute to this research on the creative leap in design thinking. Understanding how a metaphor is produced is crucial, since the creative leap does not happen after the metaphor is created but is part of the creation process of the metaphor. Unfortunately, metaphor creation is not well studied in design and linguistics research according to Cila (2013). A study into the creation of metaphors in framing would help to uncover the mystery of the creative leap in design thinking. This leads to the need for an in-depth theoretical and empirical investigation into metaphor creation in design.

Research questions

This study is directed by the guiding question: "What are the creative processes present in metaphor creation"? A general understanding of how metaphors are created is not adequate as it does not reflect the creation processes of specific metaphors. To find out how specific metaphors are created, it is necessary to explore the following two research questions:

Research Question 1: *"Which types of creation processes of metaphors that help produce frames can be identified?"* and
Research Question 2: *"How can the logical representations of these respective creation processes identified in RQ1 be described?"*

Research focus

The aim of this study is to uncover the core of creative practice by exploring how metaphors are produced during the framing activities in the design process. Framing is selected as the hunting ground for this investigation for the following two reasons. Firstly, metaphors are often used in the framing activities of the design process. Secondly, the abstract type of metaphors is expected to be produced in framing since framing deals with approaches to address problem issues. In this research, abstract metaphors refer to metaphors that are not created using perceptual similarities or properties (Russell 1986). They tend to be more complex than simple metaphors. For example, the abstract metaphor A PURPOSEFUL LIFE IS A JOURNEY is made up of two simpler metaphors; PURPOSES ARE DESTINATIONS and ACTIONS ARE MOTION. In comparison with metaphors created in other parts of the design project, abstract metaphors produced in framing are expected to result from larger leaps.

Contribution to knowledge

This research study contributes significant theoretical understanding to the metaphor creation process in design practice. This research uncovers two types of metaphor creation processes which comprise the *see, think* and *act* phases. While the first type of metaphor is produced using explicit thinking, the second type is intuitively created. Both types of metaphor creation processes are discussed in details in Chapter 5. Insights obtained from this investigation contribute to design theory development and goals relating to design pedagogy and design support. New understanding of what designers do in their creative practices is uncovered through linking the metaphor and design fields. This approach of applying embodied cognition through application of conceptual metaphor theory to understand how designers work is a major contribution which is recognised by Antle (2017) as “largely absent”.

1.6 Research Method

Epistemology and theoretical perspectives

Constructionism is selected as the epistemological perspective for this project after considering the research aims and objectives. It is understood in this constructionism perspective that knowledge and meaning do not reside in objects waiting for people to discover them. Meaning is constructed when humans interact and work with their worlds (Crotty 1998). In a similar way, the metaphor creation process is not out there waiting to be discovered, the metaphor creation process needs to be constructed from interaction with the design process. To uncover the underlying cognitive processes that designers apply for creating the various types of metaphors, the interpretivist theoretical perspective is chosen.

To start this investigation, it is useful to first examine existing literature findings on available types of metaphor creation processes that help produce frames. This turns out to be futile as research investigations into metaphor are mainly conducted in the context of language and not design research (Gentner 1988; Krzeszowski 2002; Lakoff 1993). Furthermore, among the design research studies, there are only a handful of structured studies which incorporated metaphor, according to Cila (2013). This present research proposes to tap on the rich and huge knowledge base of general metaphor research studies to shed light on the creation process of metaphors.

Most of the investigations undertaken by linguists, psychologists and philosophers focus on how people learn and understand metaphorical expressions or on ways in which verbal metaphors violate restriction rules (Gibbs 2010). These studies which are conducted mostly to understand the process of metaphor comprehension have produced many types of metaphors, such as poetic metaphors (Lakoff & Turner 1989), spatial metaphors (Boroditsky 2000), reification metaphors (Lakoff & Johnson 2003) etc. The studies do not contribute directly to the knowledge of how metaphors are created. There is a need to develop a means to identify types of metaphor creation process and to characterise and spot differentiating elements that affect the creation process.

A typology appears to be a useful means to clarify or put to "order" the different types of creation processes into groups. This ordering of metaphor creation processes can be based on single or multiple dimensions. Through the use of a typology, many individual cases of metaphor creation processes may be reduced to a few main types. This yields simplicity and order which helps to make the research more manageable. A typology will be used in this project to identify the main types of metaphor creation processes and to answer research question 1.

Research process and methodology

A qualitative and explorative research approach is taken in this project after considering the research questions and epistemological position. The first study is a literature research to develop the necessary analysing dimensions and attribute values that characterise the metaphor creation process. The outcome of Study 1 is a typology with dimensions and corresponding attribute values of the metaphor creation process. This typology will be used in Study 2 to differentiate metaphors based on how they are created.

Study 2 is a case study analysis of types of metaphor creation processes that produce frames in design. Case study is selected as it is often used for investigating a current event in its real life context (Yin 2002). In addition, case study could provide a rich description of the metaphor creation process through the application of multiple sources of data. While Study 1 examines the use of metaphors in general, Study 2 investigates the use of metaphors in design practices. The empirical data for metaphor creation activities will be captured in workshops where designers actively work with frames. These empirical data captured using real tasks in natural settings are critical in revealing the "intuitive" aspects of design ability that best reflect the nature of design. Based on the results of single case analysis, a cross case analysis is conducted in Study 3 to identify types of metaphor creation processes and to develop a logical representation of the various metaphor creation processes identified. The research design is further elaborated in Chapter 3.

1.7 Structure of thesis

The thesis has six chapters, as shown in Figure 1.2.

Chapter 1 Introduction provides the background and motivation for the study. As the "real crux" of creative design practice is the "creative leap", it is necessary to find out exactly what transpires in that leap. Literature reveals that abductive leaps can be understood in terms of *metaphors*. In design practice, designers create metaphors through analysing the design problems, then identifying a suitable metaphorical source and, finally, transferring knowledge from metaphorical source to design problem to generate novel design ideas. This adds to the clarification of the *see-think-act* aspects of metaphor creation. However, there is a paucity of metaphor creation knowledge which leads to the need to explore how metaphors are created using frame creation in design practice as hunting ground.

Chapter 2 Development of Typology of Metaphors summarises the findings of Study 1. Based on a literature study of the various types of existing metaphors, a metaphor typology with five dimensions and corresponding attribute values is developed. The dimensions are: (1) basis of connection, (2) representation form, (3) connecting element, (4) origins of sources and (5) cognitive utilities provided by source. These analysing dimensions reflect how metaphors are created and are used in subsequent studies to identify the types of metaphor creation processes.

Chapter 3 Research Design and Methodology describes the design and methodology for gathering empirical data for the single case analysis described in Chapter 4 and the cross case analysis in Chapter 5. The data sources are gathered using qualitative case methodology and include observation studies and secondary literature cases of metaphor creation in design applications.

Chapter 4 Individual Case Study Analysis describes the investigation and results obtained from the single case analysis. By applying the analysing dimensions developed in Study 1 onto the descriptions of how metaphors are created, the

attribute values of the five dimensions are obtained. The outcome of this chapter is the description of how metaphors are created in the ten case studies and the five corresponding attribute values.

Chapter 5 Cross Case Analysis.The results from Study 2 are applied to Study 3 in Chapter 5 to answer research question 1, *"Which types of creation processes of metaphors that help produce frames can be identified?"* and research question 2, *"How can the logical representations of these respective creation processes be described?"* The study finds two types of metaphor creation processes: Explicit Thinking (ET) Type and Perceptual Intuition (PI) Type. After identifying the types of metaphor creation processes, the logical representation of the creation processes of these respective types of metaphors are also uncovered.

Chapter 6 Conclusion summarises the key findings of this research project investigation. It discusses the contributions of the project investigation, their implications for design practice and education, limitations of the research design and recommendations for future research.

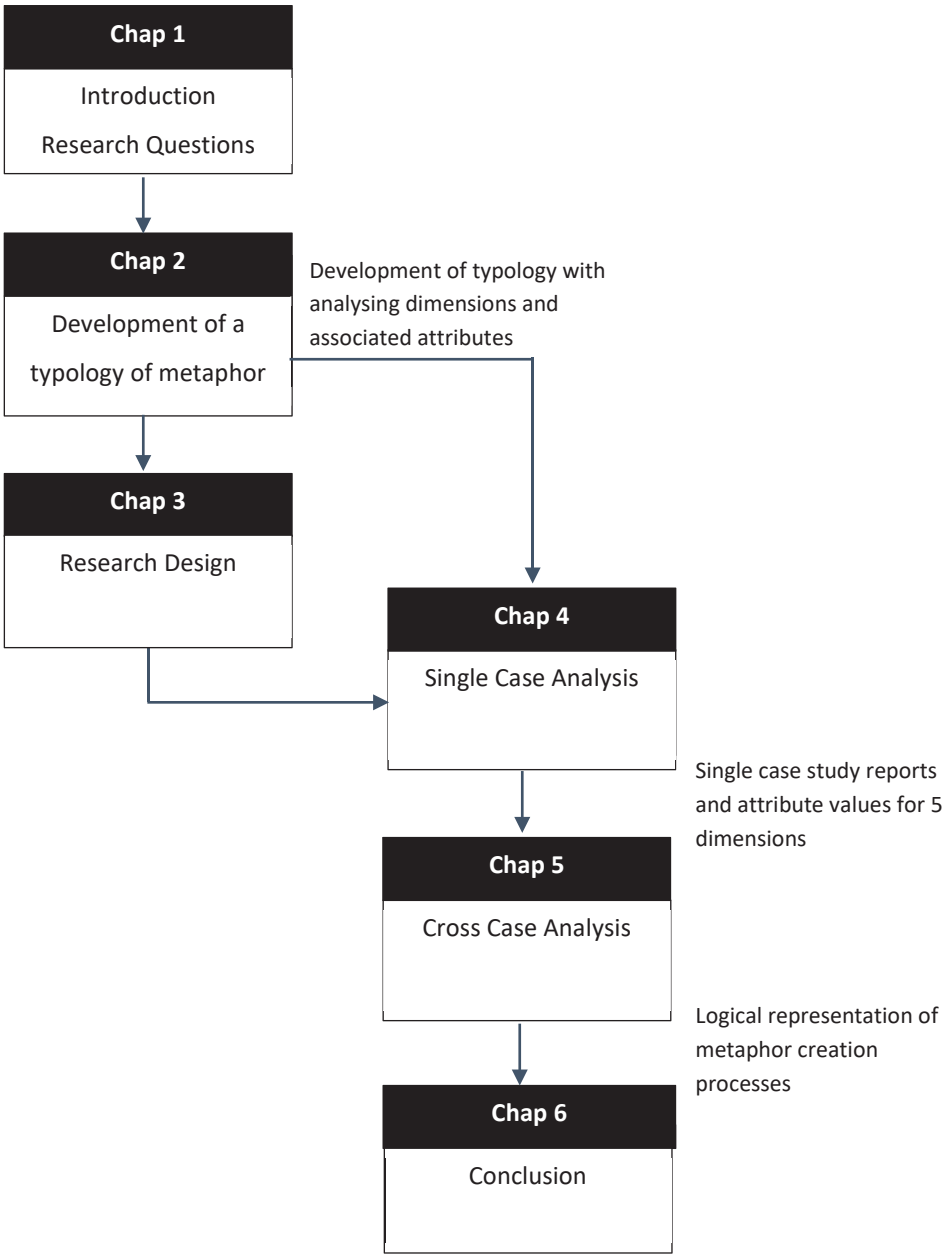


Figure 1.2 Overview of research project investigation

1.8 Conclusion

This project is an explorative study that seeks to better understand the core of creative practice and where originality in design comes from. The aim and questions of this investigation guide the design of the qualitative study using case studies. The goal is to investigate the creative processes in design by studying how metaphors are created. This is achieved by drawing knowledge from fields outside of design and tapping on

the results of the empirical research on design processes. The research findings could help shed light on the complexities of the metaphor creation process and provide a partial understanding of the source of originality in design. This understanding can provide guidance to design students, design practitioners and non-designers interested in applying design thinking in their own field.

2 Typology Development of Metaphor

It has been briefly discussed in Chapter 1 that there are numerous types of metaphors in existence. As these metaphors are likely to be created in different ways (MacCormac 1986), a general understanding of the metaphor creation process would not be beneficial. Instead, a *typology* approach will be developed in this chapter.

This chapter comprises five sections. Section 2.1 provides a general understanding of what a typology is and the approaches taken to develop a typology. Section 2.2 and 2.3 describe the development of the dimensions that characterise the creation processes of metaphors and the associated attribute values. Section 2.4 highlights the two pertinent characteristics of this developed typology. Section 2.5 summarises the observations of this study.

2.1 General understanding of typology

Typology is the study and classification of types. It is often used to reduce complexity through identification of similarities and differences in a variety of types, characterisation of types and detecting patterns (Bailey 1994; Buddemeier et al. 2008; Mandara & Murray 2002; Maru, Langridge & Lin 2011). Typologies have been applied in a wide variety of fields including healthcare, agriculture, nursing, management studies, marketing strategies and social sciences (Adler 1983; Collier, LaPorte & Seawright 2012; Flynn, Smith & Vanness 2006; Morrell 2005; Smit & Skinner 2002; Timmor & Zif 2005). Typological analysis serves three functions in qualitative research: *descriptive*, *classificatory* and *explanatory* functions (Bennett & Elman 2007; Elman 2009; Kluge 2000).

Descriptive typologies may be used to conceptualise a certain phenomenon by identifying the most relevant dimensions it possesses. In this way, typologies could lead towards the formation or revision of a concept (Koch, Mazzoleni & Mueller 2013). Classificatory typologies help identify the qualitative data obtained from research as

one of the types in a typology (Adams 1991; López, Valiño & Pérez 2008). By so doing, it enables the data to be discussed and compared in a systematic way. Explanatory typologies make use of both the descriptive and classificatory functions. The attribute values tend to be based on the variables in a pre-existing theory (descriptive function) while the content of the cells are derived from the logic of the theory (classificatory function).

Three approaches have been identified by Bailey (1994) for developing typologies: conceptual, empirical and operational. The conceptual typology is obtained *deductively* from theoretical development; the empirical typology is developed *inductively* through empirical studies; the operational typology is obtained by a combination of the deductive and inductive approaches.

The typology of metaphor creation processes serves the *explanatory function and is developed operationally*. An initial *descriptive* typology is developed deductively using the general metaphor literature in Study 1, followed by classification using an inductive empirical study of design projects in Study 2. This is used to uncover the *types* of metaphor creation processes existing in design practice. This helps to disentangle and streamline the diverse array of metaphors in the design field so as to better illuminate their creation processes.

Building blocks of a typology: attributes, dimensions, types

For this investigation, the typology is constructed to *classify* types of metaphor creation processes according to their characteristics, features or properties. These characteristics, features or properties are generally considered as *attributes,* using the terminology applied by most scholars (Kluge 2000; McKinney 1966). The grouping together of attributes that belong in a cluster forms a *dimension*. For example, Table 2.1 shows the typology of innovation strategy developed by Eiriz, Faria & Barbosa (2013). It has two dimensions: the *degree of novelty* and *type of innovation.* The attributes for the degree of novelty dimension are *incremental* and *radical* while the attributes for the type of innovation dimension are *product* and *process*.

Table 2.1 Innovation Strategy

Dimensions	Attributes	
Degree of novelty	Incremental	Radical
Type of innovation	Product	Process

A *type* represents a unique combination of attributes. For the dimensions and attributes given in the example, four types of innovation strategies are established depending on the *degree of novelty* and whether they are *product or process innovation*. The product development type of innovation strategy results from *incremental product innovation*. The remaining three types of innovation strategies are found to be (1) discovery, (2) learning by experience and (3) restructuring, as shown in Figure 2.1.

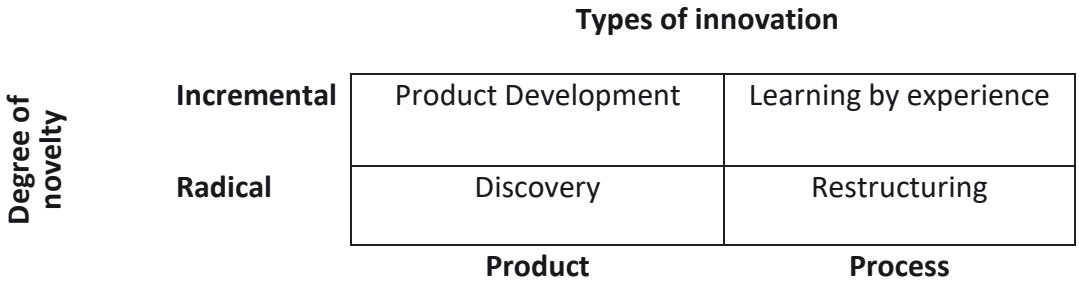


Figure 2.1 Types of innovation strategies. *Source* : Eiriz, Faria & Barbosa (2013)

This understanding of the key components in a typology will be used in the development of the metaphor typology in the subsequent sections.

Typology development

Typologies are often derived from either qualitative classification or from existing theory (Lambert 2015). They result from a grouping of selected attributes (Bailey 1994) and the construction is based on an attribute space defined by a combination of selected attributes and dimensions (Kluge 2000). The typology development process is elaborated in this section.

Various researchers have systematised the steps in creating typologies and the development of a type (Doty & Glick 1994; MacDougall et al. 2014). An examination of the methods shows that all of them comprise three essential steps: developing the dimensions, grouping of cases and type characterisation. This study does the same. It will first derive the attribute values and dimensions of the metaphor creation process from existing metaphor theories using the following steps.

1. Gathering data from metaphor literature
2. Clustering the types of metaphors found, and identifying appropriate dimensions
3. Developing the dimensions and related attribute values

The development of the dimensions and related attributes is directed by several guiding questions generated from the cognitive operations in the *see, think* and *act* phases of metaphor creation. These guiding questions are generated after consulting literature and reflecting on the cognitive operations reported in literature for producing metaphors.

In the *see* phase, knowledge of how metaphors are created helps to illuminate how we think (Kirkland 1987). This leads to the guiding question ***"What are the various ways to bring target and source together?"*** and, more pointedly, ***"How are these connections made?"***

A target is metaphorically understood by using a source through the transfer of ideas, logic and inferences from source to target. Every source offers a somewhat different way of understanding the target and, thus, influences the type of metaphors created. This leads to the guiding question of ***"Where do the sources come from or what are the origins of these sources?"***

In the *think* phase, metaphorical sources are used to throw new light on the target. This leads to the guiding question of ***"How does the source contribute to the understanding or knowledge of target?"***

The *act* phase is a generative phase that exists only in design practice and metaphor literature does not provide information that pertains to the *act* phase. Hence, no further question is developed for the *act* phase as metaphors would have served its intended purpose by providing a new way of seeing and a pattern of reasoning and problem solving (Pee S. H., Dorst & Van der Bijl - Brouwer 2015). These four questions above guide the development of dimensions in the next section.

2.2 Steps to develop dimensions

Metaphors in literature review

The rich literature of general metaphor descriptions and metaphor types can be traced to two sources: *classical* metaphor theories (Black 1979; Richards 1936) and the *conceptual* metaphor theory from the cognitive linguistic field (Grady 1999; Johnson 1987; Lakoff & Johnson 1999, 2003; Lakoff & Turner 1989). They provide two different explanations of *what* metaphors are and *how* metaphors are created.

There are three main views of metaphor in the classical theory: the comparison view, the substitution view and the interaction view. In the comparison view, two concepts seen as similar are compared. For example, the metaphor “Richard is a lion” recognises the common feature of bravery shared by Richard (target) and the lion (source). To produce a transformation in meaning, the comparison metaphor is used to find new relationship between target and source by identifying a similarity that is not seen before (Chaston 2010). As the substitution metaphor does not bring about any change in meaning, it will not be discussed further in this chapter.

In contrast to these two views, the interaction view of metaphor does not treat metaphor as merely a literary device. Metaphors under the interaction view are considered as cognitive tools and they are used for the construction of new meanings (Trčková 2014). New meanings are constructed through offering new perspectives by highlighting an inter-play between target and source. This makes the interaction metaphors useful in design. For example, in the BATTLE IS A GAME OF CHESS interaction

metaphor as shown in Figure 2.2, a number of associations may arise as we transfer everyday knowledge about the source (game of chess) to the target (battle) during interaction.

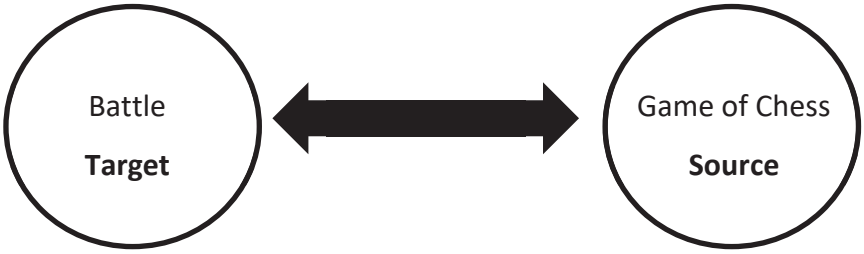


Figure 2.2 A BATTLE IS A GAME OF CHESS metaphor

In the interaction process, the target (battle) is seen through the 'filter' of the source (game of chess). Here, the metaphor has to carry out two tasks. First, it highlights certain aspects of the battle for attention such as strategy, positions of advantage and protecting the commander. Second, the metaphor excludes aspects such as casualties and cost of war in terms of emotional and physical aspects (Bond 2000). This interactive nature of metaphor leads to a change of how chess is viewed. Chess becomes a more aggressive game when it is seen through the filter of the battle (target). This inevitably heightens the emotional nature of the chess game and winning becomes very important. To win a chess game, strategic and tactical plans must be developed and there is a strong need to take control just like fighting a battle.

The above example shows that new meanings and views developed during the interaction process are not based on additional new information about battle or the chess game. The results are obtained from juxtaposing the metaphorical concepts of both BATTLE and GAME OF CHESS. Stovell (2012) notes that this interaction view remains one of the most referenced in metaphor studies and many researchers recognise its influence on the Conceptual Metaphor Theory (Indurkhya 1992; Van Rijn-van Tongeren 1997).

Conceptual metaphor theory is developed by Lakoff and Johnson in their seminal work *Metaphors We Live By* (Lakoff & Johnson 1980). The conceptual metaphor theory proposes to view metaphor not simply as a literary device but as a conceptual tool that is used for structuring and restructuring experiences (Kövecses 2008).

Of particular interest for this project are the following three characteristics of conceptual metaphors. The first characteristic relates to the function of conceptual metaphors, where metaphors can be used to open a new window to our experiences as they provide new meaning to "*our pasts, to our daily activity and to what we know and believe*" (Lakoff & Johnson 2008, p. 139). The second characteristic emphasises the use of metaphor in ordinary daily language rather than its use as ornament in comparison theories. Thirdly, conceptual metaphors are created using correlations and resemblances we encounter in our experiences (Grady 1999). Correlation refers to recurring co-occurrences of experiences. For example, the correlation of intimacy and warmth leads to the conceptual metaphor LOVE IS WARMTH.

A typology of metaphors

An investigation into the metaphor literature reveals the 12 types of metaphors listed in Table 2.2. The search is based on the works of researchers who have classified metaphors extensively (Caballero 2006; Kovecses 2002; Kovecses 2015; Lakoff & Johnson 2003; Lakoff & Turner 1989; Ritchie 2006). Some of these metaphors fall within the classical theory while others are conceptual metaphors, starting from the seminal work "Metaphors We Live By" (Lakoff & Johnson 1980) to more recent works by other researchers (Kövecses 2013; Shelestiuk 2006). The metaphor types in Table 2.2 are elaborated with examples in the remaining sections of this chapter.

Table 2.2 Metaphors obtained from literature review

	Classical/ Conceptual	Types of metaphors	Works	Researchers
1	Classical	From genus to species From species to genus From species to species Grounds of analogy	Poetics, 350 BC	Aristotle
2	Classical	Comparison Substitution Interaction	The Philosophy of the Rhetoric Models and Metaphors	Richards (1936) Black (1962, 1979)
3	Conceptual	Ontological Structural Orientational	Metaphors we live by (MWLB)	Lakoff & Johnson (1980)
4	Conceptual	Concept-to-concept (Generic, specific) Image-to-image Image schema to concept	More than cool reason (MTCR)	Lakoff & Turner (1989)
5	Classical	Similarity creating Similarity based	Metaphor and Cognition	Indurkhya (1992)
6	Classical	Syntactic Suggestive Projective	Modes of Metaphor	Indurkhya (1991)
7	Conceptual	Resemblance Correlation	A typology of motivation for conceptual metaphor: Correlation vs. resemblance	Grady (1999)
8	Conceptual	Semantic Structural Functional	Approaches to metaphor	Shelestiuk (2006)
9	Conceptual	Culture Perceptual Embodiment Conceptual knowledge	Metaphor. Encyclopedia of Philosophy and the Social Sciences	Kövecses (2013)
10	Conceptual	Structural Non-structural		Kövecses (2013)
11	Conceptual	Analogical Correlational		Kövecses (2013)
12	Conceptual/ Classical	Perceptual similarity	Perceptual Similarity and Analogy in Creativity and Cognitive Development	Stojanov & Indurkhya (2014)

Some of the metaphor types in Table 2.2 are the same as several researchers use different names to describe the same type of metaphors. For instance, *structural* metaphors, *ontological* metaphors and *orientational* metaphors (Row 3) may also be considered as structural and non-structural metaphors (Row 10) after merging structural and ontological metaphors as structural metaphors.

Analogy is featured in row 1 and row 11 in Table 2.2. Analogy is an inductive form of reasoning where there is a probability that 2 entities are similar in other aspects if they are found to be are similar in one or more aspects initially (Danesi 1999). Despite various differences that exist between analogies and metaphors, they are both used in similar ways for understanding unfamiliar problems. For the purpose of this project investigation, it is useful to observe that the cognitive processes used for reasoning in analogies and metaphors are found to be the same (Hey et al. 2008). Casakin (2011) makes a similar observation after tapping on Gentner's works (Gentner 1983; Gentner 1988; Gentner et al. 2001) where she presents a framework in which metaphorical and analogical comparisons are seen as a single process. As the purpose of this project investigation is to find out how metaphors are created, and since the cognitive processes underlying both metaphors and analogies are the same, analogies will be considered as the same as metaphors in this thesis. As the focus of research is on metaphor, analogy will not be discussed further in subsequent sections.

Metaphor clustering and selection

The 12 types of metaphors extracted from literature are first analysed based on their similarities and then sorted into clusters. Redundant groupings and those that do not contribute to the research objectives are excluded. Finally, the dimensions that are salient to the guiding questions and provide insights into the metaphor creation process are selected.

The sorting and clustering process results in four clusters of metaphors, as shown in Table 2.3. Cluster 1 describes the types of metaphors that are distinguished by the functions offered by their sources for understanding experiences that are not well

delineated, or are abstract concepts. Many of our experiences can be grasped directly, such as cooking or visiting a library. However, other experiences especially those related to human emotions such as love and anger; are not readily understood on their own. Cluster 1 provides indirect understanding of these experiences through ontological, structural and orientational metaphors. Examples of the three types of metaphors are LOVE IS A SOURCE OF WARMTH (ontological), LOVE IS A JOURNEY (structural) and HAPPY IS UP (orientational).

Cluster 2 describes the types of metaphors that are distinguished by the basis of their connection, i.e., how the metaphors are created. While the classical metaphor theories see metaphors created through *similarities* between targets and sources, such as ACHILLES IS A LION, the creation of conceptual metaphors such as LOVE IS WARMTH is known to be based on *experiential correlation* (Lakoff & Johnson 1999, 2003).

Cluster 3 describes the types of metaphors that are distinguished by the origin of their sources. Some origins are universal, for example sources derived from universal experiences such as LIFE AS A JOURNEY. Others are more personal, for example those who enjoy or act in theatres may create LIFE IS A THEATRE PLAY, based on their personal experiences.

Cluster 4 describes the types of metaphors that are distinguished by their target-source connection. In classical metaphor theory, metaphors are considered linguistic phenomenon and, hence, are generally used for connecting words and symbols, such as ACHILLES IS A LION. Under the conceptual metaphor theory, metaphors are used in cognitive and reasoning processes. The connections made between targets and sources include concept-to-concept, image-to-image and image schema-to-image schema (Lakoff & Turner 1989; Turner 1993), such as LIFE IS A FLAME.

Table 2.3 Clustering of existing metaphor types

Dimensions	Metaphor types	Researchers
1. Functions provided by sources for understanding target	Structural Non-structural	Kövecses (2013)
	Ontological Structural Orientational	Lakoff & Johnson (1980)
2. Basis of metaphor connection	Resemblance Correlation	Grady (1999)
	From genus to species From species to genus From species to species Grounds of analogy	Aristotle, 350 BC
	Comparison Substitution Interaction	Richards (1936) Black (1962, 1979)
	Similarity-creating Similarity based	Indurkhya (1992)
	Syntactic Suggestive Projective	Indurkhya (1991)
	Analogical relationships Correlation	Kövecses (2013)
3. Origins of sources	Culture Individual differentiated experience Embodiment Knowledge	Kövecses (2013)
4. Target-source connections	Concept-to-concept - Generic level - Specific level Image-to-image Image schema–to-image schema	Lakoff & Turner (1989) Turner (1993)
	Generic and specific	Kövecses (2013)

Further refinements and re-ordering are made to align the selected metaphor types to the four guiding questions in the *see* and *think* phases. As shown in Table 2.4, the basis of metaphor creation relates to the guiding question on the various ways to bring target and source together. The target-source connection contributes to an

understanding of how connections are made between target and source. Origins of sources contribute to the knowledge of where sources come from while cognitive utilities provided by source throw light on how source contributes to the understanding of target.

Table 2.4 Development of dimensions

	Guiding questions	Dimensions
SEE	What are the various ways to bring target and source together?	**Dimension 1.** Basis of metaphor connection
	How are these connections made?	**Dimension 2**. Target-source connection: Representation forms
		Dimension 3. Target-source connection: Connecting elements
	Where do the sources come from or what are the origins of these sources?	**Dimension 4.** Origins of sources
THINK	How does the source contribute to the understanding or knowledge of target?	**Dimension 5.** Cognitive utilities provided by the source

The next step in this typology development is to generate the attribute values for each of the five dimensions. These attribute values are extracted from the data captured in the "*Metaphor types"* column of Table 2.3. Many of the dimensions have a significant number of ways of representing their respective metaphor types. For example, there are numerous ways in which the *Basis of metaphor connection* dimension could be described. Therefore, one of the goals in this step of the typology development is to remove redundant descriptions by clustering similar attributes. Another goal is to select attributes that best reflect the metaphor creation process.

The following section on the development of attribute values for each of the five dimensions starts with a description of the dimension, followed by the choice of the attribute values for the associated dimension. The attribute values are then elaborated using some examples.

2.3 Development of attribute values for the five dimensions

Dimension 1: Basis of connection

This dimension describes how the source is triggered and drawn to the target. The basis of metaphor connection; also known as source-target pairing, conceptual association, grounding, motivation, is a subject of considerable interest to numerous researchers (Grady 1999; Lakoff & Johnson 2003). The research reveals five ways to describe how target and source could be connected (see Table 2.5). For discussion purpose, they are grouped according to the classical and conceptual metaphor views.

Let us first look at the attribute values in the classical view listed on the left hand column of Table 2.5. Aristotle's concept of metaphor (from genus to species, from species to genus, from species to species, grounds of analogy) may be generally considered as substitution and comparison theories in the classical view (Stambovsky 1988). Indurkhya's insightful description of *syntactic, suggestive* and *projective* metaphors elaborates the *interactive view* of metaphors. Taken together, all these classifications belonging to the classical view of metaphor may be broadly considered as *comparison*, *substitution* and *interaction* metaphors. These views have been discussed earlier in Section 2.2 where the comparison view considers metaphors as a linguistic embellishment while the interaction view links metaphors to cognition. The substitution view is not discussed in this study as the comparison view is considered more sophisticated and advanced.

On the right hand column are the *resemblance* and *correlation* metaphors within the conceptual metaphor view.

Table 2.5 Attribute values for Dimension 1: Basis of metaphor connection

Attribute values	
Classical	Conceptual
From genus to species From species to genus From species to species Grounds of analogy Comparison Substitution Interaction Syntactic Suggestive Projective	Resemblance Correlation
Similarity-creating Similarity based	

A metaphor connection based on *resemblance* is created based on similarity between target and source. There are strong opponents (Lakoff & Johnson 2003) who reject the existence of objective similarities in metaphors and argue against the notion of *literal similarity* between concepts (Lakoff & Turner 1989). To resolve this problematic situation, Grady (1999) proposes that the resemblance metaphor such as ACHILLES IS A LION is based on the *perception* of the bravery attribute in people and lions. That skirts the issue of objective similarity, since the similarity exists only when a person conceptualises it as such. This way of regarding resemblance metaphors highlights the role of subjective perception over facts about the world. From this research investigation, it is found that metaphors establish a *relation* between target and source, and do possess some degree of similarity (Cornelissen 2003; Havelka 2012).

Resemblances and similarities may arise from similarities in *concepts* and *structural relations.* Similarity in concept is the basis for metaphors such as ACHILLES IS A LION: Achilles and the lion share the common attribute of fearlessness and bravery when they confront dangerous enemies. In structural similarity, targets and sources may be drawn together in terms of their *structural relations* (Kovecses 2015). For example, in

the metaphor "THE MIND IS A COMPUTER" (Gentner et al. 2001), the mapping between mind and computer is a system of relationships comprising elements such as "information processing", "encoding", "decoding", "memory storage". The resemblance is not between physical objects but a system of relationships.

In summary, resemblance metaphors could be created based on conceptual and structural similarities between target and source. Two insights are drawn from the literature: first, subjectivity is inherent in the perception of similarity; second, different degrees of similarities exist between target and source.

Correlation is another basis for connecting target to source. Correlation metaphors are based on pre-conceptual experiences and are created based on the nature of our bodies and environment (Johnson 1987; Lakoff 1987). Pre-conceptual experiences refer to experiences that are structured prior to and independent of concepts. Correlation metaphors are derived from recurring co-occurrences of experiences rather than perceived similarity or resemblance between target and source. Hence, even distinctively remote metaphorical concepts could be cognitively linked due to their tight correlation in recurring experiences. For example, the MORE IS UP correlation metaphor. It is discussed in the following paragraphs.

Experiential co-occurrence refers to experiences of activities or events that occur at the same time. In the often used example MORE IS UP (Lakoff & Johnson 2003), the metaphor is based on associating two types of experiences that co-occur: as *more* objects or substances are added to a cup or jar, the level of its contents rises *up*. This example illustrates how perceptual experiences such as vertical movements are correlated with quantity. Relationships offered by correlation metaphors could contribute to a fresh understanding of targets by actively reminding us and bringing to consciousness previously unnoticed relationships that reside in our sub-conscious.
In situations where there is no distinctive pre-conceptual structure to the experience, such as *love*, the structure has to be imported from the metaphor source. In such instances, pre-conceptual structures of similar previous experiences are applied to understand the targets. *Experiential similarity* refers to experiences that are

subjectively felt to resemble each other. For example, the understanding of the structure of life may be imported from the experience of a gambling game using the experiential similarity metaphor. Using the example, LIFE IS A GAMBLING GAME described in the book Metaphors We Live By (Lakoff & Johnson 2008), one is led to apply the experiences of the excitement and consequences of winning and losing in a gambling game to understand life.

Similarity based and *similarity creating* metaphors may be considered as an elaboration of the resemblance attributes in which similarity is either pre-existing or created after the metaphor is produced (Indurkhya 1992, 1994). In the ACHILLES IS A LION metaphor, there is pre-existing similarity between Achilles and the lion in terms of bravery as mentioned earlier.

Based on the above discussions, all the attributes obtained from literature research for *Dimension 1: Basis of metaphor connection* may be consolidated into two main attributes, namely, resemblance and correlation as shown in Table 2.6.

Table 2.6 Dimension 1: Basis of connection

Dimension 1	Attribute values	
Basis of connection	Resemblance	Correlation

Dimension 2: Representation forms

Representation forms refer to the various ways in which targets and sources are represented. In this dimension, two forms of representation, gestalt and propositional symbol, are discussed. As the cognitive process is influenced by the types of representation forms (Johnson-Laird 1996), this dimension throws valuable light on how metaphors are created as described in the following.

From embodied experiences of interaction with the physical world, our sensory and motor apparatus acquire perceptual data that can be used for metaphor creation. Take

for example the metaphor MY WIFE WHOSE WAIST IS LIKE AN HOUR GLASS from Lakoff & Turner (1989). Gestalt derived from the perceptual data such as the general outline of the waist and the characteristics of an hour-glass are used to draw this target and source together.

Gestalt forms are commonly associated with *visual* images as shown in Figure 2.3 (a). However, it can also be found in other modalities: an auditory image of a cry, a kinesthetic image of a punch, an olfactory image of the smell of a rose and the sensational image of being stressed (Turner 1993). Figure 2.3(b) shows the gestalt of the first line of the song “Mary had a little lamb”.

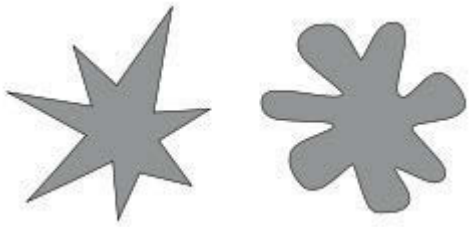


Figure 2.3 (a) Gestalt shapes

Source: Köhler (1929)

Figure 2.3 (b) Gestalt of a song

Source: Martin (2001)

Figure 2.3 Gestalt representation form

For this research, gestalt forms are found particularly useful in helping designers create metaphors when they are immersed in the physical design situations. Through constant interaction with the immersive design situations, the recurrent sensorimotor patterns in the form of a gestalt may emerge arising from the bodily interactions with the design environment.

A propositional symbolic form or concept is a general idea or understanding of something in everyday life. The traditional view of rational thought is based on mental representations using disembodied symbolic forms. Propositional symbols are

arbitrary and meaningless by themselves. These symbols get their meanings from their connections to "things, properties and relations" which exist objectively in the world (Johnson 2013, p. xxii). For example, a propositional symbol such as 'bird' has no intrinsic meaning by itself. It gains its meaning from its relation with other propositional symbols such animal, wing, flight etc., as illustrated by Figure 2.4.

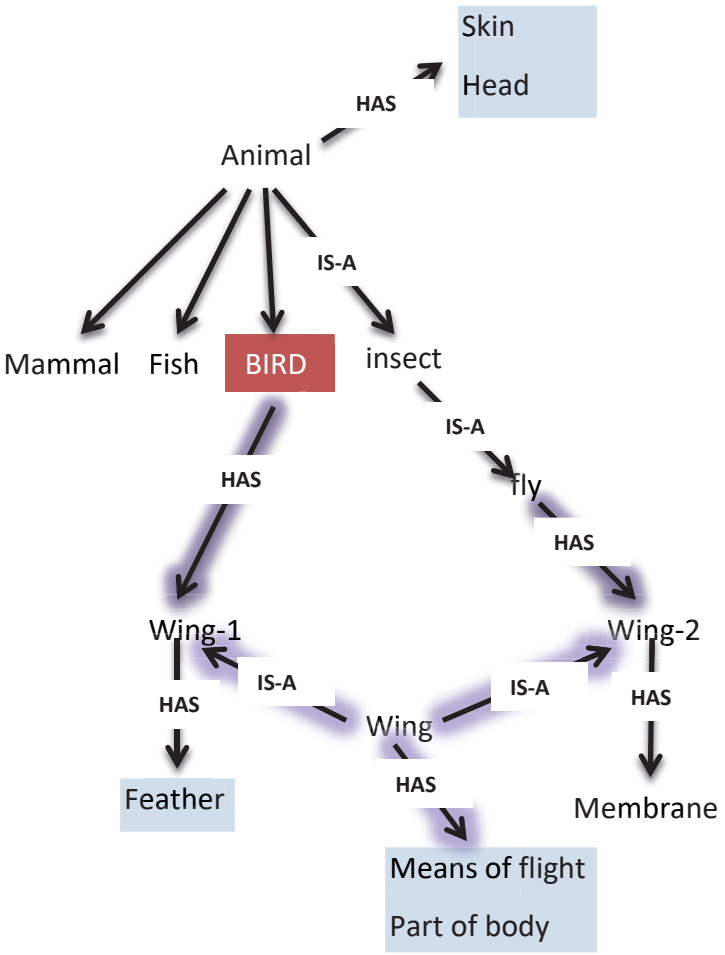


Figure 2.4 Propositional Symbolic representation form
Source: Handke (1995)

A bird and a fly may be considered similar based on the common features of having wings and the ability to fly (indicated by glow). Another way to create metaphors using propositional symbolic forms is through examining properties that belong to an entity. For instance, possessing "wings", "flies", "has feathers", "has skin and head" are some properties of birds (indicated by the coloured boxes). When an entity possesses these features, it may be considered as a "bird".

The metaphor JUILET IS THE SUN is an example of metaphor created using propositional symbolic representation form. In comparing Juilet to the sun, Romeo expresses his deep love for Juilet where Juilet is the centre of his universe just like the sun is at the centre of planets in the universe. In addition, her warmth fills his heart which is similar to the sun providing warmth for our people. Table 2.7 shows Dimension 2 (representation forms) and its attributes of gestalt and propositional symbol for connecting targets and sources in the creation of metaphors.

Table 2.7 Dimension 2 Forms of Representation

Dimension 2	Attribute values	
Representation Forms	Gestalt	Propositional Symbol

Knowing how the target and source are represented in terms of gestalt or propositional symbol could shed valuable light on the cognitive processes that take place during metaphor creation. These cognitive processes are discussed in sections 5.3 and 5.4 in Chapter 5.

Dimension 3: Connecting elements

Dimensions 1 and 2 highlight the *basis of the connection* between target and source and their *forms of representation*. Dimension 3 provides the c*onnecting elements* that link target and source at two levels: *feature* and *structure*. There is an inter-relationship between these attribute values and the sub-dimension of *resemblance* in the concept and structural relationships. Resemblance could be established through featural and structural connections. The following section describes the two connecting elements and how they are used to draw target and source together.

Features refer to obvious physical or conceptual features present in images or concepts that may be used to draw targets and sources together. For instance, the metaphor ACHILLES IS A LION is created based on the similarity between two propositional symbolic concepts. Achilles and the lion both share the common features

of fearlessness and bravery when they confront dangerous enemies. In the case of MY WIFE WHOSE HAIR IS A BRUSH FIRE, the *colour* of the woman's hair and the brush fire may be the feature that drew the source to the target.

Structures may be derived from recurring patterns or gestalt structures that exist in our physical experiences, perceptual interactions or cognitive processes. While drawing targets and sources together by explicit features is quite direct, the use of structures to create metaphors is somewhat more intricate. There are several possible ways that target and source could be linked using structure, as illustrated by the following.

Two images may be brought together based on their pre-existing physical structures. Image structures are explicitly available in both target and source as they both bear images. For example, the metaphor A MAN WITH A PEAR SHAPED BODY links the man and the pear together using the common pear shape. Using a vertical orientation of the two images, the upper half of the pear corresponds to that of the man. The structural information on the relation of parts is also applied, where the middle of the pear is linked to the middle of the person.

Besides images, concepts may also be drawn together based on their conceptual structures. In this case, target and source do not bear images but possess underlying structures. For example, the underlying structure of growth-bloom-decay could be used to draw target and source concepts together for the metaphor THE HUMAN LIFETIME IS THE LIFECYCLE OF A PLANT (Kovecses 2006). Even though both human lifetime and lifecycle of plant do not have image components, they possess distinctive structures. The common generic level structure of growth-peak-aging in HUMAN LIFETIME and LIFE CYCLE OF A PLANT is used to draw the target and source together.

The connecting elements discussed in this dimension are feature and structure, as shown in Table 2.8.

Table 2.8 Dimension 3: Connecting Elements

Dimension 3	Attribute values	
Connecting element	Feature	Structure

Dimension 4: Origins of sources

Potentially, any area of experience and knowledge can be the origin of source domains for metaphor creation. From literature research, it is found that the origins of source domains may come from general embodied experiences (Lakoff & Johnson 2003), individual differentiated experiences (Semino 2008; Semino & Masci 1996), knowledge (Benedek et al. 2014; Kovecses 2002, 2006) and culture (Kovecses 2015; Kövecses 2005; Schön 1967). In the context of design, this is an important dimension as the source is something that can be consciously changed to generate diverse types of metaphors and, consequently, might be used to generate more innovative design ideas.

Embodied experiences refer to those experiences that are derived from our physical interactions with the world. The sensory systems of our bodies enable active interactions with the physical environment that give rise to motor-sensory experiences such as vision and balance, and feelings or emotional experiences such as anger and happiness. These body-environment interactions are pre-linguistic as they occur before we articulate them using language. These embodied experiences are often considered as pre-conceptual and are linked to the development of cognition (Lakoff & Johnson 2003).

These embodied experiences, whether general or individual, form important bases from which metaphors are created. All of us carry along with us certain unique events and relations that could be used as sources for metaphor creation (Schön 1967). Experiential motivation has a particularly important place within the theory of conceptual metaphor as it is felt that “no metaphor can ever be comprehended or even adequately represented independently of its experiential basis” (Lakoff &

Johnson 2008, p. 19). Embodied experience has also been highlighted by Schön (1967, 1993) as an important source for designers to generate metaphors.

This attribute is linked to Dimension 1. Recurrent correlations between physical and emotional facets of our experiences lead to the basis of *correlation* connection (in Dimension 1), while perception of common aspects found in the experiences could be used for the *resemblance* connection (in Dimension 1).

Another valuable origin of sources is knowledge. Metaphors rely on propositional knowledge (Kovecses 2002, 2006) and knowledge derived from everyday life. It has been found from neuroscience research through functional brain imaging that metaphor production relies on generative processing that draws on stored knowledge (Benedek et al. 2014). Propositional knowledge refers to explicit theoretical knowledge derived from theory and research. It is often explicitly communicated, tends to be expressed as rules, formulas or theories and is represented by abstract symbols and relations. In contrast, everyday knowledge results from the generalisation of personal experiences in the absence of explicit systematic instructions. This knowledge is personally and socially constructed.

Culture may be considered as the "complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by a member of the society" (Taylor 1958, p. 1). Our culture and sub cultures provide useful ingredients for creating metaphors (Schön 1967) by providing theories, concepts and ways of thinking. Metaphors are often based on expressions of our culture; such as the games we play, music we listen to, books we read, and cultural events we participate in. For instance, politicians often use SPORTS metaphors (Semino & Masci 1996) in their speeches. However, the specific sport that is used as the source domain is culture-dependent; Americans tend towards football, baseball and boxing while Chinese uses volleyball, soccer and ping pong as source domains (Yu 1998). Put in more general terms, different culture uses different sources for a particular target domain (Kövecses 2005). It is found in this dimension that people draw from their experiences,

knowledge and cultures to create metaphors, as shown in Table 2.9. The discussion shows the impact different types of sources have on the types of metaphors created.

Table 2.9 Dimension 4: Origins of sources

Dimension 4	**Attribute values**		
Origins of sources	Embodied experiences	Knowledge	Culture

Dimension 5: Cognitive utilities provided by source for understanding target

In the metaphor creation process, the *think* phase is where the source is used to generate an understanding of the target. By linking and imposing concepts of different sources onto the target, new and better understanding of the target may emerge. In this dimension, three functions are considered: *ontological, structural and orientational*.

In the book "Metaphors We Live By" (2003 edition 3), Lakoff & Johnson (2003) re-classified all metaphors as structural and all are ontological as they create target domain entities. According to them, not all metaphors are orientational. Even so, the original cognitive utilities of ontology, structure and orientation are found to be valuable in the fine grain analysis of metaphors described in Chapter 4. Furthermore, knowing these functions shed useful light on how the metaphors are created.

A metaphor whose utility is to provide meaning to a more abstract target domain accomplishes it through a mapping process in which the source domain provides a more tangible and concrete meaning for the target concept. For example, in MIND IS A MACHINE, MACHINE (source) provides an ontological status to the abstract concept of MIND (target).

Ontological metaphors enable us to view an immaterial phenomena or abstract concepts as concrete entities or physical objects. It helps in making reference to, quantify and identify delineated aspects of experiences as if they are substantive, perceivable and imbued with physical qualities. For example, the MIND IS A MACHINE metaphor offers a way to think of the mind as having an on-off state, a productive capacity, a level of efficiency, elements and internal mechanism, an energy source and an operating condition (Lakoff & Johnson 2003). Once an abstract concept such as the mind becomes better understood, some concepts can be elaborated further by means of a structural metaphor. The way in which the ontological metaphor, MIND IS A MACHINE can also become a structural metaphor is discussed in the coming paragraphs.

A metaphor whose utility is to provide structure to a more abstract target domain accomplishes it through a mapping process in which the source domain provides a richer structure for the target concept. Once the source domain is triggered, the patterns, relationships, logic, inferences, etc., that are present in the source are transported to the target. In LOVE IS A JOURNEY metaphor, love is interpreted as a journey through this structural metaphor. In understanding *love as a journey*, passengers are understood as lovers and the vehicle they are in is the relationship between the lovers. The direction of the journey represents the choices made and the destination is the purpose of the relationship. Through the structure of journey, systematic correspondences can be established between journey and love. The use of the deeply structured and distinctly characterised concept of journey to structure love leads to a clearer understanding of love.

In a similar way, systematic correspondences between the mind and machine can be established. This includes the structural mapping of machine elements such as wheels, generators etc. to the parts of mind, motion and grinding machine operation to the operation in the mind, steam and fuel mapping to the source of energy needed to keep the mind in operation. This example illustrates how an ontological metaphor can be further elaborated by means of its structure. This leads to the observation that there exists inter-relationship between the ontological and structural values.

Of the three types of metaphors, structural metaphors are the ones most often applied in the formation of new metaphors, because they provide the most comprehensive structuring for target concepts (Lakoff & Johnson 2003).

A metaphor whose utility is to provide an orientation to a more abstract target domain accomplishes it through a mapping process in which the source domain provides spatial orientations rooted in physical experiences based on human spatial orientations, e.g. up-down, center-periphery (Lakoff & Johnson 2003). Lakoff & Johnson (2003) suggest that most fundamental concepts are organised in terms of orientational metaphors. For example, HAPPY IS UP, MORE IS UP, GOOD IS UP and HEALTHY IS UP. There is systematicity in the examples in that the upward direction refers to positive things while the downward direction connotes negative things. The utility of the orientational source domain helps in making a set of target concepts consistent in our conceptual systems (Kovecses 2002). For instance, the metaphor SAD IS DOWN is reflected in the drooping posture of a person when he or she is sad. Similarly, the source UP does not only structure one concept. It establishes an entire system of concepts in relation to one another (Lakoff & Johnson 2003). Similar to the above discussion on ontological values, this also applies to the inter-relationship between the orientational and structural values.

In summary, the understanding of target may be imposed by the respective cognitive utilities offered by the three types of metaphors, as indicated in Table 2.10. *Ontological* metaphor imposes its entity and substance structure onto the target, *structural* metaphor structures one kind of experience in terms of another, and *orientation* metaphor imposes its orientational structure on the target (Lakoff & Johnson 2003).

Table 2.10 Dimension 5: Functions provided by source

Dimension 5	**Attribute values**		
Cognitive utilities provided by source	Ontological	Structural	Orientational

Through the use of the cognitive utilities provided by the source, an improved conceptualisation and understanding of the target is achieved after the metaphor is created. In addition, to offering insights of how designers think after the creation of these metaphors, these attribute values are also useful for shedding valuable light on how designers *see* during the metaphor making process. The attribute values; ontological, structural and orientation reflect how conventional metaphors are made.

According to Lakoff & Johnson (1980), these conventional metaphors are based on correlations perceived in experiences. For example, HAPPY IS UP metaphor is based on observations that people's posture rise up when they possess a positive emotional state. This orientational metaphor reveals that it is created based on perceived orientational experiences. Therefore, the type of conventional metaphor that is created could reveal how the design situation is seen by the designers and directs to what is being seen. For example, the creation of the three *orientational* metaphors; DR JEKYLL AND MR HYDE, DORIAN GRAY AND THE PORTRAIT and WEREWOLF in Case Study 6, (to be discussed in Chapter 4) led the analysis of this specific case study to zoom in on the transformative *day and night* physical encounter at Kings Cross as the trigger for creating these metaphors. In summary, this dimension serves two functions. It is used to shed light on both the *seeing* and *thinking* activities of the metaphor creation.

Summary of dimensions and attribute values

The five dimensions and their related attribute values developed for the typology are summarised in Table 2.11. The metaphor, LIFE IS A JOURNEY is used to illustrate how the typology works. The understanding of the metaphor LIFE IS A JOURNEY makes use of the knowledge about journeys. For example, it is generally known that journeys include travelers. Journeys start somewhere and there are paths travelled and final destination points. While some journeys are purposeful, others involve the travelers wandering without a clear destination. The metaphor is created when a correspondence is made between the traveler and the person living his life, the road travelled and the course of life, a starting point and the time of birth, a destination and the end of life etc. These associations are likely to be made unconsciously according to Lakoff & Turner (1989).

Based on the above understanding, the target LIFE is seen to be experientially similar to JOURNEY in terms of gestalt structure. This leads to the selection of *correlation* as the attribute value for dimension 1. Underlying the *gestalt* representation forms of LIFE (target) and JOURNEY (source) is the *PATH structure.* Therefore, dimensions 2 and 3 are *gestalt* and *structure* respectively. As this metaphor is mainly based on experience, the attribute value of embodied *experience* is selected for dimension 4. If a life is conceived in terms of a journey, then a guide helps to direct the specific route to take. In this way, the JOURNEY source provides valuable ontological functions to LIFE target. As discussed in Section 2.3 (Dimension 5), all metaphors are structural as they project structure to target and all are ontological as well when they create target domain entities, such as beginning of journey is birth while destination is death. Therefore, the attribute values of *ontological* and *structural* are selected for dimension 5.

- Dimension 1: Basis of connection: Correlation
- Dimension 2: Representation form: Gestalt
- Dimension 3: Connecting element: Structure
- Dimension 4: Origin of sources: Embodied experiences
- Dimension 5: Cognitive utilities provided by source: Ontological and structural

Table 2.11 Typology of metaphor LIFE IS A JOURNEY

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

As can be seen from this example, inter-dependency and multiple attribute values (for Dimension 5: Cognitive utilities provided by source) exist in this typology. Inter-dependency is further discussed in the next section.

2.4 Discussion

Having described the five analysing dimensions for the development of a typology of metaphor, it is useful to review two characteristics of the metaphor typology observed during its development. The first is the *subjectivity* of the metaphor creation process; the second is the inter-relationships that exist between various dimensions and attribute values. Understanding these characteristics leads to a better grasp of the intricacies of the typology and could throw additional light on the metaphor creation process.

Subjectivity

Subjectivity is observed in two ways: subjectivity in drawing target and source together (Dimension 1) and subjectivity in the preference of a particular source (Dimension 4). Metaphors are created when targets and sources are drawn together (Dimension 1) based on the perception of something in common or similar. For example, the creation of the ACHILLES IS A LION metaphor is most likely based on the *perception* of common characteristics in their behaviour of confronting dangerous opponents without fear (Grady 1999). Similarly, the RELATIONSHIP MARKETING AS MARRIAGE metaphor is based on a *sufficient degree of similarity* between marketing and marriage (Cornelissen 2003). It is the *perception* of the presence of two parties and the interactions between them that leads to the creation of the RELATIONSHIP MARKETING AS MARRIAGE metaphor.

Perception can be understood as a set of processes by which we "recognise, organise and make sense" of the sensory signals we pick up from physical interactions with the environment (Sternberg & Sternberg 2016). Also, it is commonly known that perception does not reflect reality in an objective way (McClelland 2004) since it is subjected to interpretation (Daniel 2010).

The specific source triggered for the production of a metaphor is influenced by cultural bias and differential experiences (Dimension 4). The FUTURE IS AHEAD orientational

metaphor illustrates the cultural bias. This metaphor is physically grounded in how we move in the direction we face. Hence, we move toward things that are ahead of us giving rise to "future is ahead". However, there is evidence that this is not a universal metaphorical orientation as the Aymara tribe, for example, reflects the metaphor FUTURE IS BEHIND (Núñez & Sweetser 2006). This alternative metaphor derives from the physical experience of future as unknown, unseen and *behind* us, while the past is known, seen and *before* us.

Besides social influences, personal history and gender also affect the preference of one metaphor over others (Kövecses 2005). A review of metaphors used by American politicians during their campaign in 1996 found that all candidates running for office used sports metaphors. However, there are differences in the exact sports selected. Men tend to choose metaphors of more competitive sports compared to women (Callies, Keller & Lohöfer 2011). Silvio Berlusconi, Italian politician and owner of football club AC Milan, possesses an intimate link with the FOOTBALL source and, naturally, makes strategic use of football metaphors in talking about his political activities. For instance, he used "enter the pitch" metaphor to express his decision to enter politics and the successful coalition he aimed to build was referred to as a "winning team". Culture, gender and individual experiences introduce subjectivity in the triggering of metaphors, which affect the attribute value for Dimension 4: Origins of sources.

There has to be a certain depth of knowledge and familiarity with target and source before a sufficient degree of similarity can be detected for metaphor production. For instance, a person who does not know and has not seen a Dalmatian dog may think that it is a leopard or cheetah based on the gestalt image present in Figure 2.5. The sources that come to mind are subjectively limited by what we know. This implies that a variety and depth of available sources are required for the production of metaphors.

Figure 2.5 Gestalt image of Dalmatian dog
Source: Gregory (1971)

Furthermore, since the creation process is not based on objective perception, the creation of connections to a variety of sources is not fixed but is determined by one's ability to perceive similarity. The same observation is highlighted by Aristotle as "the ability to see similarity in dissimilar things". It implies that the metaphor creation process uses imaginary powers rather than a step-by-step algorithmic process. This has implications for training and discussed in Chapter 6.

The inherent subjectivity in the use of a particular source brings out an important point: certain *origins* of sources, such as culture and gender, are harder to influence. Other origins, such as embodied experiences and individual differentiated experiences, can be shaped to influence the variety of metaphors that can be created.

Knowledge of how subjectivity affects the activation of a particular source raises awareness of the various factors that influence metaphor creation and contribute to the analysis of the metaphor creation process.

Inter-relationships between dimensions

Some dimensions, such as Dimensions 1, 2 and 3, are tightly related. Consequently, the choice of an attribute value in one dimension sometimes pre-determines the attribute choice in another. For instance, the attribute value of correlation in Dimension 1 is tightly linked to the attribute value of gestalt in Dimension 3. An awareness of these inter-relationships between dimensions and attribute values raises our awareness into the probable paths of metaphor creation.

Inter-relationships between attribute values are also found in resemblances (Dimension 1) where resemblances may arise in concepts, structural relations and sensorimotor information. Another inter-relationship is found in the cognitive utilities provided by the sources (Dimension 4). The two cognitive utilities that are often provided by sources are the structural and ontological functions. This leads to a type of metaphor with two attribute values in Dimension 4. This could affect the definition of types and the implications is discussed after the case study analysis in Chapters 4 and 5.

2.5 Summary

In this chapter, five dimensions related to the metaphor creation process are synthesised from metaphor literature research. The first dimension concerns the *basis* on which targets and sources are connected. The second dimension reflects the *forms of representation* of targets and sources. The third dimension indicates the *connecting elements* between targets and sources. The fourth dimension reveals the *origins* of the source domains while the fifth and final dimension relates to the *cognitive utilities* offered by the source domains to better understand the target domains.

Two observations are made from the discussion in this chapter. First, some dimensions such as Dimensions 1, 2 and 3 are tightly inter-related. Second, it is possible to characterise the creation process of metaphors from the attribute values selected.

As the dimensions and attribute values are obtained from literature outside the design domain, it is necessary to review them to ensure their functionality in contributing to the identification of the metaphor creation in design process. These analysing dimensions will be applied to case studies in design practice in Chapter 4 to characterise how metaphors are created in the design field.

3 Research Methodology

This research is conducted to uncover the creation processes of metaphors that help produce frames in design. Frame creation is selected as the context because it spurs the creative leap in the metaphor creation process. This chapter describes the design of the research in three sections: research methodology in Section 3.1, case study research design in Section 3.2 and conclusion in Section 3.3.

3.1 Research Methodology

The research questions for this project investigation are:

> Research Question 1: *"Which types of creation processes of metaphors that help produce frames can be identified?"* and
>
> Research Question 2: *"How can the logical representations of these respective creation processes identified in research question 1 be described?"*

These questions serve as the starting point for the project. They contribute to the selection of the research design, approach and methodology.

Selection of approach and criteria for methodology

The metaphor creation process is poorly understood due to the paucity of research conducted into the *process* (Cila 2013; Paton & Dorst 2010). For gaining a better understanding into the metaphor creation process, this research adopts a *qualitative approach* for the following three reasons.

First, qualitative research is best suited for exploring little known phenomena or processes (Grbich 2012), such as the metaphor creation process. It identifies the new phenomena and answers the questions of *what* is taking place, *why* is it happening and

how does it happen (Daly, McGowan & Papalambros 2013). Second, qualitative research is used for conducting deep exploration to facilitate discovery and pattern finding (Stablein & Frost 2004). This deep exploration of qualitative research could help illuminate the nebulous metaphor creation process though development and construction of theory on how metaphors are created. This could shed light on how originality is achieved in design. Third, the qualitative approach collects in-depth data to develop *rich descriptions* (Patton 2001) in order to understand the metaphor creation process. Most importantly, the use of the qualitative approach for this metaphor creation research could help identify what is important and what needs to be studied (Ormrod & Leedy 2005). To identify the appropriate research methods and techniques for this investigation, it is helpful to first determine the research methodology. The following criteria are used for selecting the methodology.

Explorative research approach. The research methodology should be exploratory for accessing a wide variety of metaphor creation processes, since specific types of creation processes of metaphors cannot be predicted in advance.

Capture data in a natural setting. The research methodology should capture the emergence of metaphors in as natural an environment as possible. This is because the factors that affect the metaphor creation process are unclear and an artificial set-up might unknowingly impose or remove important parameters from the creation process.

Need for in-depth investigation of relationships between target and source. The research methodology should provide insight on how the various links between target and source described in the literature study are established.

Multiple data formats and sources. The research methodology should be able to process data obtained from numerous sources and in multiple representations or expressions of the framing activities, including drawing, writing and design discussions.

Unclear boundary between the metaphor creation process and design context. The research methodology should allow the investigation to proceed even when the boundary between metaphor creation process and design context is not clearly defined. This is an important consideration, because metaphors usually emerge from the interactions of designers with the design situations (Casakin 2006a) during which the design context intersects and interacts with the metaphor creation process.

Provide rich description for identification of types of metaphor creation processes and how metaphors are created. The selected research methodology should produce data that answer the research question on types of metaphor creation processes and how they are carried out. The data should reflect the attribute values of the dimensions in the typology and the methodology must produce rich descriptions of the metaphor creation process.

Commonly applied research methodologies in design

The most common qualitative research methodologies applied by researchers to study design are *action research, narrative, ethnographic research, experimental studies* and *case studies* (Creswell 2012; Crouch & Pearce 2013; Muratovski 2015; Stake, Denzin & Lincoln 2005). Three of them are considered for this project: ethnographic research, experimental studies and case studies. Action research is not considered because it is applied where practitioners want to change their ways of working or introduce a new service and monitor the change. The focus of action research is on generating solutions to practice-based issues and achieving outcomes in real-world settings (O'Reilly & Kiyimba 2015). Hence, it is not suited for this research which is aimed at understanding design activity and producing rich descriptions of the metaphor creation process. Similarly, narrative research is not suitable for this project, because the goal of narrative research is to capture detailed stories and life experiences of a small handful of people over an event or a sequence of events (Creswell 2012).

We now look at the three research methodologies for consideration in this project.

Ethnographic research focuses on the culture of an organisation and looks for patterns in social interactions, behaviours, beliefs and perceptions. The investigation generally focuses on the shared experience of the group being studied and the findings are used to describe the culture of the group. *Ethnographic research* relies very much on immersion in and experiencing the natural environment first hand as researchers get up close to the subjects. Ethnographic research is often longitudinal as the researcher needs an extensive period of time to discover the underlying cultures of the organisation.

Some uses of ethnography in design are found in the research investigation of design teams at Rolls-Royce aerospace (Baird, Moore & Jagodzinski 2000), support of expertise in engineering design (Ball & Ormerod 2000) and study of design process within engineering firms (Bucciarelli 1988). Data in ethnographic research are often collected through participant observation where the researcher approaches the subject under investigation as if it is a "foreign culture" (Bucciarelli 1988). Literature reveals that design researchers have gained valuable detailed understanding of the individuals and companies observed. However, it is not clear the exact amount of insight that is gleaned into what the participants are thinking of and their thought processes.

Design experiments have been conducted by various scholars to study design activities in an artificial setting (Christiaans 1992; Kruger & Cross 2006). For example, Dorst & Cross (2001b) produced a refined model of the co-evolution of problem and solution space after studying numerous designs in an design experiment while Valkenburg & Dorst (1998) used a design experiment to study the reflective practices in design teams. In a design experiment, a group of designers or design teams are given the same design brief and their design practices are commonly studied using protocol analysis. The benefit of a design experiment is that the influence of the design expertise and variation of design practice can be studied because the design brief is consistent across the various design activities studied.

In design research, case studies are used for analysing a phenomenon and generating hypothesis (Teegavarapu, Summers & Mocko 2008). Literature reveals that case study methodology has been applied to design investigations such as to study the strategic impact of human-centered design (van der Bijl-Brouwer & Dorst 2017), expert product design (Yilmaz & Seifert 2011) and novice versus expert designers (Kavakli & Gero 2002). Case studies are particularly useful in new research areas where existing theory is lacking (Eisenhardt 1989) as they may offer new insights not achievable using other approaches (Rowley 2002).

Selection of research methodology

When the above evaluation criteria are applied to the three research methodologies, the case study methodology is found most appropriate. As shown in Table 3.1, research methodology that satisfies the evaluation criteria is reflected by a plus (+) sign. More plus signs indicate greater satisfaction of the evaluation criteria. On the other hand, a negative (-) sign indicates that the research methodology does not satisfy the evaluation criteria. Similarly, more negative signs represent a lesser satisfaction of the evaluation criteria.

Table 3.1 Evaluation of research methodology for research project

	Explorative research approach	Capture data in a natural setting	Need for in-depth investigation of relationships between target and source.	Multiple data formats and sources	Unclear boundary between the metaphor creation process and design context	Provide rich description for identification of types of metaphor creation processes and how metaphors are created
Ethnographic research. To understand culture, values, motivations and beliefs of culture-sharing	+	+	--	+	+	--
Design Experiment. In a design experiment, a group of designers or design teams are given the same design brief. Their design practices are then commonly studied using protocol analysis.	+	-	++	++	+	+
Case Study. Employed to gain a deep understanding of a case selected by the researcher to provide insights to the research question	+	+	++	+	++	++

Ethnographic research is not selected as its purpose is to study social interactions, behaviours and perceptions within groups and communities. It does not meet the need for in-depth investigation of relationships between metaphor target and source and is not meant to produce rich descriptions to help identify types of metaphor creation process and how metaphors are created. As this is an exploratory study, there is a likelihood that some aspect of metaphor creation process might be unknowingly excluded in a laboratory controlled conditions. Hence, design experiment is not selected due to the unknown influence of the design context on the metaphor creation process.

The case study methodology satisfies all the criteria and is chosen for this project. Case study is an empirical investigation that is exploratory and studies a phenomenon in naturally occurring contexts (Yin 1994). It is particularly useful for investigating relationships and processes (Thomas 2010). Case study is applied for investigations where the boundaries between the phenomenon under investigation and context are not distinctly defined (Gall, Borg & Gall 2003; Hinkel 2011; Yin 2014). Case study research makes use of *numerous sources of data* (Stake 1995; Yin 2014) where data may include *physical artefacts, documentation, archival records, interviews, direct observation and participant observation* (Yin 2011, 2014). From these multiple data sources, the case study methodology could produce information-rich descriptions of the investigations (Coulter et al. 2007).

At the same time, the case study methodology presents some inherent challenges and practical difficulties. The most prevalent criticism against the case study strategy is its lack of generalisation (Duff 2008; Punch & Oancea 2014) and rigour (Hamel, Dufour & Fortin 1993).

Generalisation refers to the use of research findings from one particular study in other situations (Duff 2008; Maxwell & Chmiel 2014). This is best reflected in *statistical generalisation* where an interpretation about a population is made based on a sample of data gathered from that population. The generalisation can be determined with a certain level of confidence using mathematical formulas. Statistical generalisation is not applicable for this thesis investigation due to the limited number of cases.

When it comes to generalisation in qualitative research, the aim is to extend the conclusions of one case study to other similar cases. For this purpose, an *analytic generalisation* (Yin 2009) is more appropriate. Analytic generalisation refers to the abstraction of ideas from a selection of case study findings to apply to other situations (Yin 2013). The objective of the case study research approach is to shed light on theoretical concepts or principles rather than to use the case study as a sampling unit. In other words, the goal of the case is to “generalise theories” and not to add to the

size of a sample for statistical purposes (Yin 2002).

The *lack of rigour* in data analysis is another common criticism against the use of the case study methodology. However, Flyvbjerg (2006) suggests that case study research has its own rigour, different from quantitative methods. One way to ensure rigour is through the use of numerous cases to provide multiple perspectives on the phenomenon (Miles & Huberman 1994). Similarly, triangulation through verification from various sources aids validation of data (Bogdan & Biklen 2007).

To address the issues of generalisability and rigour, the research design of this study will collect a number of case studies that provide appropriate insights into metaphor creation process and are feasible to execute within the time frame of a doctoral thesis. Each case study describes and examines how a particular metaphor is created. Multiple data sources within each individual case study are used for triangulation of data. Data sources for this investigation include data from observation studies, design documents and secondary literature such as journal and conference papers. This is elaborated in the following sections.

3.2 Case Study Research Design

This project adopts a multi-case design to investigate metaphor that creates a frame in design practice. The various steps conducted in the research design as shown in Figure 3.1, are described in this section. The research design starts with the determination of the unit of analysis. After identifying the unit of analysis, the selection criteria and available case study resources are considered. The next step is the selection and collection of data on how metaphors that create frames in design. The final step is the processing and generation of rich descriptions of the creation of metaphors in each specific design project. A brief overview of the data analysis is covered at the end of this section.

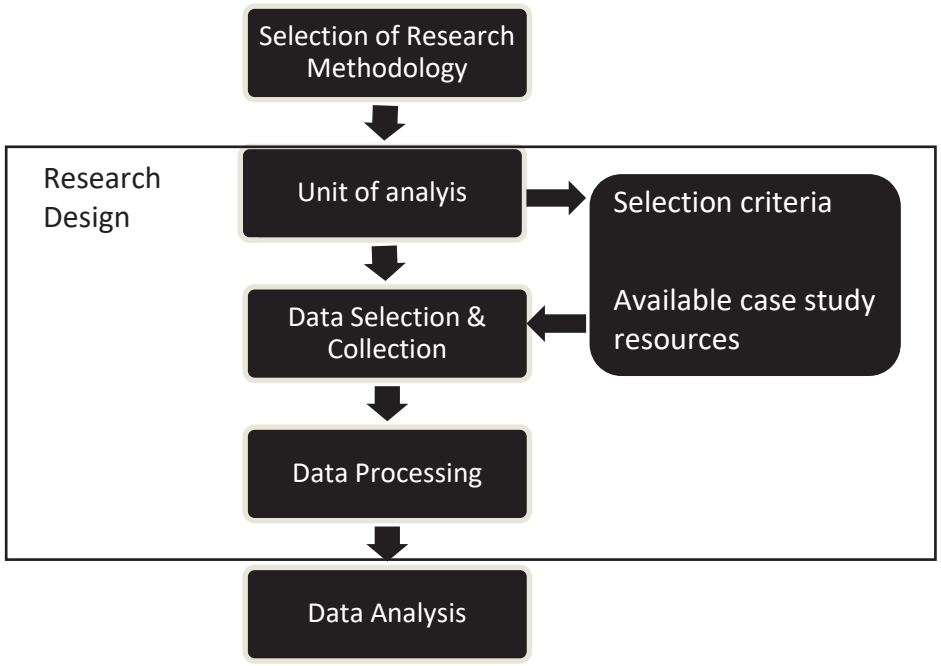


Figure 3.1 Case study research design

Unit of analysis

The unit of analysis is important because it affects how and where the data will be collected and determines what is "in" and what is "out" for the research (Rose, Spinks & Canhoto 2014). In this study, the creation process of each metaphor generated serves as the unit of analysis. It sets the boundaries of the investigation in that each metaphor study responds to a specific problem issue or design brief. The design activities of how each metaphor is created constitute the case.

Selection criteria for cases

Even though the intention is to learn from as many cases as possible, the number of cases remains small due to time and resource constraints. Studies with small sample sizes such as the present investigation are particularly susceptible to selection bias. In moving away from random selection, King, Keohane & Verba (1994) suggest that the selection criteria allow for some variation on the dependent variable.

In this study, the *creation process* of the metaphors may be considered as the dependent variable. To produce the necessary variation in the *creation process*, some parameters in the case may be manipulated. For example, the following case selection criteria are introduced to achieve some variation in the dependent variable of the creation process.

- *Diversity of design problems* within the pool of available cases.
- *Diversity in the design methodology applied in the metaphor creation process.*
- *Varying levels of complexity* of problem issues, from simple to complex.

Other considerations for the choice of cases include:

- *Relevance* to understanding the phenomena of the creation of metaphors.
- *Opportunities to learn* about both the context and process of metaphor creation. It is necessary to produce rich descriptions of the creation process so as to conduct a fine-grained examination. Observations must include subtle movements of the cognitive steps taken, including tracking closely the emergence of metaphors and the mapping process from the metaphorical source to the design target.
- *Minimum expertise level* of at least one designer in the team with three or more years of experience. This criteria is added as a team without this minimum design skill might not be able to create metaphors that are worthy of investigation. A designer with three years of experience would have gained sufficient experience in real life design situations. These experiences contribute to how designers approach design situations and it is about designers not being naïve.
- *Accessibility* of data for collection.

Available case study resources

Three sources of data are identified based on the above selection criteria. They are empirical data, retrospective data and literature. The retrospective and empirical cases are taken from projects conducted in the Designing Out Crime (DOC) at the University Technology Sydney (UTS).

Designers at DOC apply design practices to revolutionise the way safety and security are achieved in society. The research centre provides research, consultancy, training and education in design innovation, particularly in frame creation for both students in UTS and external organisations. This professional practice at DOC provides a natural setting to capture the creation process of metaphors that creates frames. Conducting the doctoral research at DOC provides the opportunity to observe design activities up close across a range of projects. The methodology at DOC is frame innovation (Dorst 2015b), developed by Professor Kees Dorst from his extensive studies of the practices of expert designers.

The Frame Innovation model identifies nine distinct but overlapping phases: *Archaeology* → *Paradox* → *Context* → *Field* → *Themes* → *Frames* → *Futures* → *Transformation* → *Integration*. The first four steps (archaeology, paradox, context, and field) are analytical and provide the necessary contextual information of the problem situation. The next two steps, themes and frames, are where the design problem is linked to the solution. This is where the frames emerge and a metaphor is often used in the framing process. The remaining three steps develop the solutions based on the frames and also address implications arising from the solutions and frames.

A major benefit of Dorst's Frame Innovation model is its systematic approach to frame creation which guides the problem solver through explicit thinking instructions. A unique feature of the model is the way it reformulates the problem by changing the context from which the problem arises. A reformulation of the problem comes with a set of suggested practices. This suggested practices contribute to the change in context from which the problem arises as illustrated in two case studies; KINGS

CROSS AS A MUSICAL FESTIVAL and A PAINTBRUSH AS A PUMP, as will be further discussed in Chapter 4. In the Kings Cross case study, the reformulation leads to a new context of event management which is different from the original law and order problem. Similarly, in the paintbrush as a pump case study, the context is shifted from a painting process to a pumping process. This new approach is more successful in producing innovative outcomes compared to solutions developed in conventional problem solving approaches. The model has successfully guided and produced fruitful results for 140 projects at DOC as at 2014 (Dorst 2015a). These projects serve as useful retrospective resources for this research.

Retrospective cases are retrieved from reports of completed cases and data where the metaphors created and the steps taken are already known. This reduces significantly the data collection time and effort as the cases can be evaluated very quickly whether they are suitable for further investigation.

Empirical case studies are included because empirical studies in *natural setting and authentic tasks* offer new insights (Toh et al. 2014). More importantly, it is revealed from design investigations that intuition is extremely effective in and intrinsic to the nature of design, as discussed earlier in Chapter 1. Therefore, empirical research is required in attempt to capture these "intuitive" features of design ability.

Case studies from secondary literature provide diversity in design contexts in terms of types of problems, diversity in methodologies applied and levels of expertise. These secondary cases are data obtained from documents such as books and design journals. They are valuable materials that provide a wider range of metaphor creation processes beyond what can be gathered due to time and geographical constraints. Some researchers e.g. Merriam (2014), consider documents to be the best source of data as they are easily accessible and contain information that would otherwise require enormous amount of time and effort to produce.

Data selection and collection

Interviews, secondary sources and participant observation (Cross 2001; Muratovski 2015) are some common data collection methods applied in this research project to gather data for writing the case studies. Data for ten cases are gathered based on these data sources using the selection criteria discussed in Section 3.2. Table 3.2 shows the selected data sources which include five empirical studies, two retrospective cases and three from secondary literature, with their respective data collection methods.

Table 3.2 Data Sources, Data Collection Methods and Types of Data

Sources of Data	Metaphor generated	Data collection methods	Types of Data
Empirical studies	• WATERLOO HOUSING AS REBIRTH • KINGS CROSS AS JEKYLL AND HYDE • SOCIAL HOUSING AS "SCAFFOLDED" EDUCATION • VICTIM OF CRIME SUPORT AS AMBULANCE SERVICE • VICTIM OF CRIME SUPPORT AS POSITIVE PARENTING PROGRAM	Observations (participant or passive observation) Follow-up interviews	• Observation notes of design activities • Interview data • Video and audio • Sketches
Retrospective case studies	• KINGS CROSS AS A MUSICAL FESTIVAL • PROTECTING THE SAILS AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT	Search servers Follow-up interviews	• Interview data • Observations from videos found on servers • Observation notes obtained from design activities captured
Literature	• A PAINTBRUSH AS A PUMP • A PATHWAY AS BEETHOVEN's 9TH SYMPHONY • A CAPSULE WORKSTATION AS AN EYE IN THE STORM	Search web databases and libraries	• Document analysis (reports and minutes) • Analysis of design materials (sketches and notes) • Secondary descriptions of design activities obtained from literature

Five empirical cases are selected for this research investigation from 25 observation studies of metaphor creation processes carried out at DOC. The observations are carried out in the frame innovation workshops conducted for the purpose of generating design ideas for consultancy projects or for training participants on Frame Innovation Model (Dorst 2015b). They are projects that took place at the start of my attachment in the center during 2013 to 2014. The selection of the five cases is based on problem types, complexity levels and expertise levels of designers involved. The list of 25 metaphor creation sessions is found in Appendix A.

Of the five empirical metaphor creation processes selected for the project investigation, two are obtained from participant observations while the remaining three are captured from passive observations, as shown in Table 3.3.

Table 3.3 Empirical cases

Metaphor created	Data captured	Passive/Participant Observation
WATERLOO HOUSING AS REBIRTH	Digital photos of whiteboard discussions, post-it notes, observation notes	Participant observation
KINGS CROSS AS JEKYLL AND HYDE		Participant observation
SOCIAL HOUSING AS SCAFFOLDED EDUCATION		Passive observation
SUPPORT FOR VICTIMS OF CRIMEAS POSITIVE PARENTING PROGRAM (PPP)		Passive observation
SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE		Passive observation

Most of the empirical studies are observation studies of designers producing metaphors using Frame Innovation Model. Observation studies provide data on what designers do and how the metaphors emerge from the interactions among designers, between designers and design situations. Design activities were observed and captured using observation notes, photos and audio recording. Design materials produced in the observed sessions are captured with observation notes, photos of post-it notes and white board writings and artefacts of writings on paper. Informal follow-up interviews are conducted to clarify questions such as the origins of the

sources of metaphors, other metaphorical sources that designers have in mind and explanation of why certain specific steps were taken. Ethics approval has been obtained from UTS Human Research Ethics Committee for these research data collections. The ethics approval number issued by UTS is 2014000413.

Trying to observe and understand how the metaphor is produced in the Frame Innovation Model can be daunting if the observer is unfamiliar with the frame creation process which has many steps. A participant observer, on the other hand, has greater familiarity with the design steps and the thinking involved in each step. For example, as a participant observer, there is the opportunity to watch individual actions and thinking sequence in different phases of metaphor production. Being a participant observer is useful in two ways. First, personal involvement facilitates reflection on how specific thinking processes and information are brought to bear in metaphor creation. Second, getting into the designers' world through participant observation sharpens the focus in subsequent empirical data collection through passive observation (Jorgensen 1989).

Many retrospective projects and experimental frame creation exercises are stored in DOC data servers in the format of reports or artefacts such as charts, photographs and post-it notes. As most of these projects are for external clients or students' projects, many of them only capture the final design outcomes but not the process of metaphor creation. Therefore, only some of them are suitable for use in this investigation.

Two retrospective cases are selected for their appropriate details on how metaphors are created in the framing process as shown in Table 3.4. Both cases are selected using the criteria described in Section 3.2 and they are undertaken by UTS students using design briefs provided by external clients. The students apply the Frame Innovation Model (Dorst 2015b) to help them develop design solutions.

In addition to data captured from local servers, the Kings Cross case study is also described in several papers and reports produced by DOC (Camacho Duarte, Lulham & Kaldor 2011; Dorst 2015b; Thurgood et al. 2015; Watson 2013) while the Sydney Opera

House case is recorded in a video stored in DOC's internal web server. This video captures the design activities leading to metaphor creation. For both case studies, informal interviews with involved designers are conducted, when necessary to complete the understanding of the design process.

Table 3.4 Retrospective cases obtained from secondary data

Metaphor created	Available data	Project or Training
KINGS CROSS AS MUSICAL FESTIVAL	Papers • Co-designing out crime (Camacho Duarte, Lulham & Kaldor 2011) • Designing crime prevention-A review of methods (Watson 2013) Internal reports and presentations produced by DOC students • Light-savers (Butorac et al. 2009) • The Thin Yellow Line (Sheverda, Poon & Lee 2009)	Training
PROTECTING THE "SAILS" AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT	Video Recording: 2 hours of video recording which captures the metaphor creation process. Internal report produced by DOC Sydney Opera House Project (*Sydney Opera House Project by D.O.C. Designers* 2012)	Training

From the numerous design activities described in books and design journals, three case studies are identified as they describe the metaphor creation process in great detail. The researcher acknowledges that even though literature is an efficient data source, it does not allow clarification should the need arise. Nonetheless, it is still valuable in extending the diversity of cases beyond that of empirical case studies.

The first literature case is the PAINTBRUSH AS A PUMP metaphor. The creation process is found in Schön's description of a paintbrush product innovation in his book *Displacement of Concepts* and his paper *Generative metaphor: A perspective on problem-setting in social policy* (Schön 1967, 1993). Several researchers, such as Indurkhya (1992, 1994, 2007) and Clancey (1997, 1999), have further analysed this case study and provided their insightful comments that are applied in this study.

The second literature case is A CAPSULE WORKSTATION AS EYE IN THE STORM metaphor developed in a product idea generation exercise. It is described in the form of transcripts of design discussions between two tutors (one a professional designer and the other a theorist) and a design student in the book 'Vision in Design' by Hekkert & van Dijk (2011).

The third case is the PATHWAY AS BEETHOVEN's 9TH SYMPHONY metaphor developed as an architectural design student's project. The description of how this metaphor is created is found in two papers written by Casakin (2006a, 2006b).

The three literature cases are summarised in Table 3.5. They contribute significantly to the study with their detailed account of the design activities and fine-grained observations of subtle design steps.

Table 3.5 Cases obtained from literature

Metaphor created	Available data	Project or Training
A PAINTBRUSH AS A PUMP	Detailed description of the metaphor creation process and insights	Innovation Project
A CAPSULE WORKSTATION AS AN EYE IN THE STORM	Transcripts of metaphor creation process are captured through the conversations between the student designer and two tutors.	Training (design discussion recorded using transcripts of conversations)
A PATHWAY AS BEETHOVEN's 9TH SYMPHONY	General description of how the metaphor is created. Some reasons are provided for the selection of the metaphorical source	Training (architectural design student project)

Data processing

Data from the three sources are processed to generate rich descriptions of how metaphors are created. Figure 3.2 shows the research data for creating the WATERLOO SOCIAL HOUSING AS REBIRTH metaphor. In Figure 3.2(a), the design team clustered together the needs of all the stakeholders. After deciding to focus on residents who are ex-prisoners, the needs listed are re-examined from that new perspective. It leads to the creation of the REBIRTH metaphor shown in Figure 3.2(c). The examination of these artefacts makes explicit the cognitive processes of the designers. The details of how this metaphor is created will be further elaborated in Section 5.3.

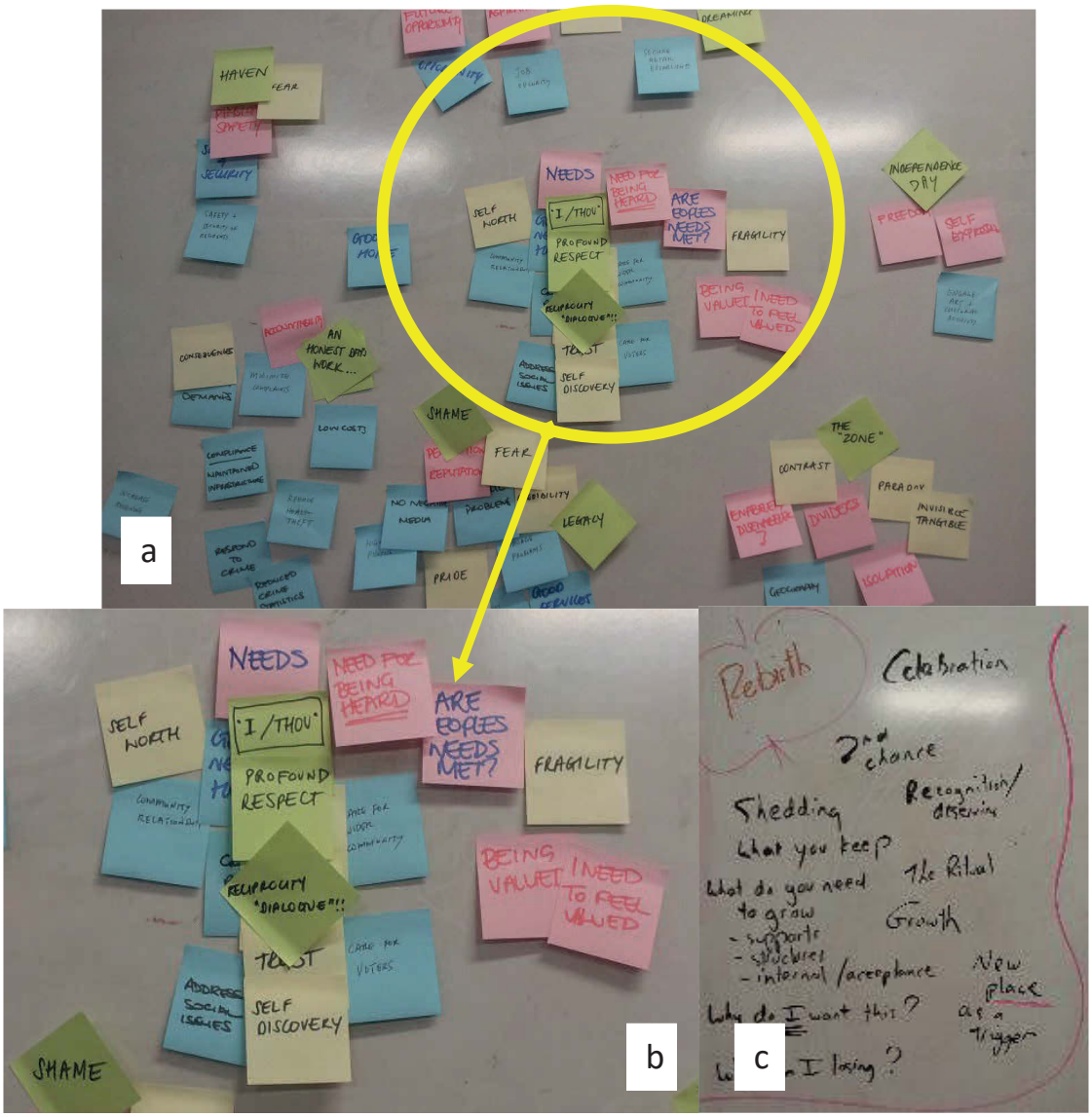


Figure 3.2 Captured data from empirical studies

Descriptions of the metaphor creation processes are then analysed using the dimensions developed in Study 1, as highlighted in box with bold outline shown in Figure 3.3. Similar cases are clustered to identify types of metaphor creation processes and their logical representation. Results from the analysis together with the rich descriptions are then presented in single case study reports. It is useful to note that the overall process is conducted iteratively even though it is described linearly in the thesis report.

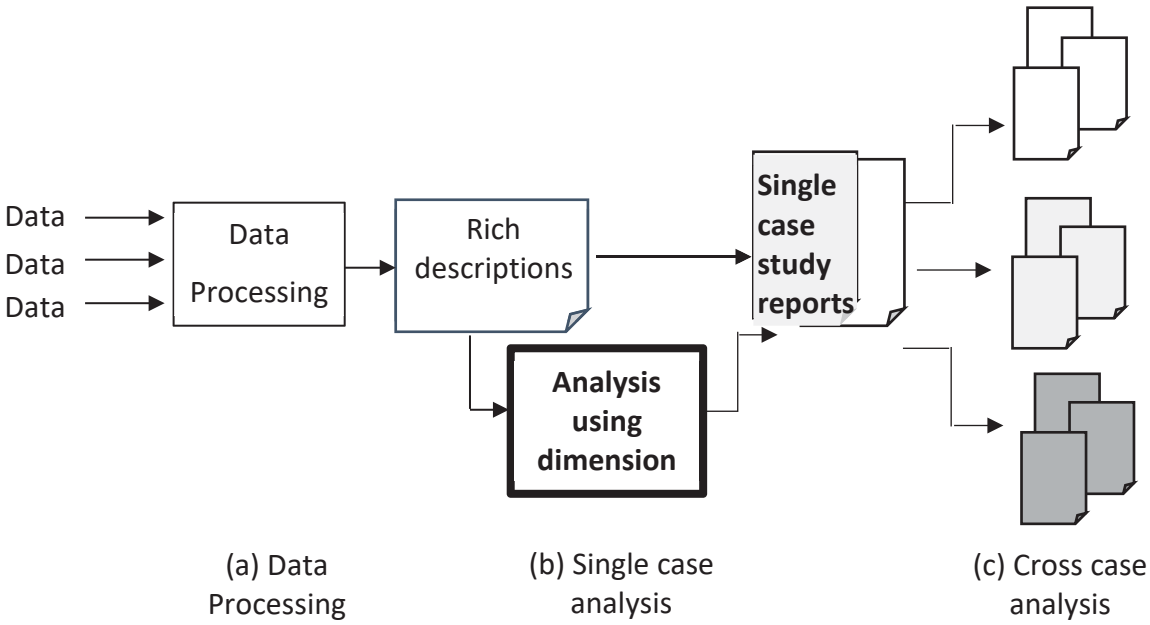


Figure 3.3 Data processing and analysis

An outline of the case study report is provided below which guides the data processing. Summaries of the case study reports can be found in Section 4.2. Every case study report is organised into three sections. The first section provides the background information of the case: context of the design project, design brief and specific design method that is applied. The second section highlights the see-think-act phases of the metaphor creation process described in chronological order. The third section provides the analysis results obtained from applying the dimensions on the case study.

The data required for writing the first two sections of the report comes directly from the data gathered. The processing that is needed to transform the raw data to the case study report format includes organisation, transcribing and sequencing.

Organisation of details about the case. The specific facts about the design project are gathered for writing up the background information of the report and checked for "completeness".

Transcribing. Video or audio recordings have to be transcribed before they can be studied closely. Discussions during the different design activities, in particular during the see-think-act phases, are then highlighted. Transcribing is needed for retrospective and empirical cases.

Sequencing the flow of design activities. Data are arranged in the see-think-act chronological order. This is necessary especially when there is more than one source of data. For example, in the WATERLOO HOUSING AS REBIRTH project, data collected includes notes taken during project briefing, site visits, project discussions and interviews as well as digital photographs. It aids the writing process if the notes and photographs are arranged in the see-think-act sequence before describing the process.

Sequencing is also required for the PAINTBRUSH AS A PUMP literature case study. This is necessary as the focus of Schön (1993) in writing the case study is to describe generative metaphor and how it is similar to the creation of a frame, rather than to analyse how the metaphor is created, it is necessary to re-arrange the flow of the design activities to explicitly bring out the *see, think and act* phases. Furthermore, the additional analysis by other researchers, such as Indurkhya (1992, 1994, 2007) and Clancey (1997, 1999), are also examined and extracted. Their insightful observations are incorporated to build a more comprehensive description of the PAINTBRUSH AS A PUMP metaphor creation process.

Once the data processing is completed, the rich description is ready to be analysed using the dimensions for determining the attribute values.

Data Analysis

The dimensions developed in Study 1 are applied to identify the attribute values of how each metaphor is created, as shown in Table 3.6.

Table 3.6 Analysing dimensions and related attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

The five dimensions that characterise the metaphor creation process are synthesised from the metaphor literature research in Chapter 3. The first dimension identifies the *basis of connection* between targets and sources with two attribute values, *resemblance* and *correlation*. The second dimension reflects the *representation forms* of targets and sources. The two attribute values are *gestalt* and *propositional symbol*. The third dimension indicates the *connecting element* between target and source. The two attribute values are *feature* and *structure*. The fourth dimension reveals the origins of the source with three attribute values; *embodied experiences*, *culture* and *propositional knowledge*. The fifth dimension indicates the cognitive utilities provided by the source and the three attribute values are *ontological*, *structural* and *orientational.*

By applying these analysing dimensions to the descriptions of how metaphors are created, the attribute values of metaphor creation process are identified. Attribute values for dimensions 1, 2 and 3 are obtained from the activities described in the *see* phase of the metaphor creation process while attribute values for dimensions 4 and 5 are obtained from the *think* and *act* phases.

Ten case study reports are generated from both secondary data and empirical observations of the metaphor creation processes. All the reports are generated in a descriptive format of how the metaphors are created and the attribute values identified using the five analysing dimensions. The summaries of the ten case studies can be found in Chapter 4 Individual Case Studies.

Two steps are needed in the cross case analysis to answer the two research questions of this project: first, to determine the types of metaphor creation process from the ten single case studies; second, to find out the unique creation processes of each particular type of metaphor identified in the first step. The cross case analysis is described in Chapter 5.

3.3 Conclusion

The overall research design of this study is illustrated by Figure 3.4. Efforts are made to develop exemplary research methodology in data collection and processing. Single case analysis and cross case analysis are conducted using data obtained from empirical observations as well as secondary data. The single case analysis produces rich descriptions of the metaphor creation processes from which the attribute values of the dimensions are identified. The cross case analysis identifies the types of metaphors and develops the logical representation of the creation processes of each type.

While the single case reports describe the creation processes of metaphors in specific design projects, the cross case analysis generates the common underlying logic of the metaphor creation process. The data needed for the two studies are produced by the research design and implementation described in this chapter.

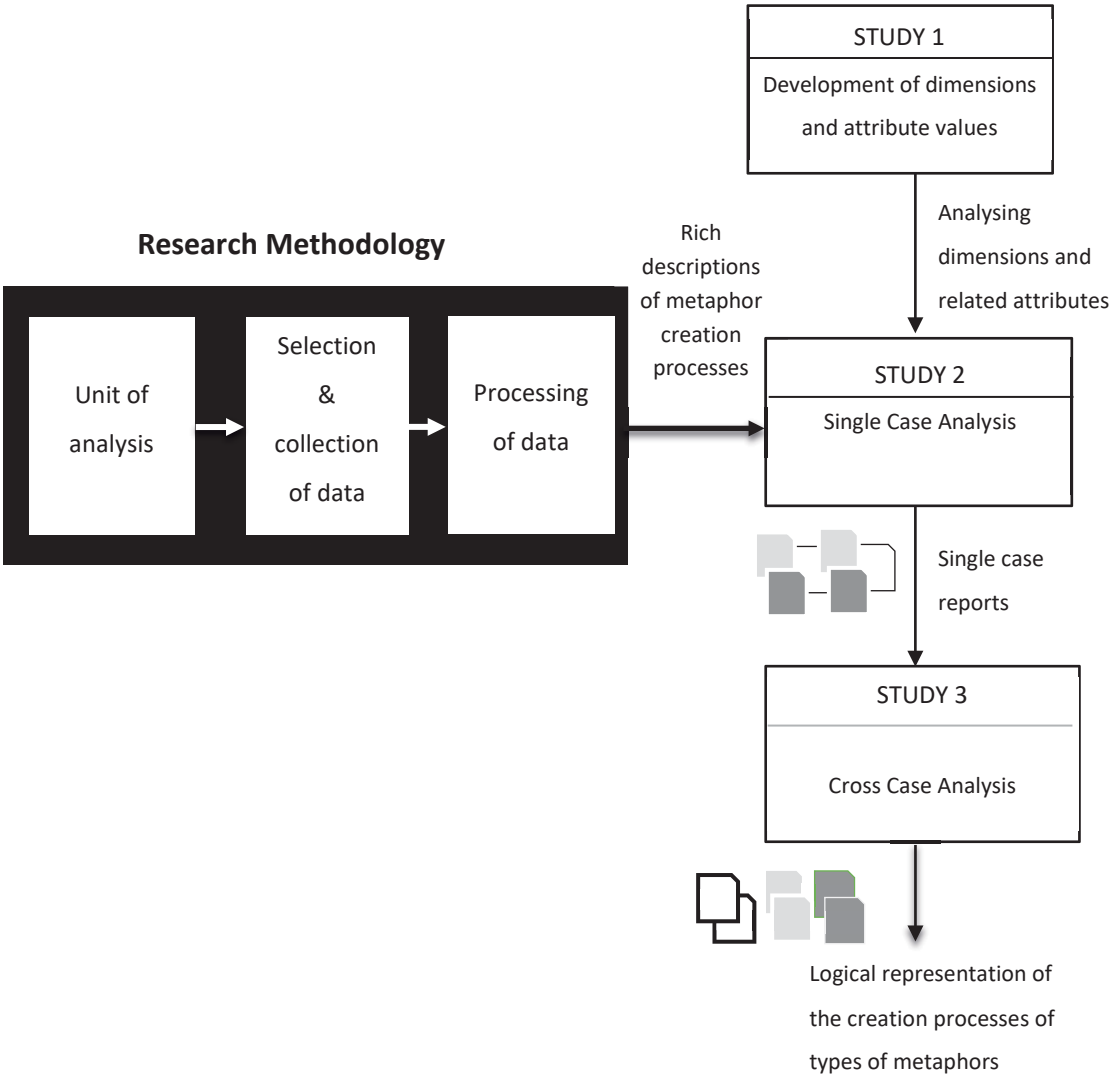


Figure 3.4 Overview of research design and three research studies

4 Individual Case Studies: Analysis and Discussion

Chapter 4 describes the investigation and results obtained from the single case analysis of Study 2. The research question for the study is "What are the attribute values of each of the ten case studies?" The findings together with rich descriptions of how the metaphors are created are written as single case study reports. The reports are used in Study 3 to answer Research Question 1: *"Which types of creation processes of metaphors that help produce frames can be identified?"* and Research Question 2: *"How can the logical representations of these respective creation processes identified in RQ1 be described?"* An overview of the research project outline is shown in Figure 4.1. As shown in the figure, the outcome of Study 2 is the single case report comprising rich description of the metaphor creation process and attribute values of the 5 dimensions identified using the typology developed in Study 1.

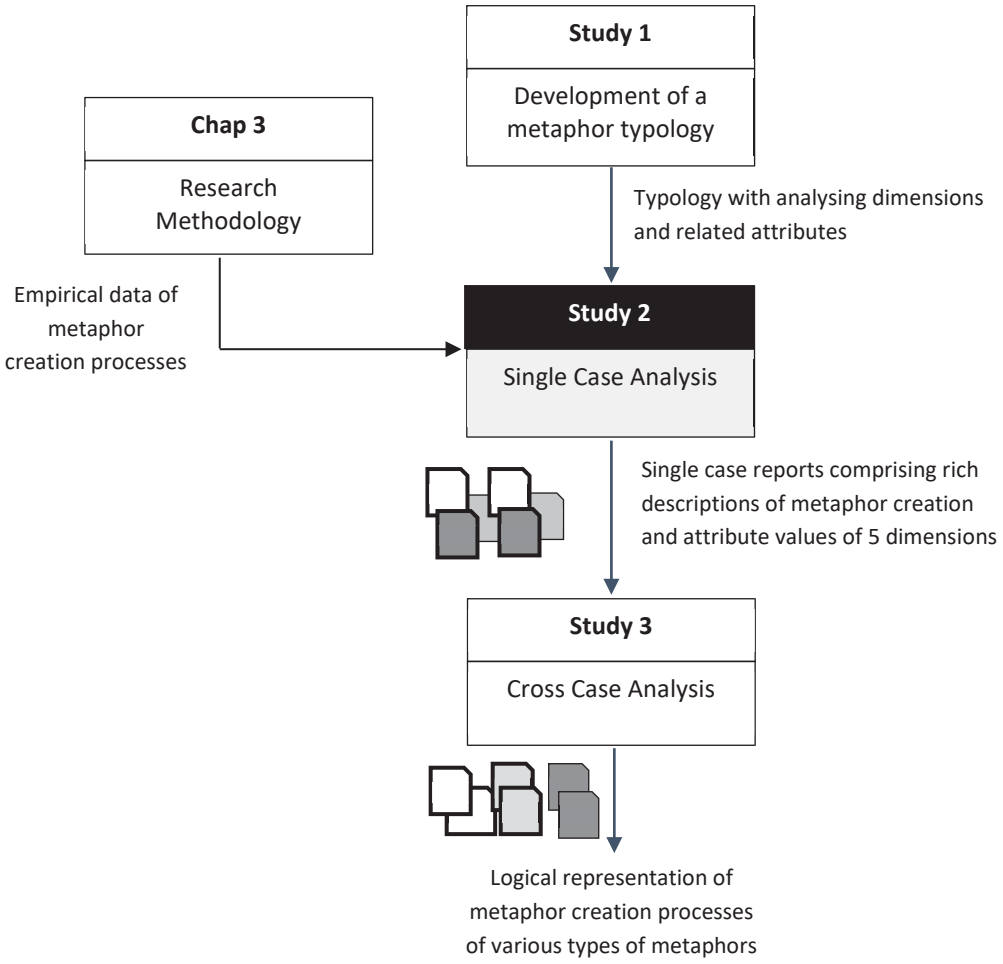


Figure 4.1 Overview of project

Chapter 4 comprises four sections: Section 4.1 provides a review of the five analysing dimensions and their respective attribute values; Section 4.2 summarises the case study reports and the identification of attribute values in each case study; Section 4.3 discusses the observations and lessons learned from the attribute values obtained in the ten case studies. The conclusion is found in Section 4.4.

4.1 Review of analysing dimensions and related attribute values

The five dimensions that characterise metaphor creation are synthesised from the metaphor literature research of Study 1. The first dimension identifies the *basis of connection* between target and source. The second dimension reflects the *representation forms of* target and source. The third dimension indicates the *connecting elements* between target and source. The fourth dimension reveals the origins of the source, while the fifth dimension highlights the cognitive utilities offered by the sources to better understand the target design situations. The related attribute values for the five dimensions are as follows.

Dimension 1: Basis of metaphor connection

This dimension describes how the source is triggered and drawn to the target. Its two attribute values are *resemblance* and *correlation*. Targets and sources may be drawn together based on conceptual or structural similarities. Metaphors may also be produced based on correlation of recurring co-occurrences in experiences.

Dimension 2: Representation forms

This dimension refers to the ways in which targets and sources are represented. The two attribute values in this dimension are *gestalt* and *propositional symbolic* representation forms. Gestalt representation form is a structured representation of patterns obtained from unstructured information perceived. A propositional symbolic representation form, or what is commonly known as a concept, is considered as a

particular phenomenon such as a process, an event or an object (Knezevich 1984). Concepts are made meaningful through their pre-determined relations with other concepts (Bess & Dee 2008).

Dimension 3: Connecting Element

This dimension specifies the element that links the target to source. The two attribute values in this dimension are *feature* and *structure*. All entities possess a set of features or attributes that distinguishes one entity from another. A structure is the underlying systems of relations between the parts of something more complex.

Dimension 4: Origins of sources

Origins of sources refer to where the source comes from. The three attribute values of this dimension are experiences, knowledge and culture. Common experiences and embodied experiences can be used as a metaphorical source. The second attribute value, knowledge, is often derived from everyday life and explicit propositional knowledge such as those learned from books or in school. Finally, culture, sub-culture and expressions of culture form the third attribute value of Dimension 4.

Dimension 5: Cognitive utilities provided by the source

This refers to the cognitive utilities provided by the source to facilitate understanding of the target. The three cognitive utilities provided by the metaphorical sources are ontological, structural and orientational. In providing ontological utility, the metaphorical source enables concepts that are abstract and intangible to be quantified and characterised through the use of substantive and physical qualities. A second utility that the source provides is the *structural* patterns and relations for understanding the target. Sources may also project a spatial *orientation* onto a target situation that does not possess an innate orientation.

The five analysing dimensions and their related attribute values are summarised in Table 4.1. They are applied in the next section for determining the attribute values for each of the ten case studies.

Table 4.1 Analysing dimensions and related attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

4.2 Summaries of single case studies

The research data for the ten cases listed in Table 4.2 are obtained from the research design described in Chapter 3. The data for each case are translated into a case report using a descriptive factual format that focuses on how the metaphors are created. The length of each report is approximately 1,500 words.

Table 4.2 Ten single case studies

Section	Case Study
4.2.1	A PAINTBRUSH AS A PUMP
4.2.2	200m PATHWAY AS BEETHOVEN's 9th SYMPHONY
4.2.3	A WORK STATION AS THE EYE IN THE STORM
4.2.4	WATERLOO HOUSING AS REBIRTH
4.2.5	KINGS CROSS AS MUSICAL FESTIVAL
4.2.6	KINGS CROSS AS JEKYLL AND HYDE
4.2.7	SOCIAL HOUSING AS SCAFFOLDED EDUCATION
4.2.8	SUPPORT FOR VICTIMS OF CRIME AS POSITIVE PARENTING PROGRAM (PPP)
4.2.9	SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE
4.2.10	PROTECTING THE SAILS AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT

The following section present summaries of the ten case study reports. Each summary comprises three parts: (i) brief context or background; (ii) highlights of the *see-think-act* design activities of the metaphor creation process and (iii) identification of the attribute values of the five analysing dimensions.

Case Summary 1 A PAINTBRUSH AS A PUMP

Context: The case study is based on the works of Schön (1967, 1993) and is written in his role as both a participant and an observer. The design project is triggered by the observation that the new synthetic brushes delivered paint in an uneven "gloppy" way when compared with the original natural bristle brushes. Schön recounts the attempts of product researchers to innovate the paintbrush and the creation of a PUMP metaphor. The investigation is conducted over an unspecified period of time.

Design Brief: A team of product researchers is required to improve the paint finish of new paintbrushes made of synthetic bristles.

Method: No specific design method is mentioned in Schön's recount other than the use of reflective practice.

See. The product researchers make the following insightful observations based on their interaction with the new synthetic paintbrushes from their immersive painting experiences. They observe that paint is *forced* to flow through the spaces between bristles onto the wall surface when the new paintbrushes are pressed against a surface.

a. A sharp bend tends to *force* all the paint out suddenly in both natural fibre and synthetic fibre brushes.
b. The product researchers demonstrate the experiment by doing the painting and inviting others to observe as they did so, and by describing the painting behaviours using terms such as *'squeezing'* or *'forcing'*.
c. They notice that natural brush shows smooth angles while synthetic brushes have sharp angles.
d. One of the product researchers notices that to facilitate a better flow of paint, some painters attempt to *vibrate a brush* as they apply paint onto a wall.

As the product researchers reflect on what they have observed and discussed, they begin to notice the *spaces* between the bristles (which used to be in the background) rather than the bristles themselves. One of them remarks that the "paintbrush is a kind of pump".

Think. After the emergence of the metaphor, the metaphorical concept of the pump guides how the new paintbrushes ought to be viewed. Rather than perceiving paint as being transferred from the *bristles* to the wall surface, the product researchers now *see* paint flowing through the *spaces* in between the bristles. The operation of the paintbrush is re-constructed by the PUMP metaphor. The cognitive activities in this *think* phase lead to the valuable insight that the bending angles affect how the paint is squeezed through the channels.

Act. With this new way of understanding how the synthetic paintbrushes work, the product researchers focus on ways to smoothen the bending angles of the synthetic paintbrushes. This enables the flow of paint to be 'pumped' smoothly through the 'channels' onto the wall.

Analysis

Attribute values of Dimensions 1 to 4, are explicitly mentioned in the works of Schön (1967, 1993) and Clancey (1999), as the following indicates. Attribute value of Dimension 5 is deduced from the case description.

D1: Correlation. Clancey notes that the pump metaphor is triggered by the ***perceptual correlation*** (Clancey 1999, p. 186) between bristles space in the paintbrush and channels in the pump.

D2: Gestalt. Schön finds this way of seeing the problem situation similar to the gestalt figure.

D3: Structure. Based on the three recurrent observations of the *flow, path* and *force* patterns and insight of Clancey (1999) that the metaphor is not based on feature matching, it is deduced that the connecting element is *structure*.

D4: Embodied experiences. Schön attributes the successful generation of the *pump* metaphor to the concrete situation in which the product researchers are able to experience the phenomena of the problem and reflect on the problem at the same time.

D5: Structural. The pump metaphor provides a *structural* function that transforms the researchers' conception of painting to one of controlling a system of capillary spaces that soaks up the paint and then applying the paint by manipulation of the bending angles.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experience	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 2 A PATHWAY AS BEETHOVEN's 9TH SYMPHONY

Context: This case study is taken from works of Casakin (2006a, 2006b) in which he describes his design research to investigate the application of metaphors in design problem solving. In the research project, 58 first year architectural design students participate in the design of a 200m pathway in an urban context. The project stretches over 16 sessions of 4 hours each, with 2 sessions per week and student designers working individually under 5 teachers who assist them through the design process. Of particular interest is the BEETHOVEN's 9TH SYMPHONY metaphor created by student designer Amihay. *Design Brief*: Student designers are required to develop their design projects in a dense, mixed use neighbourhood situated in a real city. The brief also requires students to describe the itinerary of the pathway and to define specific spatial relationships between the dwellings and the public urban spaces. *Method*: No specific design method is described by Casakin. However, the process is explicitly characterised by a series of cyclical stages of concept definition and framing; specification of goals and constraints; mapping and transference and application of concept to problem and solution development.
See. The design brief stipulates two explicit design specifications of a *route* for the 200m pathway and a *new system of relationships* between public and private spaces. Related to the design brief is the motion and experience of walking along the path. In his works, Casakin highlights two reasons that led the student designer to generate the BEETHOVEN's 9TH SYMPHONY problem frame. a. Student designer feels that ''every single musical detail, including the minor ones, is treated as something special". b. Student designer sees how "music constructs itself… little by little, step by step progressively strengthens itself, reaches a peak, and then fades away."
Think. By using the metaphor of BEETHOVEN's 9TH SYMPHONY, student designer Amihay develops his design ideas by conceiving a street as an interaction between the main and secondary elements. He begins to think of each minute building detail as something singular, as in BEETHOVEN's 9TH SYMPHONY. By using the metaphor, the student designer thinks of his selected site in Kerem Hataimanim as a symphony with a continuous and powerful interaction between public and private spaces, and how it fades away.
Act. The metaphor helps student designer Amihay to re-characterise the relation between the pathway and residences. He is able to "soften" the disconnection between the two spaces. This stronger connection between the pathway and residences encourages and increases the dialog between residents and visitors. This innovative relationship between internal and external spaces results in a new and novel way of living in the pathway.

Analysis

The attribute values of the five dimensions are based on interpretations from applying related metaphor literature on the descriptions provided by Casakin (2006a, 2006b). The following information is particularly useful for identifying the attribute values.

1. When we walk along a pathway, the motion comprises a starting point, a route and a destination. When we listen to music, we also enter into its motion and experience its moves. This feeling of motion is a fundamental and powerful feature of musical experiences (Larson 2012). Therefore, listening to music and walking along a pathway are experientially similar to us.
2. Some people encounter motion and melodies the same way: proceeding step by step, and having a direction with twists and turns (Snyder 2000).

D1: Correlation. Listening to music is rooted in our trajectory of movement through space and experiencing a musical piece could be considered as an extended motion (Johnson 2008). This leads to the interpretation that the metaphor is created using correlation.

D2: Gestalt. The musical piece Beethoven's 9th symphony and the pathway are linked by the common experiential gestalt: there is a starting point, a route and a destination.

D3: Structure. As music is set in motion, it follows a path just like physical motion when we move from point A to point B. Therefore, the connecting element is structural.

D4: Embodied experiences. Origin of source is the experience of listening to Beethoven's 9th Symphony.

D5: Structural. Amihay applies the structural pattern of how musical notes interact in Beethoven's 9th symphony to re-characterise the interaction between the pathway and residences.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experience	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 3 A CAPSULE WORK STATION AS AN EYE IN THE STORM

Context: The case study is taken from the book "Vision in Design" (page 86 to 114) written by Hekkert & van Dijk (2011). The case contains the conversations of two design tutors as they guide a student through his original project idea of a capsule workstation product development. The tutor who is a professional designer gives suggestions based on his own experience with the Vision in Product Design Approach (ViP). The other tutor who is a theorist suggests ideas for various themes that emerge from their discussions. *Design Brief:* The original intention of the student is to build a capsule workstation for working at home. The student is keen to build his work capsule as he envisages that people can enjoy working in the comfort of their homes by turning nice spots such as the garden into workspaces using his capsule. *Method:* The student is guided through the ViP design approach over 11 design sessions. ViP is a context and interaction based approach in which the context and the interaction are first developed followed by the design of the product physical attributes. In this approach, the context that affects the problem at the point of design and beyond is first identified. By using these context factors, the most context appropriate product is then developed.
See. From the design discussions, the team identifies several contextual factors which they summarise into the following statement: "People know that they can work sustainably at home and enjoy being at home but they fear losing touch with the outside world, or that they don't have access to the challenges and excitement that the world can offer." The student is then led to formulate the problem statement: "People working from home experience intrusion as if they were at the centre of universe working safely and comfortably". These discussions help the student create the metaphor EYE IN THE STORM. In addition to EYE IN THE STORM, the student designer also develops two other metaphors, TRAM SHELTER and MAIL ROOM.
Think. The student is next led to reflect on some feelings that are evoked by the interaction using EYE IN THE STORM metaphor. The characteristics are identified as *peaceful submission* and *cognitive privilege*. From these characteristics, some product qualities are derived: *a higher idea; something we don't quite understand, having integrity, trustworthy, fairness, wise and just, and unity in variety.*
Act. The discussions result in the product idea of a central unit in a workplace that filters information according to what is meaningful to the user. One of the design ideas is that the device produces an audio file for the day's activities just like a symphony of information stream. The chosen soundtrack contains some basic priorities set for the day and does the necessary to free the user from unnecessary disturbances.

Analysis

The attribute values are deduced from the data presented in the case study. In particular, the attribute values of dimensions 1, 2 and 3 are obtained from analysing the creation process of the metaphorical source EYE IN THE STORM. The results are further strengthened from studying the creation processes of two other metaphors, MAIL ROOM and TRAM SHELTER, which are also generated by the same student designer.

D1: Correlation. A correlation is observed between the two problem statements and the metaphorical concept of the EYE IN THE STORM. Refer to Section 5.5 for details.
D2: Gestalt. The gestalt described in the problem statements "working at home", "at the centre of universe working safely and comfortably" and "having access to the challenges and excitement" reflects a similar gestalt with EYE IN THE STORM where there is peacefulness and calm right in the eye or centre of a storm.
D3: Structure. The metaphorical source is triggered as it bears the same structure as the problem statement.
D4: Knowledge. The origin of the source could be knowledge or culture, as the conversations did not reveal any personal encounters. More likely, the metaphorical source comes from expressions of culture such as books, movies or music as the transcripts highlight the movie "Twister".

D5: Ontological. The EYE IN THE STORM metaphorical source provides ontological functions in describing the interaction characteristics as *peaceful submission* and *cognitive privilege.*

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 4 WATERLOO SOCIAL HOUSING AS REBIRTH

Context: Waterloo Public Housing, like all other housing projects, is provided by Australian Government agencies and offers temporary social housing to people in need. Residents who stay in these temporary housing are expected to seek employment. It is also expected that they move into more independent types of living once they are employed. Unfortunately, the reality is that many tenants are unable to find employment and have to continue to rely on these social housing. The project is conducted as part of a three-day training workshop on Frame Innovation Model developed by Dorst (2015b) in 2013. The data for this case study are gathered from participant observation by a four-member project team of which I am a member. The design activities in this project include design briefing, site visit and design discussions. *Design Brief*: The brief provided by the project owner for this social housing project is to improve the living experiences of residents in Waterloo Public Housing. *Method*: Frame Innovation Model is used. (Refer to Section 3.2 for description).
See. Project data for this project are gathered from a presentation by the City of Sydney and a site visit to Waterloo Housing Estate that includes some conversations with the residents to gain a first-hand understanding of the problem issues. During the design project discussion, the team decides to focus on residents who are ex-prisoners as they are regarded as the most needy group. As the team delves deeper into the issues faced by a particular group of residents who are ex-prisoners, three needs that could help increase their sense of optimism surface: *celebration, second chance, and recognition.* It becomes clear to the project team that the ex-prisoners are like all of us: they aspire to a better future despite their troubled past. The REBIRTH metaphor emerges shortly after the identification of the three needs.
Think. Once the REBIRTH metaphor is created, many elements related to rebirth are used for idea generation. They include values of growth and rituals to symbolise the completion of the rebirth process. As rebirth connotes shedding some parts of the old self, it leads to the question of what to keep and what to leave behind. Hence, in this *think* phase, the recycle structure of rebirth is applied to guide the development of several initial design ideas.
Act. To flesh out the design ideas, the team develops a series of activities that could contribute to the rebirth process. They are: stages of pre-release preparation, release and welcome to housing, integration and transition to mainstream housing and celebration. Systems and programs are also developed in the areas of self-discovery, job plan, transition plan, buddy system and generative project with payback.

Analysis

Two interpretations are developed for the creation of REBIRTH metaphor. The first interpretation is based on the explicit data derived from the design discussions conducted by the design team. The second interpretation is obtained after reflecting on the design activities and discussions, based on my role as a participant observer.

Analysis 1

D1: Resemblance. The three needs, *celebration, second chance, and recognition,* when viewed in the context of ex-prisoner residents who aspire for a better future, *resemble* the metaphorical concept of REBIRTH.

D2: Propositional Symbol. The propositional symbolic representation form of the three words, *celebration, second chance, and recognition,* triggers the metaphorical source.

D3: Structure. Rebirth stories usually depict change, renewal and transformation. They often start with the hero under the shadow of bad influence that misguided them (Booker 2004). Then, there is an awakening that gives a sense of renewal and a new beginning. This offers new hope and another chance of re-integrating back to mainstream life. The underlying structure of ex-prisoner residents re-integrating into mainstream society, signified by *recognition, celebration* and being given the *second chance* at life, resembles the structure of *rebirth.*

D4: Knowledge/expressions of culture. The metaphorical source is based on our *knowledge* of rebirth or reading/watching related novels or movies.

D5: Structural. The recycle *structure* of the REBIRTH metaphorical source guides the development of initial design ideas that include paths and steps that enable the ex-prisoner residents to go back to their former lives.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Analysis 2

This second interpretation is obtained by reflecting on the different housing arrangements that ex-prisoner residents rely on when they transit through different housing arrangements. These housing arrangements are reflective of their life stages. Instead of focusing solely on the immediate concerns at Waterloo Housing, this zoom-out view of how the ex-prisoners navigate through the various life stages represented by the various housing situations, contributes to the creation of the REBIRTH metaphor.

D1: Correlation. There is a correlation between the underlying cycle structure present in the metaphorical source, REBIRTH and the journey taken by the ex-prisoner residents from the prison to social housing and eventually to mainstream housing.
D2: Gestalt. The gestalt depicting the progression of ex-prisoners through different housing situations is used to trigger the REBIRTH metaphorical concept.
D3: Structure. The underlying structure that outlines the ex-prisoner residents entering and leaving the various housing situations reflects the CYCLE structure. This structure could also trigger the REBIRTH metaphorical concept.
D4: Knowledge. The metaphorical source is based on conceptual knowledge of rebirth.
D5: Structural. The recycle *structure* of the REBIRTH metaphorical source guides the development of initial design ideas that include paths and steps that enable the ex-prisoner residents to go back to their former lives.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 5 KINGS CROSS AS MUSICAL FESTIVAL

Context: Kings Cross in the City of Sydney used to attract 30,000 people over the weekends. Much of the crowd activity was concentrated in a narrow 500m stretch. This influx of people into the small space causes numerous problems, including drunkenness, fights, theft and drug dealing. Problems escalate as intoxication increases late into the night, sometimes leading to sporadic violence resulting in deaths and serious injuries. The problem frame for this project is developed during 2009 and 2010 Winter Schools. The four-week long Winter schools are supervised by DOC staff and tutors engaged for the duration of the program. A total of 25 students, mainly third-year undergraduate UTS students from design disciplines took part in the project. The data for writing this case study are obtained from three sources: student project reports, personal communication with design tutors who led the student teams, and literature (Camacho Duarte, Lulham & Kaldor 2011; Dorst 2015b; Dorst & Tomkin 2011; Livy 2011). *Design Brief*: The issues at Kings Cross are originally approached as a law-and-order crime prevention frame to tackle the alcohol-related violence and antisocial behaviours. There is a need to create another frame to better address the issues. *Method:* Frame Innovation Model (Dorst 2015b) is used. (Refer to Section 3.2 for description.
See. As the student designers and DOC staff study the problem issues in Kings Cross, an insight dawn on them when they realise that these 30,000 visitors to Kings Cross over the weekends are mainly young people who are out to enjoy themselves, they are not criminals. Unfortunately, some got themselves into trouble due to the lack of organisation in managing the circulation of 30,000 young people. The structure of experience in Kings Cross is similar to that of an *event.* This results in the creation of the KINGS CROSS AS A MUSICAL FESTIVAL metaphor.
Think. KINGS CROSS AS A MUSICAL FESTIVAL metaphor links a place to an event. When the musical festival is mapped to Kings Cross, several parallels may be drawn between their respective elements. The element of 'musical festival attendees' can be linked to 'visitors to Kings Cross' and 'organised facilities in a musical festival' to 'public infrastructure in Kings Cross'. The mapping reveals the elements missing in Kings Cross: a manager/organiser and infrastructure (such as toilets and transportation) that would be present at an event.
Act. Designers apply the MUSICAL FESTIVAL metaphor to generate design ideas for organising the fun that the young people enjoy in Kings Cross. New design solutions are generated after filling the missing role of event manager at Kings Cross. Some of the design ideas include transportation to bring the youths safely out of Kings Cross after midnight, guides, fringe activities and other services such as toilets. These measures aim to bring some order to the chaos that exists in Kings Cross due to the absence of an organiser.

Analysis

The following experiential gestalt encountered in musical festival is developed using the six dimensional structure developed by Lakoff & Johnson (1999). As illustrated by Table 4.3 below, the visit to Kings Cross is found to be similar to the experiential gestalt of going to a musical festival. This leads to the identification of representation form (Dimension 2) as gestalt.

Table 4.3 Experiential gestalt of attending musical festival

Participants	Youths
Parts	• A group of youths looking for entertainment and fun • A program schedule for the musical event • Participation in the key musical event and side activities • Access to services such as food, drinks, transportation • Satisfaction derived from the entertainment and company • An organiser who ensures that the musical event is in order
Stages	**Initial condition**: Receive invitation from friends or extend invitation to friends **Beginning**: Arrangement to visit musical event (place, time, mode of transportation, tickets) **Middle:** Entry to venue and participation in the main musical event Enjoy music, consumption of drinks and food Attending side activities Access to services **End**: Leave musical event for home or continue to another activity with friends **Final state**: Feeling satisfied with the entertainment and company
Linear sequence	Meet and travel to event venue Enjoyment of musical event and side activities Access to services Continue to hang around to enjoy side activities or leave venue
Causation	Enjoyment results from satisfaction with company and entertainment
Purpose	Fun and entertainment

Analysis

D1: Correlation. The metaphorical source of musical festival is triggered by experiential similarity with the encounter in Kings Cross by the youths.

D2: Gestalt. The gestalt of the Kings Cross experience activates the musical festival event metaphorical source.

D3: Structure. The event structure underlying Kings Cross triggers the musical festival event.

D4: Embodied Experiences. The metaphorical source of musical festival is drawn from embodied experiences of the student.

D5: Structural. The metaphorical source of MUSICAL FESTIVAL with its distinctive structure provides an event structure to Kings Cross.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 6 KINGS CROSS AS JEKYLL AND HYDE

Context: This metaphor is developed in a preparation workshop to get ready for 2014 Winter School for a UTS course (Bachelor of Creative Intelligence and Innovation, BCII) design workshop. The DOC team participated in this 3-hour workshop from which I collected data using participant observation. *Design Brief:* To generate design ideas to develop future directions for Sydney's nighttime economy for OPEN Sydney and the precinct of interest is Kings Cross. *Method:* No particular design process is used in the workshop. The discussion is primarily guided by four questions: (1) What do you see in Kings Cross? (2) What is exciting? Or surprising? What are your insights? (3) What works well there? (4) What does what you have seen at Kings Cross remind you of? Can you identify some opportunities?
See. The team makes several interesting observations based on their knowledge of Kings Cross. The discovery of the variety and huge number of people at Kings Cross comes as a surprise. That plain clothes police are present in the place stirs some excitement and Kings Cross also reminds them of Las Vegas with its surreal experience. The team is also amazed at the interesting buildings in Kings Cross. While several laneway restaurants serve the important function of nourishing visitors, funky shops help spice up the place. Overall, the team notes that the place offers uniqueness, surprises and openness for different mix of businesses. Another significant observation is that Kings Cross looks like any other place in the day but is transformed into something very different in the night. During the day, the team sees families with children and routine everyday activities that are no different from those in other precincts. However, in the night, they observe a transformative change. This leads them to the generation of KINGS CROSS AS JEKYLL AND HYDE. Other metaphors generated for this case study include DORIAN GRAY AND THE PORTRAIT and WEREWOLF. These stories are briefly shared at the end of this case study summary.
Think. The JEKYLL AND HYDE metaphor provides a perspective to look at the opportunities offered by the mysterious, dark seduction of Kings Cross. The JEKYLL AND HYDE metaphor also lends insight that the transformative process from Jekyll to Hyde is another feature that can be exploited.
Act. Several design ideas are generated for the design situation. The following two design ideas pertain to the morphing process from Jekyll to Hyde: a. Create completely different day and night scenes like a set change in the movies. b. Turn the street into a parade that emulates the Disney Night parade which takes place after the sunset.

Analysis

What appears as a leap from "day and night" at Kings Cross to the metaphor JEKYLL AND HYDE is made up of at least two underlying steps, as illustrated by Figure 4.2. The intermediate steps are "day is bright and night is dark" followed by "bright is good and dark is evil". The gestalt of the "dualism of good and evil or lightness or darkness" that is present in individual and society (Singh & Chakrabarti 2008) is used to create the metaphor.

Day and Night at Kings Cross | Day is bright Night is dark | Bight is good Dark is evil Primary Metaphor | Dr. Jekyll and Mr. Hyde

Figure 4.2 Multiple jumps in the creation of Dr. Jekyll & Mr. Hyde metaphor

D1: Correlation. GOOD IS LIGHT is a primary metaphor that is derived from experiential correlation. The metaphor of KINGS CROSS AS JEKYLL AND HYDE is similarly based on correlation.
D2: Gestalt. This metaphor is created using the gestalt of brightness/darkness.
D3: Feature. The metaphor is generated based on the distinctive feature of day/night that is then transposed to bright/dark and good/evil.
D4: Culture. Dr. Jekyll and Mr. Hyde is a novel written by Robert Louis Stevenson and has been adapted in numerous movies. The novel is considered an expression of culture.

D5: Structural and orientational. The metaphor conveys the message of morality/immorality and provides the path of transformative change from Dr. Jekyll to Mr. Hyde.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Background stories of Jekyll and Hyde, Dorian Gray and Werewolf

The curious case of Dr Jekyll and Mr Hyde. Dr Jekyll and Mr Hyde are the two key characters in this novel. Dr. Jekyll is a widely respected, successful and intelligent man. However, underneath this positive persona hides a dark life filled with evil. To free himself from this evil, Dr Jekyll produces a concoction from his experiments that leads to his transformation to Mr Hyde. While Dr Jekyll is widely respected and successful, Mr Hyde is seen as evil and immoral. There is also a distinctive difference in their physical appearances where Dr Jekyll is a "large, well-made, smooth-faced man of fifty" while Mr Hyde is grotesque and deformed. As the story develops, Hyde becomes increasingly powerful and manifests whenever Dr Jekyll shows signs of physical or moral weaknesses. When Dr Hyde realises that he will stay as Mr Hyde permanently due to the lack of necessary ingredients to create the concoction, Dr Jekyll decides to end his life.

Dorian Gray and the Portrait. The story of Dorian Gray is about a young and handsome man, Dorian and his portrait. When Dorian realises that his portrait bears the weight of his immoral acts, he sets out on a life of self-indulgence and evil deeds. He starts to live a double life where he leads a reputable life outwardly while inwardly pursues an immoral life. As Dorian heads down this path of immorality, his portrait becomes increasingly disfigured and hideous reflecting his moral deterioration. Nearing the end of the story, Dorian hates what he has become and tries to end his misery by destroying the portrait as it reminds himself of his sordid past of violence and immorality. However, in slashing his portrait that contains his soul and consciousness, Dorian unknowing kills himself.

Werewolf. Werewolves are often featured in cult literature or movies as creatures that are both man and wolf. These creatures often change from man to a wolf when there is a full moon in the night. Hollywood has romanticised the notion of werewolves and it has been featured in numerous movies.

Case Summary 7 SOCIAL HOUSING AS SCAFFOLDED EDUCATION

Context: The aim of social housing is to provide temporary housing for tenants until they move to mainstream housing, with the understanding that they have an obligation to improve their situations so that they can be independent of social housing. However, this original frame of MUTUAL OBLIGATION could not help the participants produce ideas that could lead to a path of action. The data for this case are based on observation of a workshop session conducted by DOC for senior public servants from various Australian State Government Departments in December 2013. In addition, this report takes reference from a paper written by Van der Bijl - Brouwer & Dorst (2014) that describes how a project team develop their problem frames. Sixteen participants attended this one-day training workshop on Frame Innovation Model. The participants are divided into four teams, each led through the frame creation process by a design expert. *Design Brief:* The original brief is taken from a pre-existing frame of MUTUAL OBLIGATION between the providers of social housing and tenants. *Method:* Frame Innovation Model. Refer to Section 3.2 for description.
See. Several themes that existed in the context and field are identified. They include self-determination, autonomy, control, belonging, trust, shelter and stability. The team chooses the themes of *control* and *autonomy* as they are applicable to all the stakeholders. To unpack the themes, the team members share personal experiences of when they feel they are in control and when they have no control. Also, what it feels like when control is relinquished to someone else. In this thematic analysis, *to be in control* means having available options, knowing what they are and having the power to decide. Knowing that *one is in control* gives a *sense of calmness* and *self-respect.* However, it requires one to stretch beyond the comfort zone. People are willing to relinquish control to others they trust and when they possess the choice to choose people they trust. The metaphor of SCAFFOLDED EDUCATION is suggested by a public manager from the educational sector. The metaphor is produced using similar patterns of relationships found in the two themes, control and autonomy.
Think. In scaffolded education, the teacher initially controls the learning task that is beyond the learner's capability. As the learner acquires the necessary competence, scaffolding is removed so that the student is able to take over the control of learning. In using the metaphor of scaffolded education as a perspective to view the problem, the participants come to realise that by imposing rules of social obligation, social housing has taken over control. That is a step backwards, as it not only did not remove the scaffold, it actually enforces further controls.
Act. This phase is not covered in the workshop.

Analysis

The attribute values are deduced from data gathered.

D1: Resemblance. The metaphorical source is based on the resemblance of the patterns of relationships of the two conceptual themes *of autonomy and control*.

D2: Propositional Symbol. The propositional symbolic themes of *control and autonomy* lead to the emergence of the metaphor of *scaffolded education*.

D3: Structure. Both my observation and literature (Van der Bijl - Brouwer & Dorst 2014) reveal that the metaphor is created based on similar patterns of relationships found in the themes of control and autonomy.

D4: Experience/knowledge. The metaphor of scaffolded education is suggested by a public manager from the education sector based on her knowledge and experience of scaffolded education.

D5: Structural. The metaphor provides a structure for thinking about the problem issues in a new way.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experienc	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 8 SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE

Context: Two one-day workshops are conducted on 25 and 26 June 2014 to address the experiences of victims of crime at an individual level and as a group. The objective is to guide policy direction and the government's role in creating a system that can better meet victim needs within a highly complex justice system. Thirty participants attend each workshop and are led through the design process using Frame Innovation Model (Dorst 2015b). The participants come from various departments and agencies within the "justice cluster" of the NSW Government bodies, and include government and non-government victim advocacy groups. They are divided into four groups, each led by two facilitators. This case summary describes the frame creation process for the group working on the theme of Child Assault crime. The research data for writing this case study are obtained from user observation and literature produced by DOC (Kaldor & Watson 2015; Wong, Kaldor & Watson 2014). *Design Brief:* The objective of this workshop is to develop clear and deliverable changes to the criminal justice system and to create optimal user journey for victims of a number of crime types. The goal is to "develop clear ideas for improving the justice system for victims of crime, by putting the victim at the center of the justice system"(Wong, Kaldor & Watson 2014). *Method:* Frame Innovation Method (Dorst 2015b). (Refer to Section 3.2 for description.)
See. For this case study, five themes are generated: *clarity, fairness, responsiveness, safety*, and *wellbeing*. In identifying the entity that possess these attributes, the team is led to the creation of the AMBULANCE SERVICE metaphor, which is a customer-centered emergency response system for providing immediate and appropriate treatment to patients.
Think. The metaphor of ambulance service highlights desirable characteristics such as 'reliability', 'known experience', 'door-to-door care and support'. From that, the design team comes to realise that the experience of care that ambulance patients receive could also help to alleviate the victim's anxiety and trauma. As the court experience has historically been known to traumatise this group of victims (Goodman, 1992), the team comes up with a suite of improvements that resemble the support that ambulance patients receive.
Act. Some initial solution ideas include a chaperone in court, transport to and from court, and options to testify remotely by video are developed.

Analysis

The attribute values for the dimensions are deduced from the data gathered from user observation and literature.

D1: Resemblance. The metaphorical source is triggered by the similarity of the themes (clarity, fairness, responsiveness, safety, and wellbeing) with the common knowledge of Ambulance Service as providing *safety* and *wellbeing* of patients through *responsive* pre-hospital services and emergency patient care.

D2: Propositional Symbol. The propositional symbolic concepts of the themes and ambulance service draw them together to form the metaphoric frame.

D3: Feature. The common features found between ambulance service (responsiveness, accessible services that are appropriate to the needs and wellbeing of the patients, and services that adhere to safety standards) and the themes lead to the creation of the metaphor.

D4: Knowledge. The metaphor is created based on the common knowledge of what the ambulance service offers.

D5: Structural. The metaphor provides a structure for thinking about the needs of the victims and about offering 'door-to-door care and support'.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 9 SUPPORT FOR VICTIMS OF CRIME AS POSITIVE PARENTING PROGRAM (PPP)

Context: The context for this case is the same as the previous case (Case Study 8). This case summary describes the frame created by the group working on the Break and Enter crime during the workshop. *Project Brief:* More than 50,000 households in New South Wales (NSW) experience home burglary every year. Break and Enter crime is often invasive and disrupts daily lives. Break and Enter crime causes personal distress and inconvenience besides incurring expenses. The aim of this project is to generate ways to support the needs of the victims of home burglary crime. *Method:* Frame Innovation Model. (Refer to Section 3.2 for description).
See. Six themes are identified using the Frame Innovation model: self-worth, doing one's best, choice, well-being, belonging and empowerment. From these themes, the group creates the metaphor *Positive Parenting Program* (PPP).
Think. Four design ideas are developed using PPP as a perspective to think about victim services. Firstly, interventions aim to support and educate not only the victims, but also professionals working within the victim services. Secondly, just like PPP seeks to create a culture of parenting that is transparent and understood by many, a culture of victim support would similarly be developed so that it could be widely recognised by the community. Thirdly, professionals working in victim support would belong to an active community that enable them to deepen their knowledge, just like PPP where parents can connect to PPP practitioners through the PPP web site. Finally, professionals providing victim services will uphold minimum service standards such as the accreditation system in PPP. By tapping on the understanding of PPP, the project team gains insights into how PPP services and programs are made possible due to its culture and critical supporting systems.
Act. Just as PPP is supported by foundational knowledge of child development and a child's intellectual and physical journey to independence, a journey map of a victim's experience would be useful to provide a baseline understanding. This journey map could throw light on how and when information and support should be made available to the victims of crime.

Analysis

The attribute values for the dimensions are deduced from the data gathered from user observation and literature.

D1: Resemblance. The metaphor is triggered by the similarity of the themes (self-worth, doing one's best, choice, well-being, belonging and empowerment) with the common knowledge of PPP as equipping parents with skills and strategies to be effective parents and to develop close and lasting relationships with their children.
D2: Propositional Symbol. The propositional symbolic concepts of the themes and PPP lead to the creation of metaphor.
D3: Feature. The common features (such as well-being, belonging and empowerment, choice) of PPP and the themes lead to the creation of the metaphor.
D4: Knowledge. The metaphor is created based on knowledge of Positive Parenting Program (PPP).

D5: Structural. The structures of the various supporting systems in PPP provide a structure for thinking about services and support systems needed to help the Break and Enter victims.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experiences	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

Case Summary 10 PROTECTING THE SAILS AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT

Context: This metaphor is developed in a two-hour frame creation session in 2012 to devise design ideas to prevent people from climbing up the "sails" of the Sydney Opera House. The research data for writing this case study are obtained from a video recording that captures the framing process and from literature (Dorst 2015b). The two-hour design discussion is led by Prof Kees Dorst and participated by 18 young UTS architects and designers and three DOC staff.

Design Brief: The project is initiated by the Opera House to explore ways to augment existing security measures and enhance the visitor experience (for both patrons and tourists). The specific problem focusses on the issue of protestors climbing the "sails" of Sydney Opera House to unroll banners or paint slogans on the sails. The problem situation is originally presented as a security problem of people trespassing the Sydney Opera House.

Method: Frame Innovation Model. (Refer to Section 3.2 for description).

See. During the design discussion, it is noted that the "elements of nature, wind, water, earth and the sails as mountains on either side come together in an abstract and impressive way". The experience of the spiritual intent of the Opera House at the podium space leads to the development of the *spiritual uplift* theme.

Think. A *cathedral* and *Utzon's original sketches* of the Opera House are suggested as precedents to generate design ideas to create the feeling of *being in a special place*. Several qualities are extracted from these two precedents. They include *calmness, stillness, harmony, nothingness, absorbing, feeling, flow* and *removed.*

Act. To bring stillness and a sense of peace to the podium space at the Opera House, design ideas are developed to evoke a sense of lightness or weightlessness through the natural elements and natural lighting. Together with the other two themes of "liveliness/rejuvenation" and "the sense of place/home", the mid-podium area could be curated as a twenty-four hour space with diverse uses during the morning, day, late afternoon/evening and late evening.

The spiritual uplift theme is transposed into meditative events using light art or moonlight/star gazing for the late evening. This round-the-clock usage of the podium space would provide passive surveillance and make it harder for protestors to climb the sails without attracting attention. This proposed curated space in the podium double up as a security measure to reduce the number of trespasses without resorting to obtrusive policing measures.

Analysis

The attribute values of the dimensions are deduced from the data gathered.

D1: Resemblance. The two precedents *cathedral* and *sketches by Utzon* exhibit similar quality of *spiritual uplift*.

D2: Propositional Symbol. The propositional symbolic concept of the spiritual uplift theme leads to the creation of the two metaphors.

D3: Feature. The feature of *spiritual uplift* leads to the precedents of cathedral and Utzon's original sketches of the Opera House (with the floating clouds).

D4: Experience. The experiences of spiritual uplift evoke the two metaphors.

D5: Ontological. The two precedents offer the ontological meanings of calmness, stillness, harmony, nothingness, absorbing, feeling, flow and removed.

Attribute values

Dimensions	Attribute values		
Basis of connection	Resemblance	Correlation	
Representation form	Gestalt	Propositional Symbol	
Connecting element	Feature	Structure	
Origins of sources	Embodied experience	Knowledge	Culture
Cognitive utilities provided by source	Ontological	Structural	Orientational

4.3 Observations and lessons learned

The following are observations developed from the single case analyses and attribute values. The observations offer useful lessons that deepen the understanding of the creation processes of metaphors. Likewise, the findings are also useful for refining the present typology.

Target and source connection

Two observations are obtained for the connection between target and source. First, it is observed that the link between target and source is made up of a series of smaller connections. The second observation is that designers strategically probe the design situations through multiple metaphors.

It is observed that the JEKYLL AND HYDE metaphor is created from several small jumps rather than one big leap, as illustrated in Figure 4.2. While several of these connections in between the metaphorical source and target are based on resemblance, one of them (bright is good, dark is evil) is based on correlation.

The second observation is that designers strategically probe the design situations through the creation of multiple metaphors using the same themes. For example, in the SOCIAL HOUSING project, two metaphors, SCAFFOLDED EDUCATION and REUNION are generated using the same themes of *control* and *autonomy* (van der Bijl-Brouwer & Dorst 2017; Van der Bijl - Brouwer & Dorst 2014). These two metaphors provide different yet complementary perspectives on the social housing design situation. This ability to view the design situations in various ways through multiple metaphors enables the designers to quickly probe the design situations to uncover different facets of the design problem.

These observations of how metaphors are created in multiple steps and the use of similar themes to create multiple metaphors yield useful insights on the underlying

logical representation of the metaphor creation process. Further analysis is discussed in Chapter 5.

Representation forms

The analysis results suggest that the way in which the design situations are perceived by designers affects the production of particular types of metaphors. For example, it appears that student designers create metaphors such as BEETHOVEN's 9TH SYMPHONY and PAINTBRUSH AS A PUMP by correlating the gestalt *representation* form of design situations to the respective metaphorical sources. However, metaphor such as SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE appears to be created by associating the *propositional symbolical* representation form of the problem situation to the source.

There are probably several factors and conditions existing in the design processes or situations that promote one representation form over another. However, as the representation forms are eventually applied by designers during the creation of the metaphors, it appears that the designer may well exert the strongest influence on how the design situation is perceived. Further discussion on how the representation forms are perceived and how they affect the creation process is shared in Chapter 5.

Variations in gestalt representation forms

In this project investigation, two gestalt structures from Cognitive Linguistics literature, *experiential gestalt* and *image schema* are used to illuminate the metaphor creation process using gestalt representation form. It is useful to note that the world takes on gestalt forms as a result of being perceived by someone. Gestalts are not physical objects that exist in the world. This implies that some amount of imagination is necessary in order for one to perceive gestalts.

Experiential gestalt is an integrated and comprehensive way of organising human experiences (Lakoff & Johnson 2008). As illustrated in case study 5 KINGS CROSS AS A

MUSICAL FESTIVAL, the experiential gestalt of *attending a musical festival* could include structural elements comprising participants, stages, linear sequence, causation and purpose as described in Lakoff & Johnson (2008). When the designers visit Kings Cross to study the design problem, the actual immersive experience at Kings Cross is perceived relative to the musical festival gestalt and that led them to create the KINGS CROSS AS A MUSICAL FESTIVAL metaphor

In addition to experiential gestalts, the observations from several single case analysis spurs a deeper investigation into a different type of gestalt. The type of gestalt that has been found particularly relevant for this study is the image schema. From literature, image schema is known to be a kind of gestalt structure that emerges from recurrent perceptual interactions or bodily interactions with our physical environment (Johnson 1987). For example, when someone takes a biscuit out of a box, he or she knows that the biscuit is inside the box and the container has a boundary that holds the biscuits within the box. In everyday life, the CONTAINER image schema is associated with many things and concepts around us. For example, a cupboard, pail, stomach, room, car and a bus are all containers even though all of them are physically different. All these containers share the same relations and interactions as they possess three similar parts; outside, boundary and inside as illustrated in Figure 4.3.

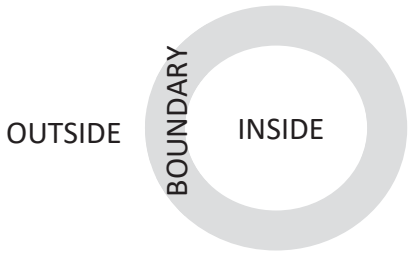


Figure 4.3 CONTAINER image schema

From these daily interactions with all these CONTAINER objects, a store of similar experiences are built up implicitly. In addition to physical containers, a metaphorical projection of this schema can lead to the creation of a more abstract version of containers eg. THE BANK ACCOUNT IS A CONTAINER. This metaphorical container of a bank account allows funds to flow in and out. Using the same line of reasoning,

marriage can also be considered as CONTAINER in which partners go in and out of their marriage.

In addition to the CONTAINER image schema, the PATH image schema is also used extensively to facilitate an understanding of how metaphors are created. The PATH image schema underlies the following experiences; seeing a stream of water flowing from a cup, walking along the road, giving a friend a birthday present, singing a song, listening to music, climbing a mountain, achieving a goal etc. Despite the apparent differences of the activities described in these examples, all of them bear the same recurrent image schematic structure. By tapping on these parts and relationships, the PATH image schema is able to make explicit the underlying pattern of all the above mentioned experiences.

a. starting point
b. ending point
c. sequence of connecting points in between

Figure 4.4 PATH image schema

These experiential knowledge captured in image-schematic gestalt forms are applied intuitively when designers encounter particular design situations as described in this project investigation. Therefore, image schemas may be considered as bodily tacit knowledge. For this project, the notion of tacit knowledge is taken from the works of Lakoff and Johnson to mean knowledge that "operates beneath the level of cognitive awareness, inaccessible to consciousness and operating too quickly to be focussed on" (Lakoff & Johnson 1999). Applying the notion of image schema provides a means to make explicit the tacit gestalt structure of recurrent sensorimotor experience encountered by designers in the design process. Image schemas may therefore be considered as 'distillers' of experiences (Oakley 2007) as they are condensed re-

descriptions of perceptual experiences. Image schema has also been referred to as the "missing link" (Hedblom et al. 2017) between embodied experiences and metaphorical thinking (Johnson 1987). This knowledge of image schema is found particularly useful in this research investigation on metaphor creation as the identification of underlying image schemas in the case studies will throw significant light on the metaphor creation process. In this project investigation, the PATH and CONTAINER image schemas can be used to contribute to an improved understanding of numerous metaphor creation processes described in case study 3. The details of how these image schemas can be triggered will be discussed in section 5.5. The discussion will also include the manipulation of image schemas to illuminate the metaphor creation process.

From the discussions conducted in this section, image schemas appear to share similar features with visual images and visual representations such as sketches. Therefore, it is useful to gain a clearer picture of how image schemas relate to visual images and visual representations before proceeding further.

How image schemas relate to visual images, visual representations and metaphors

Before relating image schemas to visual images and visual representations, it is useful to first clarify what they refer to. Visual images are representations of the visual appearance of objects perceived (Goldstein 2010). Visual images are therefore perceptually similar to the particular objects or events they represent. Besides generating visual images from sensory information, visual images may also be produced from memories of prior encountered experiences. While visual images are representations of objects or events, visual representations are knowledge supporting objects to help designers in their work. Visual representations are deliberately constructed images that assist knowledge work in two areas. Firstly, visual representations are used for articulating and understanding design ideas. Secondly, design practitioners interact with visual representations to generate knowledge (Ewenstein & Whyte 2007). Therefore, visual representations can serve as external memory and be used in reasoning and reflection (Lawson 2009).

A comparison between them will now be made. Image schemas are derived from commonalities detected from different experiences that may be related in some way. Therefore, as compared to visual images, image schemas are generic and universally abstract while visual images are more contextualised as they are associated with the actual experiences or episodic memories. This means that visual images are more concrete, richer and sensual relating to a particular instances as compared to image schemas which tend to be more general. Image schemas, being more abstract and general can therefore help people in establishing connection between different experiences that share similar recurring structure. For example, a PATH image schema could activate a range of diverse experiences or knowledge such as SUGAR DISSOLVING IN WATER, HURRICANCE and BEETHOVEN's 9th SYMPHONY. This implies that specific image schemas may be derived from different visual images that share similar structure.

While visual representations are images deliberately constructed during the design process, image schemas are known to operate beneath the level of "conscious awareness" according to Johnson (2005). Therefore, designers can be very explicit about how they interact with visual representations (Schön 1983) while the thinking processes involving image schemas tend to be more implicit.

In addition, the notion of image schemas can contribute to the creation of metaphors and the details are elaborated in section 5.5. Having gained greater clarity of these related notions from literature, the next section discusses the origins of sources.

Origins of sources that influence the universality of created metaphors

It is observed that embodied bodily experiences often lead to the creation of near universal metaphors. In Kings Cross, the embodied bodily experience of day/night leads to the primary metaphor of *BRIGHT IS GOOD, DARK IS EVIL*. However, the *origin of sources* dimension which possesses the attribute values of individual experiences, *knowledge* or *culture,* leads to differences in the created metaphors. For example, JEKYLL AND HYDE, DORIAN GRAY AND THE PORTRAIT, WEREWOLF are produced by various

designers due to the different books and media they come into contact with, even though all share the common *BRIGHT IS GOOD, DARK IS EVIL* primary metaphor.

Cognitive utilities provided by sources

Of the three attribute values present in Dimension 5, the two attribute values, *ontological* and *structural,* are more prominently featured than the orientational function in the ten case studies. The only case study that makes use of the orientational function is KINGS CROSS AS JEKYLL AND HYDE in which the day/night orientation is linked to the moral/immoral features in JEKYLL AND HYDE.

Observations drawn from relating Dimensions 3 and 5

Interesting insights surface when correlating the attribute values of Dimension 3, the connecting element for creating the metaphor, and Dimension 5, the cognitive utilities provided by the metaphorical source to the target after the metaphor is created.
In several cases, cognitive utilities provided by the sources (Dimension 5) are *structural* while, at the same time, they are connected using *structure* connecting element (Dimension 3). However, there are three cases where the structural functions do not come together with structure connecting elements, as highlighted with bold borders in Table 4.4.

Table 4.4 Difference in the connecting elements and functions provided by sources

		Dim 1 Basis of metaphor creation	Dim 2 Representation Form	**Dim 3 Connecting element**	Dim 4 Origin of source	**Dim 5 Cognitive utilities provided**
1	A PAINTBRUSH AS A PUMP	Correlation	Gestalt	Structure	Experience (embodied)	Structural
2	A PATHWAY AS BEETHOVEN's 9 SYMPHONY	Correlation	Gestalt	Structure	Experience (embodied)	Structural
3	A WORK STATION AS THE EYE IN THE STORM	Correlation	Gestalt	Structure	Knowledge/ culture	Ontological
4a	WATERLOO HOUSING AS REBIRTH	Resemblance	Symbol	Structure	Knowledge/ culture	Structural
4b	WATERLOO HOUSING AS REBIRTH	Correlation	Gestalt	Structure	Knowledge/ culture	Structural
5	KINGS CROSS AS MUSICAL FESTIVAL	Correlation	Gestalt	Structure	Experience (embodied)	Structural
6	KINGS CROSS AS JEKYLL AND HYDE	Correlation	Gestalt	**Feature**	Culture	**Structural /Orient-ational**
7	SOCIAL HOUSING AS SCAFFOLDED EDUCATION	Resemblance	Symbol	Structure	Embodied experience/ Knowledge	Structural
8	SUPPORT FOR VICTIMS OF CRIME AS POSITIVE PARENTING PROGRAM (PPP)	Resemblance	Symbol	**Feature**	Knowledge	**Structural**
9	SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE	Resemblance	Symbol	**Feature**	Knowledge	**Structural**
10	PROTECTING THE SAILS AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT	Resemblance	Symbol	Feature	Experience (embodied)	Ontological

In Case 6 (KINGS CROSS AS JEKYLL AND HYDE), Case 8 (SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE) and Case 9 (SUPPORT FOR VICTIMS OF CRIME AS POSITIVE PARENTING PROGRAM), the connecting element is *feature* whereas the cognitive utility provided by the source is *structural.* In the following, the particular case of KINGS CROSS AS JEKYLL AND HYDE is used to elaborate this observation and then some general lessons learnt are drawn.

In Case 6, the metaphor KINGS CROSS AS JEKYLL AND HYDE is created when designers saw the correlation of the day/night at KINGS CROSS with the good/evil in JEKYLL AND HYDE. After creating this metaphor, the design team starts to pay attention to the transformation process when the character changed from Jekyll to Hyde. Interestingly, this observation of change from day to night at Kings Cross triggers the design idea of a street parade, just like a Disney parade or a set change.

Therefore, this creation of the metaphor that is originally based on the feature of day/night does not restrict the mapping process to the original pre-existing similarities of features. A structural mapping took place during the *think* phase despite the fact that the metaphor is created based on feature similarity in *see* phase.

Several important lessons are gleaned from relating Dimension 3 to 5:

1. Metaphors are triggered using some pre-existing connections (between target and source) that are observed by designers. These connecting elements can be either *features* or *structures* (Dimension 3). After the creation of the metaphors, the metaphorical source could provide the target with *structural* utility function (Dimension 5) even when the initial link was established using features.

2. While some metaphors are based on pre-existing structures, such as Case 1: A PAINTBRUSH AS A PUMP, others such as Case 6: KINGS CROSS AS JEKYLL AND HYDE derive their structure from the metaphorical source. It is only after the KINGS CROSS AS JEKYLL AND HYDE metaphor is created using association by *features* that the designers draw the structure present in the source (JEKYLL AND HYDE) to target situation (KINGS CROSS).

3. It is found that the way in which target and source are drawn together during the *see* phase does not affect what is mapped to the target in the *think* phase. In the KINGS CROSS AS JEKYLL AND HYDE case, the structure of the source (JEKYLL AND HYDE) is mapped to target (KINGS CROSS) based on initial similarities in features. In other cases such as A PAINTBRUSH AS A PUMP, the target (paintbrush) is drawn to

the metaphorical source (pump) through initial pre-existing shared structure of the target (spaces in between the bristles in the paintbrush) with the source (channels of the pump). The metaphor A PAINTBRUSH AS A PUMP is created based on initial structure. Building on this starting point, the product researchers further apply the logic of the source (pump) to the target to give additional structure to the target (paintbrush). The initial similarities in features that draw target and source together in the *see* phase does not limit only the features to be transferred to target in the *think* phase.

4. The structuring of a metaphorical concept is not an "all-or-nothing matter" (Johnson 1993). From this research, it is observed that metaphors do not necessarily start without structures and need to be constructed entirely. Neither are their pre-existing structures necessarily in a completely finished and fixed state at the beginning of the creation process. There is a cluster of metaphors from the ten case studies that are based on pre-existing structures. They are cases with *structure* as the attribute value in Dimension 3. Additional structures are added when the designers gain a deeper understanding through drawing the targets and sources together during the mapping process.

In conclusion, discerning the feature and structure relationships between targets and sources marks a beginning of the metaphor creation. Correspondences that take place during the source-to-target mapping complete the additional structure construction in the metaphor creation process.

Seeing in a new way

Just like the glass that is half filled with water may either be seen as either half empty or half full, the design situations may be viewed differently depending on how designers *choose* to *see* them. In the ten case studies, the designers are able to see the design situations in new ways through two possible routes. The first route is the deliberate application of design methods and techniques. In this research investigation, ViP (Vision in Design) (Hekkert & van Dijk 2011) and Frame Innovation

model (Dorst 2015b) are the approaches with deliberate application of methods and techniques. The second route is through the *perceptual intuition* of the designers. The following are some ways in which the deliberate approach of applying specific design methods and techniques attempts to change how designers see the design situations differently.

Taking different users' perspectives. When the problem issues are viewed from the perspective of the police, Kings Cross takes on a law enforcement frame; when seen from the perspective of youths visiting Kings Cross, the metaphorical frame changes into the fun and enjoyment experienced in a musical festival. Thus, depending on different users' perspectives, metaphorical frames may vary.

Giving prominence to different aspects of the problem issues. The selection of themes in Frame Innovation model (Dorst 2015b) makes certain aspects of the problem issues more prominent than others. By focusing on the themes of *control* and *autonomy* in the SOCIAL HOUSING AS SCAFFOLDED EDUCATION, the problem issues in social housing are seen as scaffolded education and that enables the designers realise the counterproductive effect of imposing rules of social obligation.

From the single case analysis, it is observed that designers could see design situations in intuitive ways through the creation of PI metaphors. From literature, it is known that image schemas could be used for building up the sensorimotor gestalt representations (Hurtienne 2009) of design situations. These gestalt representations contribute to the creation of PI metaphors. The following describes how new ways of seeing are achieved through the creation of PI metaphors from immersive project experiences and project discussions.

Creation of PI metaphors from immersive project experiences. It is known that designers could detect recurrent sensorimotor patterns from immersive project experiences such as the PAINTBRUSH AS PUMP case study. These image schematic patterns may then be used to trigger other experiences that bear similar gestalt structures.

Creation of PI metaphors from project discussions. Besides immersive project experiences, it is also found from literature that image schemas are also triggered from utterances (Hurtienne 2009), use of spoken or textual words (Mandler 2005) especially when the conversations involve the use of prepositions or verbs (Hooij 2016), and when readers are reading and understanding text (Gibbs 2005).

In summary, seeing in a new way through gestalts can be triggered in at least two ways; through bodily interaction with the design situations and also during design discussions. The application of image schema in this project investigation is found particularly useful to shed important light on metaphor creation process.

Different metaphor creation process even with similar design approach

Six of the ten case studies listed in Table 4.5 are conducted using the same design methodology described in Frame Innovation model (Dorst 2015b).

Table 4.5 Different metaphor creation processes despite similar design approach

Case studies		Dim 1 **Basis of metaphor creation**	Dim 2 **Representation Form**	Dim 3 **Connecting elements**	Dim 4 **Origin of source**	Dim 5 **Cognitive utilities provided**
4a	WATERLOO HOUSING AS REBIRTH*	Resemblance	Symbol	Structure	Knowledge/ culture	Structural
4b	WATERLOO HOUSING AS REBIRTH*	Correlation	Gestalt	Structure	Knowledge/ culture	Structural
5	KINGS CROSS AS MUSICAL FESTIVAL	Correlation	Gestalt	Structure	Embodied experience	Structural
7	SOCIAL HOUSING AS SCAFFOLDED EDUCATION	Resemblance	Symbol	Structure	Embodied experience/ Knowledge	Structural
8	SUPPORT FOR VICTIMS OF CRIME AS POSITIVE PARENTING PROGRAM (PPP)	Resemblance	Symbol	Feature	Knowledge	Structural
9	SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE	Resemblance	Symbol	Feature	Knowledge	Structural

Interestingly, the resulting metaphor creation processes characterised by the attribute values in different rows are not the same. This observation which will be investigated in Chapter 5. This contributes to the understanding of how different design teams create different types of metaphors through different design processes even when they adopt the same approach, such as the Frame Innovation Model (Dorst 2015b).

Multiple creation processes

It is envisaged that metaphors are created using multiple creation processes that take place concurrently. In this project investigation, the creation processes have been intentionally delineated distinctly in order to understand the various creation processes discretely. However, in real live design situations, the same WATERLOO HOUSING AS REBIRTH metaphor (listed in first two rows in Table 4.5) could be developed using both symbolic-structure and gestalt-structure creation processes, even though it has been described as either of these creation processes in Case Study 4.

Finally, it is useful to re-iterate that the objective of this project is not to determine the specific way that a particular metaphor is created by a designer in the design project. That is, the intent is not to trace the specific thinking steps that are taken by designers as it is not possible to do so using the present research method. Rather, the objective is to find out the various ways in which metaphors can be created through studying similar types of metaphor creation processes.

4.4 Conclusion

In this chapter, ten single case study analyses are discussed. From these analysis, nine observations are made which further clarifies the *see-think-act* phases of the metaphor creation process.

1. Metaphors are created in multiple steps and the same underlying themes and gestalts can lead to multiple metaphors.

2. The ways that representation forms are perceived and derived from design situations appear to be dependent on the designer.
3. Findings of case studies suggest various levels of gestalt forms.
4. The case studies show variation in the creation process even when the metaphors are from the same cluster of gestalt-type metaphors.
5. The analysis of case studies reveals that the universality and subjectivity of created metaphor is due to origin of sources.
6. It is seen from the case studies that the use of ontological and structural utility function are more prominent compared to the orientational function.
7. The structuring of a metaphorical concept is not an "all-or-nothing matter" (Johnson 1993) i.e., metaphors do not necessarily start without structures and need to be constructed entirely. Neither are their pre-existing structures necessarily in a completely finished and fixed state at the beginning of the creation process.
8. Case studies reveal that the metaphor creation process may vary even when the same design methods and techniques are applied.
9. From the analysis of the case studies, it appears that metaphors could be produced through multiple creation processes. That is, the produced metaphor could be the outcome of several types of creation processes.

The analyses also lead to the following two questions.

- How do representation forms affect the metaphor creation process?
- What is the specific nature of the structural connecting element that supports the creation of the metaphors?

These questions pertain to *representation forms* and *connecting elements*. They are related to the metaphor creation process and are answered in Chapter 5. The two research questions set out in this project investigation will also be addressed in Chapter 5 using cross case analysis of the types of metaphor creation processes obtained from the ten single case studies.

5 Cross Case Analysis

Chapter 5 describes the investigation and results obtained from a cross cluster analysis. The following research questions are answered in this chapter.

Research Question 1: *"Which types of creation processes of metaphors that help produce frames can be identified?"* and
Research Question 2: *"How can the logical representations of these respective creation processes identified in RQ1 be described?"*

This chapter starts with an overview of the identified attributes obtained from the single case studies in Section 5.1. In Section 5.2, two types of metaphor creation processes are identified from clustering case studies that share similar attribute values. Sections 5.3 and 5.4 describe the creation processes of Explicit Thinking (ET) and Perceptual Intuition (PI) metaphors, respectively. Section 5.5 highlights the various levels of PI type metaphors while Section 5.6 discusses the logical representation of the PI metaphor creation process. An exception case of metaphor creation is highlighted in Section 5.7. The findings are discussed in Section 5.8 and the conclusions are presented in Section 5.9.

5.1 Overview of case studies and identified attributes

The five attribute values obtained from the ten case studies are summarised in Table 5.1. As can be seen in some of the case studies such as those in rows 1 and 2, all the five attribute values are the same. Others such as metaphors in rows 9 and 10, similarities are found only in the first 3 dimensions. Initial observation reveals some distinctive patterns and this table of attribute values will serve as a starting point to further this investigation of how metaphors are created.

Table 5.1 Attribute values of 5 dimensions

Case studies	Dim 1 Basis of metaphor creation	Dim 2 Represent-ation Form	Dim 3 Connecting element	Dim 4 Origin of source	Dim 5 Cognitive utilities provided
1.A PAINTBRUSH AS A PUMP	Correlation	Gestalt	Structure	Experience (embodied)	Structural
2.A PATHWAY AS BEETHOVEN's 9 SYMPHONY	Correlation	Gestalt	Structure	Experience (embodied)	Structural
3.A WORK STATION AS THE EYE IN THE STORM	Correlation	Gestalt	Structure	Knowledge/ culture	Ontological
4a.WATERLOO HOUSING AS REBIRTH	Resemblance	Symbol	Structure	Knowledge/ culture	Structural
4b.WATERLOO HOUSING AS REBIRTH	Correlation	Gestalt	Structure	Knowledge/ culture	Structural
5.KINGS CROSS AS MUSICAL FESTIVAL	Correlation	Gestalt	Structure	Experience (embodied)	Structural
6.KINGS CROSS AS JEKYLL AND HYDE	Correlation	Gestalt	Feature	Culture	Structural/ Orientational
7.SOCIAL HOUSING AS SCAFFOLDED EDUCATION	Correlation	Symbol	Structure	Embodied experience/ Knowledge	Structural
8.SUPPORT FOR VICTIMS OF CRIME AS POSITIVE PARENTING PROGRAM (PPP)	Resemblance	Symbol	Feature	Knowledge	Structural
9.SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE	Resemblance	Symbol	Feature	Knowledge	Structural
10.PROTECTING THE SAILS AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT	Resemblance	Symbol	Feature	Experience (embodied)	Ontological

[The colour coding in Table 5.1 is applied to aid visual identification for clustering case studies that possess similar attribute values. There is no particular significance in the choice of colours.]

5.2 Clustering case studies

In this section, the discussion focusses on the attribute values of the first four dimensions that characterise the *see* phase of the metaphor creation process. These attribute values are used to reflect on how the metaphor first emerged.

A close observation of the attribute values described in Table 5.1 reveals two clusters of metaphor creation process. One cluster possesses attribute values of *resemblance*

(Dimension 1) and propositional *symbolic representation form* (Dimension 2) while the second cluster possesses attribute values of *correlation* (Dimension 1) and *gestalt representation form* (Dimension 2).

Using the attribute values found in Dimension 1 (resemblance versus correlation) and Dimension 2 (Propositional Symbol versus Gestalt) as the two axis in Figure 5.1, it can be seen that three quadrants are occupied by different case studies. Two prominent clusters of case studies are found in the bottom left hand quadrant (Cluster A) and the top right hand quadrant (Cluster B). There is one exception case (CASE STUDY 7: SOCIAL HOUSING AS SCAFFOLDED EDUCATION) found in the top left hand quadrant. No cases are found in the bottom right hand quadrant.

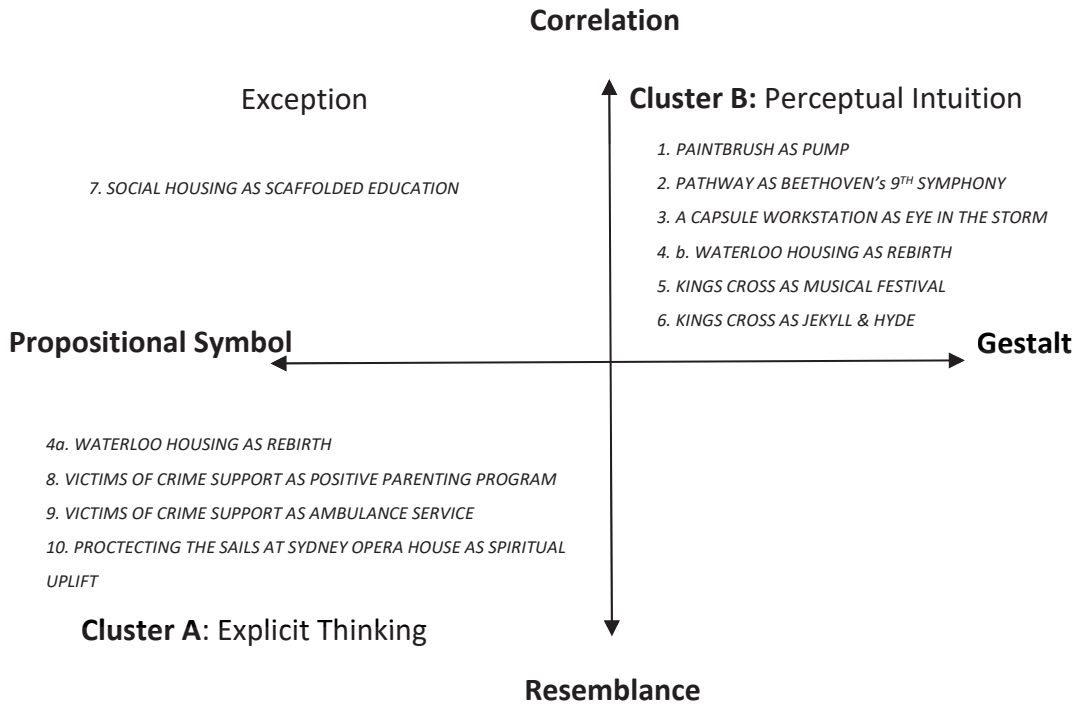


Figure 5.1 Types of metaphor creation processes

A comparison of the creation processes of the metaphors in the two clusters using the descriptions of the single case reports reveals the following. Compared to metaphors in Cluster A that are created using explicit thinking, metaphors in Cluster B are generally produced by intuitive leaps in which the creation processes are often not readily understood from the gathered data. In addition, Cluster A metaphors are created using symbolic representational concepts while Cluster B metaphor creation

processes resemble the pattern based design thinking described by various scholars in the design research field (Alexander 1977; Cross 2006; Dorst 2008). Cross (2006) observes that this pattern constructing feature has been considered as the core of design activity by Alexander (1964, 1977, 1979). In a similar way, Dorst (2008) recognises that expert designers could perform design actions instantaneously in response to high level patterns detected in design situations.

Cluster A metaphors which are created using explicit thinking process will be known as *explicit thinking* metaphors while Cluster B metaphors that are created by intuitive leaps will be known as *perceptual intuition* metaphors. It is found that the creative design processes which designers apply in *explicit thinking* (ET) metaphors are quite different from that of *perceptual intuition* (PI) metaphors based on the rich descriptions of the single case studies. In the creation of ET metaphors, designers are visibly more aware and explicit about their cognitive processes as compared to the creation of PI metaphors. The two types of creation processes will be further investigated in Sections 5.3 and 5.4.

As can be seen in Figure 5.1, there is one unique instance of the SOCIAL HOUSING AS SCAFFOLDED EDUCATION (Case 7) metaphor creation in the upper left hand quadrant. This metaphor creation process possesses attribute values of *correlation* (Dimension 1) and propositional *symbolic representation form* (Dimension 2). The creation process of this exception case is discussed in Section 5.7.

Finally, no case studies from this investigation are found in the lower right hand quadrant of Figure 5.1. Metaphors in this quadrant are created with attribute values of *resemblance* (Dimension 1) and *gestalt* representation form (Dimension 2). The purpose of producing metaphors in design is to learn from the differences between the target and source. In this lower right quadrant, there are too much in common in terms of resemblance and gestalt. Hence, there are not much designers can learn from this cluster of metaphors. This may explain why there are no metaphor in this quadrant from this investigation as it is not interesting and does not help designers in their work.

In addition to attribute values in Dimensions 1 and 2, attribute values in Dimensions 3 (connecting element) are used to further delineate the type of metaphor creation processes. While the first 3 dimensions contribute significantly to the research into the metaphor creation process, attribute values of Dimension 4 do not affect this investigation as much. This difference arises from the intended purpose of this research which is to find out how metaphors are created in general and not how particular metaphors are created in a specific context. This results in findings that are described in a logical representation and not in any particular context. However, some implications of the use of attribute values applied in Dimension 4 (Origin of source) are discussed in Chapter 6.

5.3 Metaphors created by Explicit Thinking

There are four cases of Explicit Thinking metaphor creation process. Explicit Thinking type metaphors are created using propositional symbolic representational concepts that stand in relation with other symbolic concepts using their commonalities in features or structural relationships.

In the design process, ET metaphors are created by using explicitly stated or written ideas or words shared during design project discussions. As ET metaphors are created using symbolic concepts which possess pre-defined meanings, the targets and sources are connected in a pre-determined logical order using established relations. Consequently, the cognitive operations for manipulating these conceptual symbols are explicit logical steps and 'algorithmic-like'. An example of cognitively operating on the propositional symbolic concept of a bird is described in Section 3.3 (Dimension 2: Representation form).

As shown in Table 5.1, three of the cases (Case Studies 8, 9 and 10) are created using the *feature* connecting element while there is one case (Case Study 4a) that uses the *structure* connecting element. These two types of metaphors are denoted as *Explicit Thinking Feature Type, 1(a)* and *Explicit Thinking Structural Type, 1(b)* in subsequent

descriptions. As the creation process of Explicit Thinking Type metaphors is already described in the single case studies in Chapter 4, this section will clarify how similarity in features and structures are used to draw the targets and sources together.
It is useful to first identify the difference between feature and structure similarities as they result in different metaphor creation processes. Feature similarity refers to similarities found between the attributes of target and source. For example, chalk and paper are *featurally* similar in that they both have the same white colour. To understand structure similarity, we first need to know that both target and source have parts and relations that hold them together. In structure similarity, it is the *relation* among the parts of target and source that is similar. Using the example developed by Hesse (1970), birds and fishes are *structurally similar* in terms of the relation among their respective parts.

Figure 5.2 shows the similarity in the *relation* among the parts of target and source: wings – lungs – feathers = fins – gills – scales. The specific parts e.g. wings and fins, need not be similar. It is the relation among the *function* of the wings, lungs and feathers that is similar to those of fins, gills and scales.

	Similarity		
	BIRD	**FISH**	**Functions**
Relation	Wings	Fins	Movement
	Lungs	Gills	Breathing
	Feather	Scales	Protection

Figure 5.2 Structural similarity between birds and fishes

In summary, feature similarity refers to similarities found between the attributes of target and source while structure similarity is a relation existing between relations (Itkonen 2005).

To better illustrate how the feature similarity metaphor is created, selected extracts of transcripts gathered from the design discussion of Case Study 10 PROTECTING THE SAILS AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT will now be discussed. As mentioned in the summary of case study 10, this case study is written based on transcripts of a two-hour

video recording and some secondary literature. The first time the word “spiritual” was mentioned at 34th minute. This is followed by another explicit mention of the word “spiritual space” at 49th minute. At 55th minute, a faculty designer linked the experience encountered at Sydney Opera House to the *Within without* 2010 lighting installation by James Turrell at Canberra, National Gallery of Australia as both places gave him the same “spiritual experiences”. In the following extracts, F represents the facilitator while D is a faculty designer. S1 and S2 are the student designers. Words in italics are highlighted by the author to stress the triggers that could contribute to the creation of the metaphor.

0:34 F: … and I think that's a really important thing in the ideas so that it's almost like a *spiritual journey* to a higher sort of rid yourself of whatever and that may or may not work, and that may or may not be true but if you talk about design intent for these kind of space, this would be the space for you to sort of be in the midst of the opera house. You're between shells; everywhere else is looking at the outside so if anything *spiritual* were to happen, it would be there, I guess; in the space that we're talking about….

0:49 F: … so taking the cue from Utzon is kind of... he would say it could be a *spiritual space* in the sense because it's a progression away from the city ……What kind of human values can you see happening in that kind of space?

0:55 D: When you mention the inside out. Has anyone been to Canberra and seen the inside out dome ummm… When you go inside, just outside the new entrance is uhh an experience and you go in pass the port and a weird feeling and you're looking at the sky through an opening. It's really fabulous and it's a really *spiritual experience* and that has some similarities with this space.

While the phrases “spiritual space” and “spiritual experiences” are captured in the above extracts, the following extracts highlight the particular kinds of experiences that the design team wants people to feel. Words in italics are again highlighted by the author to stress the triggers that contribute to the creation of the metaphor.

0:55 F: what kind of experience do you want people to feel when they come to this space

0:57 S1: There’s also connections to nature connections to water and so the surface of the buildings and materials

0:57 F: ... maybe feel like a universal place where everything comes together culture nature and I can sort of live with that ….. *rejuvenating* or a young space gives you *a sense of excitement* being there but not the kind of excitement but more of an *inner excitement*, let's put it that way so yes it's all about the opera house but it's also about the experience that the opera house can give to people uhhh and all those space can engender it .

1:07 F: … i do like the *rejuvenation sort of theme* or the inspiration or the *exhilaration* and ummm which is close to perhaps i mean it's for those *spiritual thing* sort of very *Zen internal quietness* and sort of ecstasy and erm joyousness, that is sort of *jumping out of you* normal through your systems says architect ummm…

1:08 F: We've got the ummm... ecstacy sort of stuff mmm this is like a *spiritual uplift*

As illustrated by the above transcripts, the words “rejuvenating”, “sense of excitement”, “inner excitement”, “exhilaration”, “jumping out of you” eventually led to the creation of the SPIRITUAL UPLIFT metaphor. The transcripts from this case study contribute to a better understanding of the generation of the feature similarity metaphors in its real context.

The development of the logical representation of the Explicit Thinking structure and feature metaphor creation processes will now be shown through two case studies. The SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE metaphor will illustrate the *Explicit Thinking Feature* metaphor creation process (Type 1a) while the WATERLOO HOUSING AS REBIRTH metaphor will be used for the *Explicit Thinking Structure* metaphor (Type 1b). The creation processes of both Type 1 metaphors will be described using the *see-think-act* phases.

Explicit Thinking Feature metaphor creation process (Type 1a)

As discussed in Section 1.4, designers perceive the design situation in a certain way during the *see* phase. The Explicit Thinking feature type metaphor is created by drawing together target and source that share similar symbolic features obtained from the generated themes using the Frame Innovation Model (Dorst 2015b). For example, for the SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE metaphor, the *featural*

themes of *safety, responsiveness* and *well-being* lead the design team to the AMBULANCE SERVICE metaphorical source which possess similar themes as highlighted by (X) in Figure 5.3.

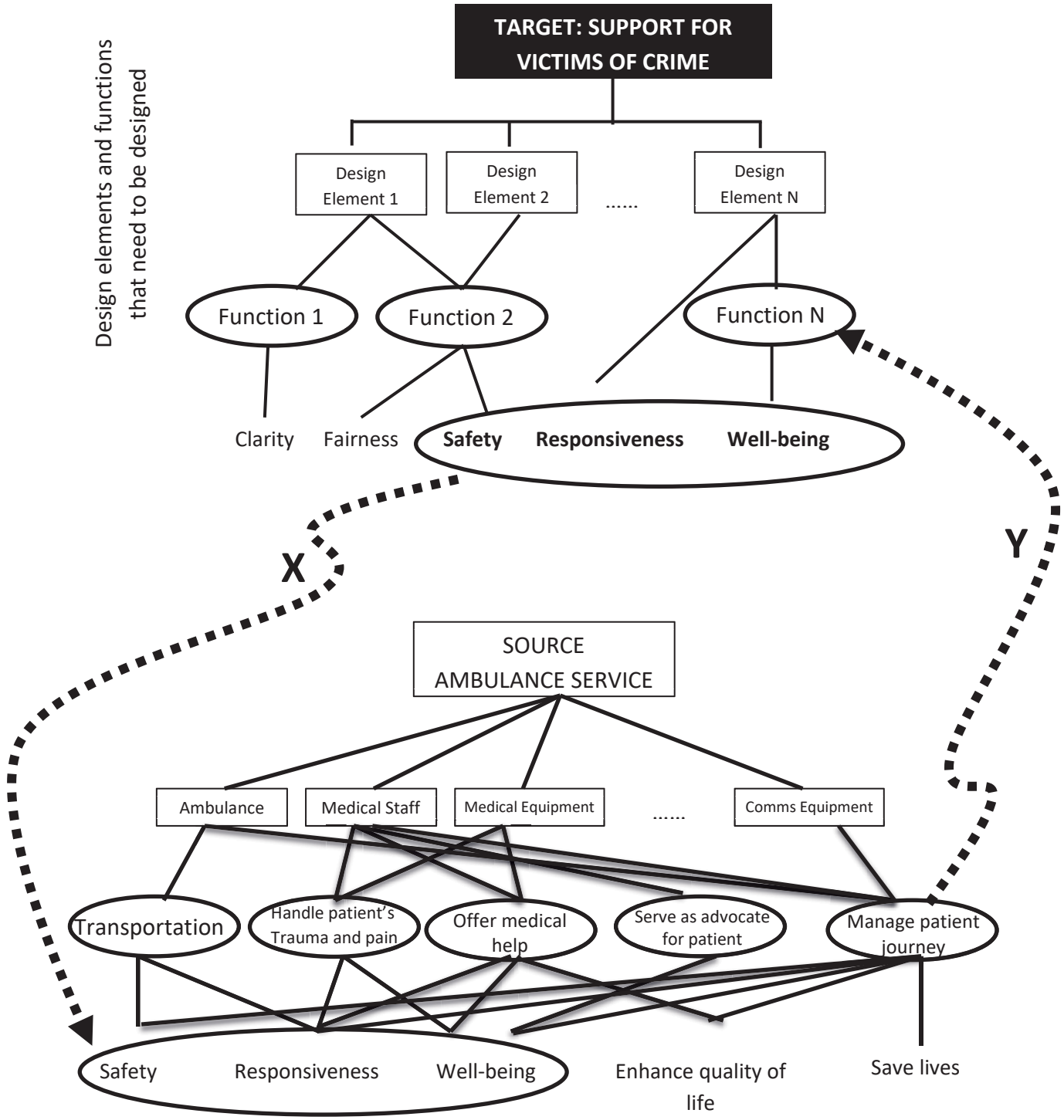


Figure 5.3 Explicit Thinking feature metaphor:
SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE

The desired themes of safety, responsiveness and well-being can be considered as the selected properties or attributes of the system under development. The attributes reflect the functionalities or services (represented by the oval shape) provided by the design solution. These functionalities have to be supported by respective design elements (represented using the rectangular shape). For this SUPPORT FOR VICTIMS OF CRIME design problem, the elements and functions have to be developed to achieve the desired themes uncovered.

After restructuring the design situation in a new way by tapping on the metaphorical source, the designers then apply this new pattern of thinking and problem solving steps to the design situation. The assumption underlying this design solution is that the design problem, SUPPORT FOR VICTIMS OF CRIME can be solved with the help of an already existing solution of AMBULANCE SERVICE to the problem of helping victims who are suffering from physical injuries.

This new pattern of thinking and inferences are facilitated by the mapping process in the *think* phase. In the SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE design problem, several initial design ideas result from mapping the metaphorical source of ambulance service to the target. As can be seen from Table 5.2, improvements needed for the support of victims of crime mimic the experience of care that ambulance services provide. They include providing transport to and from court, easing victim anxiety and trauma, being an advocate for victims of crime, providing door-to-door care and a chaperone in court (Kaldor & Watson 2015). This mapping is highlighted by (Y) in Figure 5.3.

The *act* phase of Explicit Thinking Feature metaphor (1a) is similar to the Explicit Thinking Structure (1b) metaphor and will be described together in the next section.

Table 5.2 Mapping for SUPPORT OF VICTIMS OF CRIME AS AMBULANCE SERVICE

Source (AMBULANCE SERVICE)	Target (SUPPORT FOR VICTIMS OF CRIME)
Provide transportation for patients	Provide transport for victims to and from court
Handle patient's trauma and pain	Manage victim's trauma and anxiety
Serve as advocate for patient	Serve as advocate for victims of crime
Manage patient journey	Provide door-to-door care and support
Support patient during trip to hospital for seeking medical help	Provide chaperone in court

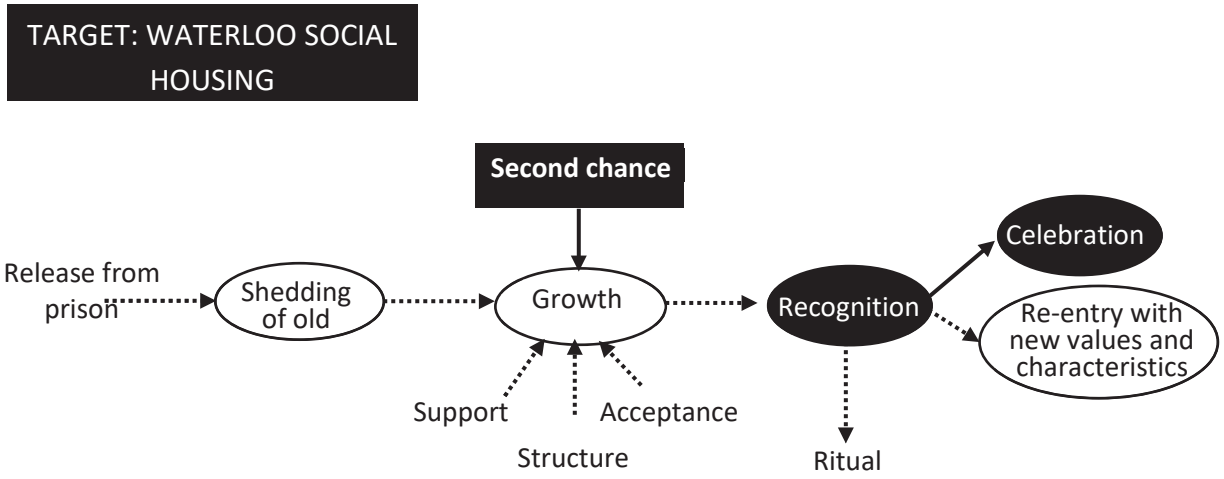
Explicit Thinking Structure metaphor creation process (Type 1b)

The creation of Explicit Thinking Structure type metaphor depends on *structural similarity. Structural similarity* refers to similarity of relation among elements of the target and relation among elements of the source (Proctor 2014). Explicit Thinking Structure type metaphors are created using similarity in symbolic *structure.* This is illustrated using the WATERLOO HOUSING AS REBIRTH metaphor. In the creation of this metaphor, the skeletal conceptual structure derived from the WATERLOO HOUSING design situation lead to the association with the REBIRTH source metaphor.

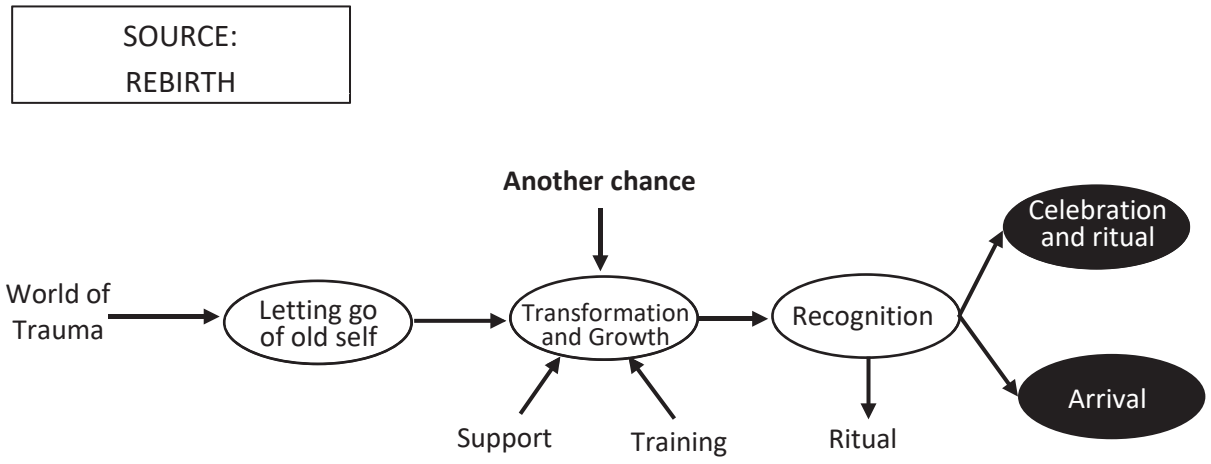
The target structure is based on three identified needs obtained from the user research; 'second chance', 'celebration' and 'recognition'. These needs were captured in the whiteboard writing in Figure 3.2(c). They contribute to a skeletal structure of *seeing* the problem situation. They are highlighted using filled shapes in Figure 5.4(a). The shapes without fill are not present when the metaphor is first created. They are generated during the mapping process in the *think* phase.

As shown in Figure 5.4 (a), the beginning structure possesses only a few connections. The three initial themes are very sketchy and hence, it is quite unlikely that the designers link the target and source together through recognition alone. What is more

probable is the use of imagination which aids designers to build sufficient structure in the target before they make the creative leap to produce the metaphorical source. Therefore, a certain level of imagination is needed to link the three words, “second chance”, “recognition”, “celebration” to produce the “rebirth” metaphor initially.



(a) Metaphorical Target WATERLOO SOCIAL HOUSING



(b) Metaphorical Source REBIRTH

Figure 5.4 Explicit Thinking Structure type metaphor:
WATERLOO SOCIAL HOUSING AS REBIRTH

Structural similarity is the similarity between the relation within the parts of the target and the relation within the parts of the source. In the metaphorical target, there exists

propositional symbolic concepts sketching the ex-prisoners' experiences and the processes they go through after their release from prison, are placed in the public housing and, finally, re-join mainstream society. The underlying skeletal structure linking the various elements is similar to the REBIRTH metaphorical source which is used to signify the rebirth process that is experienced through a process of transformation. The transformative process in the REBIRTH metaphorical source involves letting go of the old self and embracing new significant changes through transformative growth that culminate in celebration and arrival as illustrated by Figure 5.4(b).

In the think phase, additional elements in those unfilled shapes in Figure 5.4 (a) are developed and expressed during the project discussions. By tapping on the REBIRTH metaphorical source, the WATERLOO SOCIAL HOUSING design problem gain a stronger structure.

This is shown in Table 5.3 which reflects the mapping conducted in the *think* phase. Even though the general direction of the design activities conducted in *think* phase is forward from source to the target design situation, it is observed that the activities taken in the think phase is iterative, that is, going back and forth.

Table 5.3 Mapping for WATERLOO SOCIAL HOUSING AS REBIRTH

Source (REBIRTH)	**Target (WATERLOO SOCIAL HOUSING)**
Support and training	Support from counsellors, guides and training programs
Letting go of old self	Shedding of old self by adopting new perspective and skills for livelihood. Equipping with new skills for seeking employment
Arrival and completion of transformative process	Re-entry with new values and characteristics
Recognition of growth arising from transformative change	Recognition of the change by social housing community and of successfully joining mainstream life
Celebration of successful transformation	Celebration upon completion of transformative process and leaving social housing

In the *act* phase, the mapped values from the metaphorical source are used to generate some initial design ideas. In fleshing out the design ideas, the design team develops a series of activities that take place over the various stages of pre-release preparation, release and welcome to housing, integration and transition to mainstream housing and celebration. The activities include a self-discovery program, job plan, transition plan, buddy system and a generative project with payback.

Conclusion

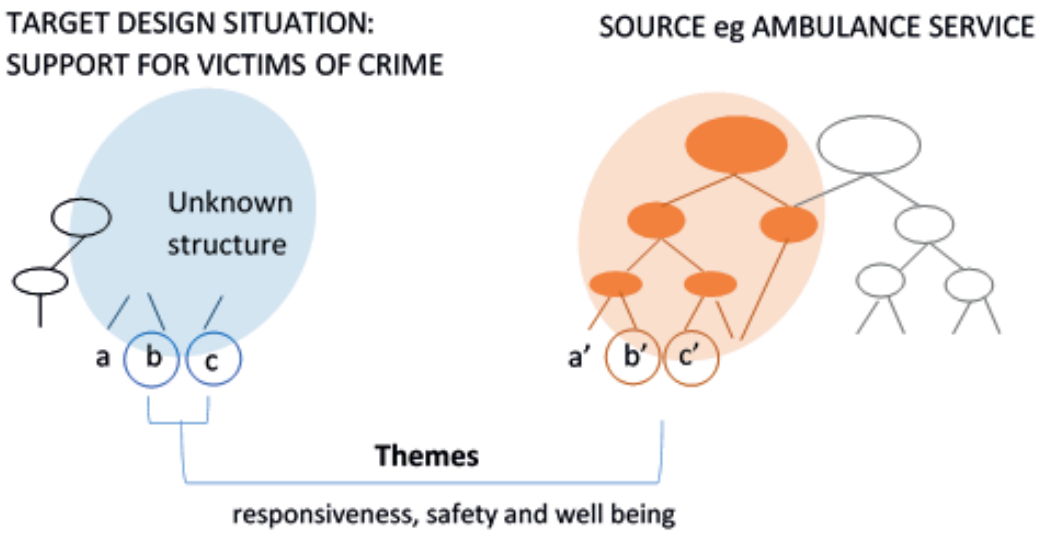
The creation process of the Explicit Thinking metaphors are explicitly carried out by the design teams. This facilitates the analysis of the four cases in this cluster which results in the logical representation of the ET metaphor creation process summarised as follows.

The Explicit Thinking metaphors are created using the themes generated by the application of design methods. The Explicit Thinking feature metaphors are created through association in propositional symbolic features using similarities in the themes while Explicit Thinking structure metaphors are created using resemblance of propositional symbolic structures.

For Explicit Thinking structure metaphors, the metaphor emerges when the structure is suggestive enough for the designers to activate the metaphor. For instance, the three identified user needs of 'second chance', 'celebration' and 'recognition' provide the skeletal propositional symbolic structure that leads the team of designers to activate the REBIRTH metaphor. The ways in which the target and source of Explicit Thinking Type metaphors are associated in the *see* phase are illustrated in Figure 5.5 (a) and (b).

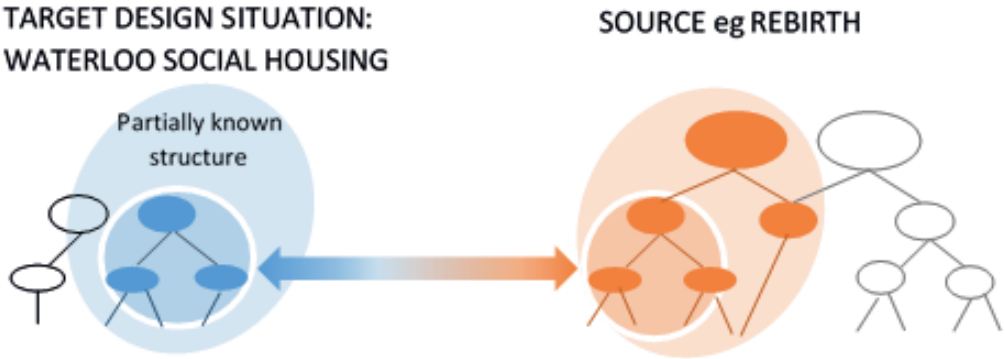
See

(a)Explicit Thinking feature metaphor



Target and source linked by feature similarity.

(b) Explicit Thinking structure metaphor



Target and source linked by structural similarity.

Think

(c) Mapping of functionalities and structure from source to target

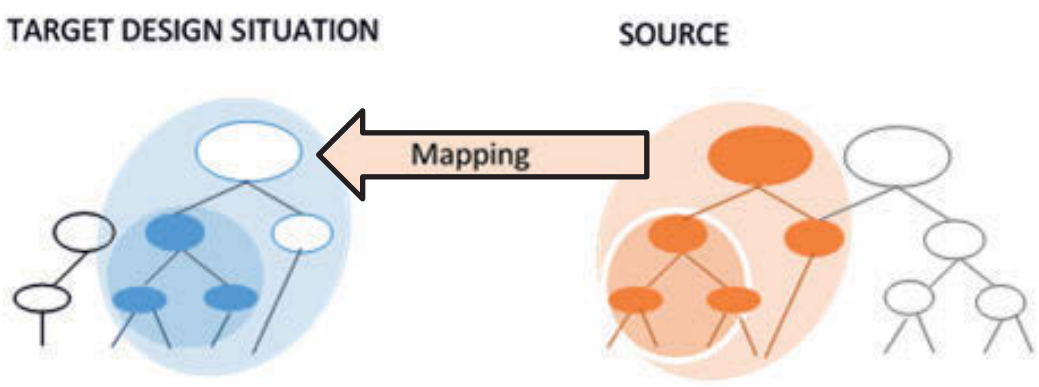


Figure 5.5 Explicit Thinking metaphor creation process

To produce a novel metaphor, designers try to *see* the design situation differently through generating theme(s) that are not generally applied in the particular design situations. For example, the initial angle taken for the WATERLOO SOCIAL HOUSING is to improve the living experiences of residents and includes the maintenance of the buildings. It was changed to REBIRTH after considering the themes generated.

Once the association between target and source is made through symbolic features for Explicit Thinking feature type metaphors, other properties and structure of the source may be mapped onto the target design situation as illustrated by Figure 5.5 (c).

In the act phase, design ideas are further elaborated and fleshed out into some initial design solutions.

Several observations are made from the analysis of the creation process of Explicit Thinking Type metaphors. The first observation is that even though Explicit Thinking Feature Type metaphors are initially created using similarity in features, they can later lead to the mapping of functions and structure. For example, in the creation of the SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE metaphor, the target and source are initially linked by similarities in features in the *see* phase. However, during the *think* phase, the structural design elements and functions of *enhance quality of lives* and *save lives* from the ambulance service (source) are mapped to the support of victims of crime (target).

This observation offers a useful approach to help student designers get started on creating metaphors. As it is usually easier to identify feature similarities as compared to structural similarities, beginner designers can learn to create metaphors using a two-step approach. The first step is to draw target and source together using similarities in features; the second step to do a structural mapping.

A second observation in analysing the creation of Explicit Thinking Type metaphors is that, in addition to linking target and source using similarities in features, a partial structure derived from the target situation can also be used to trigger the

metaphorical source. This is illustrated in the creation of the WATERLOO HOUSING AS REBIRTH metaphor: after target is drawn to source through a partial structure in the target, additional structure is then mapped from source to target. A similar observation is also made by Johnson (1993) where he highlights that metaphors can be created using *pre-existing structures* or *partial structure* provided by the target domain. He sums it up succinctly when he observed that determining a structure in a target is not an "all-or-nothing matter" (Johnson 1993, p. 414).

In conclusion, targets and sources may be linked using explicit features, partial structures or complete structures. The case studies have shown that it is not necessary for the designers to grasp the complete propositional symbolic features or structure before creating the metaphor.

5.4 Metaphors created by Perceptual Intuition (PI)

In Section 5.2, six cases of Perceptual Intuition (PI) metaphors are identified using the attribute values of *correlation* in Dimension 1 and *gestalt* representation form in Dimension 2. Correlation refers to experiential co-occurrence or experiential similarity. Experiences of activities or events that take place at the same time is considered as experiential co-occurrence while experiential similarity refers to experiences that are subjectively felt to resemble one another.

From the single case study analysis conducted in Study 2, PI metaphors appear to be mysteriously generated in intuitive leaps. Unlike ET metaphors that are created using explicit thinking steps, the investigation of the creation processes of PI metaphors is more challenging since not all the thinking steps are explicitly expressed in the design processes.

In perceptual intuition, the mind explores, sees and understands the perceived data in an enriching way (Uhrmacher 1997). This perceptual intuition provides a direct awareness of the organisation of data apprehended through our senses (Cheshire

1967). The gestalts of these sensory data provide understanding and are used to organise our mental representations. This is well illustrated by the observation that, before the young child is able to explicitly define the notion of a house in propositional symbolic knowledge, he or she could already grasp intuitively something of the large object. Even though houses look different from one another, they have something in common that allows the young child to differentiate houses from other objects such as a bus. This ability to organise perceived data in various forms can similarly be applied in the design process.

This finding has strong resonances with observations arising from "dual process theories" of thinking and reasoning as exemplified in cognitive psychology literature such as *Thinking twice: Two minds in one brain* (Evans 2010) and *Thinking, fast and slow* (Kahneman & Egan 2011). These dual processes have been widely considered as System 1 versus System 2 (Stanovich & West 2000), associative versus analytical rule-based (Frankish 2010), intuition versus deliberate (Glöckner & Witteman 2010), fast versus slow thinking (Kahneman & Egan 2011). While fast thinking is quick, effortless, associative and experienced based; slow thinking needs effort, the need for cognitive resources and is dependent on symbolic processing by using abstract rules. There are apparent resonances between PI metaphor creation to intuitive thinking and ET metaphor creation to analytical rule-based thinking. As it is not the intent of this research to delve into dual process theories, readers interested to find out more could refer to the above-mentioned literature.

The analysis of case studies listed in Table 5.4 reveals that the *gestalt* of design situations could be used to create *Perceptual Intuition* type metaphors. In particular, gestalt features and gestalt structures could be used for creating the Perceptual Intuition feature and structure metaphors (Type 2a and 2b), respectively.

Table 5.4 List of Perceptual Intuition Metaphors created in case studies

PERCEPTUAL INTUITION TYPE	METAPHOR	TARGET	SOURCE
Gestalt Feature	KINGS CROSS AS JEKYLL AND HYDE	KINGS CROSS	JEKYLL AND HYDE
Gestalt Structure	A PATHWAY AS BEETHOVEN's 9TH SYMPHONY	PATHWAY	BEETHOVEN's 9TH SYMPHONY
	WATERLOO HOUSING AS REBIRTH	WATERLOO HOUSING	REBIRTH
	A WORKSTATION CAPSULE AS AN EYE IN THE STORM	WORKSTATION CAPSULE	EYE IN THE STORM
	A PAINTBRUSH AS A PUMP	PAINTBRUSH	PUMP
	KINGS CROSS AS MUSICAL FESTIVAL	KINGS CROSS	MUSICAL FESTIVAL

Gestalt feature refers to an attribute of the design situation. KINGS CROSS AS JEKYLL AND HYDE is a metaphor that can be created using correlation in gestalt feature. The metaphor is created using the relation of day and night as morality and immorality. It is classified as Perceptual Intuition feature metaphor (Type 2a). The definition of gestalt structure is taken from Johnson (1987) and refers to an "*organised, unified whole within our experiences and understanding that manifests a repeatable pattern or structure"* (Johnson 1987, p. 44). The remaining five metaphors in Table 5.4 are created using correlation in *gestalt structure* and are considered as Perceptual Intuition structure metaphors (Type 2b).

5.5 Creation process of different levels of Perceptual Intuition type metaphors

Three case studies will now be used to illustrate how PI metaphors could be created. KINGS CROSS AS JEKYLL & HYDE metaphor is used to show how the Perceptual Intuition Feature type metaphor is created. The PATHWAY AS BEETHOVEN's 9th SYMPHONY and A CAPSULE WORKSTATION AS AN EYE IN THE STORM illustrate how Perceptual Intuition Structure metaphors are created. Transcripts of the case study A CAPSULE WORKSTATION AS AN EYE IN THE STORM are used to contribute to a better understanding of the generation of PI metaphor in the real context of design process. The knowledge and use of image schemas are applied to shed light on the creation processes. These creation processes are synthesised into the logical representation of Type 2 metaphor creation process and are described in Section 5.6.

KINGS CROSS AS JEKYLL & HYDE

The creation process of the perceptual intuition feature metaphor KINGS CROSS AS JEKYLL & HYDE is described in Section 4.2, Case Study 6. This metaphor is considered to be feature based as it taps on the *feature* of the transformative day to night change in Kings Cross for creating the metaphor. The relationship we establish between light and a sense of safety in the day versus darkness and a sense of danger in the night is based on the underlying primary metaphor BRIGHT IS GOOD/DARK IS EVIL and our experiences when we are young. Most of us are frightened when the room is dark while a bright room gives us a sense of safety and security. Even as adults, we continue to feel safe in the day but become wary of lurking dangers in the dark night. The experiential correlation of light is good, dark is bad is grounded in the co-occurrence of these two types of experiences. This knowledge of bright/dark image schema and correlation metaphors is now applied to contribute to the understanding of the creation of the metaphor "Dr. Jekyll and Mr. Hyde".

Using the analysis above, the following steps could contribute to the creation of the Perceptual Intuition Feature metaphor:

(i) day and night observation from the discussion of Kings Cross project

(ii) day is bright and night is dark

(iii) "bright is good and dark is evil" correlation metaphor

(iv) emergence of Dr. Jekyll and Mr. Hyde

Figure 4.2 in Section 4.2 shows that the leap from day/night to Dr. Jekyll and Mr. Hyde is a triple jump with two intermediate landing points of image schema and primary metaphor. What appears to be subjective and unstructured is now viewed to be rational and "objective". It shows that our ideas do come from somewhere and that they are not random thoughts. They are based on and structured by recurring patterns of our physical interactions with the design situations. This can be succinctly explained using the image schema of bright/dark and good/bad and provides the basis for imaginative projections onto our conceptual domains ("Dr. Jekyll & Mr. Hyde"). The connections and projections can be traced to patterns of physical interactions and the imaginative powers of designers.

This case study also shows that the mapping in the *think* phase is not restricted to connections that originally lead to the creation of the metaphor. That is, mapping in the *think* phase is not restricted to the bright/dark feature as metaphors do not merely point out pre-existing similarities. It also involves the projection of structure from the metaphorical source of the morphing process from Jekyll to Hyde metaphor to Kings Cross as illustrated by Figure 5.6. This contributes to the design idea of turning the street at Kings Cross into a parade that emulates the Disney Night parade.

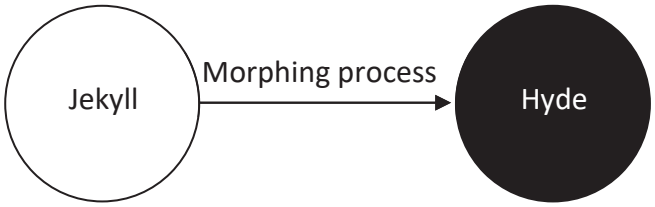


Figure 5.6 Jekyll, Hyde and the morphing process

Two insights are obtained from the analysis of this case study. Firstly, PI metaphor creation process is a multiple step process. Secondly, the thinking process underlying PI metaphor creation can be better understood through the use of non-cognitive levels of experiences; more specifically, light is good and dark is evil in this case study.

A PATHWAY AS BEETHOVEN's 9th SYMPHONY

This analysis attempts to explain the *see-think-act* phases of the creation of the BEETHOVEN's 9th SYMPHONY metaphor by means of its underlying image schema. As described in Section 4.2 (Case Study 2), the design task is a 200m pathway in a dense area in the city characterised by low rise dwellings. Student designers are required to design a pathway and to develop a system of relationships between private residences and the pathway in a city. In addition to the BEETHOVEN's 9th SYMPHONY metaphor, three other metaphors developed by other student designers for the same 200m pathway design task are also used to lend support to this analysis.

Casakin (2006a, 2006b) shares in his works that a student designer, Amihay created the BEETHOVEN's 9th SYMPHONY metaphor as he thought of a street as an interaction between main and secondary elements. When seen in that way, the street can be considered as possessing interacting *paths* where main and secondary elements meet. In creating the PATHWAY AS BEETHOVEN's 9th SYMPHONY metaphor, the student designer *understood how music constructs itself … little by little, step by step progressively strengthens itself, reaches a peak and then fades away* (Casakin 2006b).

These descriptions reflect that musical and physical motion shares the same logic as both possess the same underlying PATH image schematic gestalt. As discussed earlier in Section 4.3, the PATH image schematic gestalt structure comprises a starting point and an ending point linked by a series of connecting points in between. The PATHWAY AS BEETHOVEN's 9th SYMPHONY is a perceptual intuition *structure* metaphor with a structure that possesses relations between the parts described as follows. Melody of music is made up of notes that can be described as a step, skip or leap depending on

the distance from one note to the next. A step is the distance from one pitch to the next in a diatonic scale. In Figure 5.7, the interval from C to D is a step.

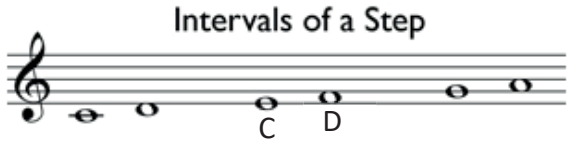


Figure 5.7 Step in a melody

As these notes build up, the music "*step by step progressively strengthens itself, reaches a peak and then fades away"* (Casakin 2006b)*,* as illustrated by Figure 5.8. This build-up of pitch is sometimes regarded as strengthening of the melody (Antovic 2009). The student comments that the contour resembles an ascending path with a peak. The student designer's remarks suggest that he has adopted a musical landscape metaphor and conceives of music as a landscape, ready to be explored. As he moves over the *path* of the piece of music, BEETHOVEN's 9th SYMPHONY in this particular case, the current musical note that he is listening to corresponds to where he is located in the physical space. What has been heard is conceptualised as musical notes in the landscape behind him. Sections of the music which are not yet heard are musical notes on the path ahead.

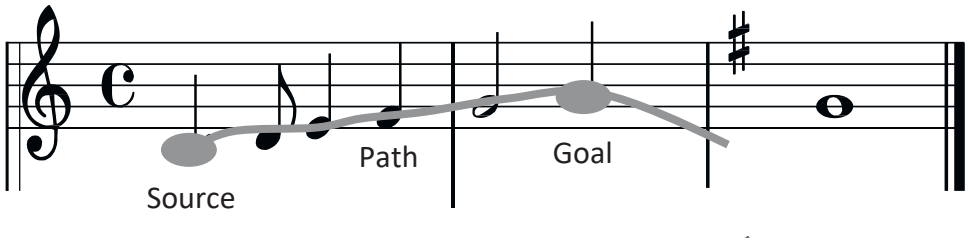


Figure 5.8 Ascending contour present in melody

The way he thinks is captured by the musical landscape metaphor, as illustrated by Table 5.5. This line of thinking reflects what several researchers (Brower 2000; Eitan & Granot 2006) identified as the musical image schema of *melody is movement along a PATH.* Table 5.5 shows that the mapping the PATH image schema onto the musical space through the metaphor, is not an arbitrary process: the experiential logic of the PATH image schema with its inference patterns are preserved. Unlike the bright/dark

image schema feature applied in KINGS CROSS AS JEKYLL AND HYDE, the PATH image schema possesses a *structure* comprising parts and relationships which provide the underlying experiential logic to both listening to music and walking along a pathway.

Table 5.5 Mapping between musical space (Source) and physical space (Target)

Musical space (Source)	**Physical space (Target)**
Listener	Pedestrian
Musical piece (Beethoven's 9th Symphony)	Pathway
Present note	Present location
Music already heard	Path already travelled
Music not heard	Path not travelled
Distance between notes	Step

Source: Johnson (2008)

Besides the PATHWAY AS BEETHOVEN's 9th SYMPHONY metaphor, three other metaphorical sources are created by other student designers attending the same class.

a. ROUNDABOUT
b. HURRICANE
c. SUGAR DISSOLVNG IN WATER

On the surface, these other three metaphors appear different with little or nothing in common. At least on first glance, one would not expect to compare them meaningfully to one another. For instance, what can possibly be in common between sugar dissolving in water and Beethoven's 9th Symphony? On closer examination, one can start to notice that all three metaphors share a common underlying PATH image schematic structure as the BEETHOVEN's 9th SYMPHONY. The *roundabout* has a *path* in which the starting and ending points are the same point which makes it a CYCLE image schema. The *hurricane* comprises two *paths* of forces; one which is in the eye of the hurricane where there is calmness surrounded by a ring of towering thunderstorms. The metaphor of *sugar dissolving in water* has the starting point and ending point

representing the change in state of sugar, from solid to liquid where states are considered as locations (Lakoff 1993).

This analysis suggests that all four metaphors are triggered by the PATH image schema which is expressed in the design brief of a "200m **PATHWAY** with a distinctive focus on interacting elements long the PATHWAY". In addition to the underlying PATH image schema, the metaphors also have distinctive interacting features as the design task requires the student designers to focus on the interacting elements along the pathway. Different paths have to come together to enable interaction to take place. This interaction feature is present in BEETHOVEN's 9th SYMPHONY and is illustrated by the interaction of different paths of musical notes as shown in Figure 5.9.

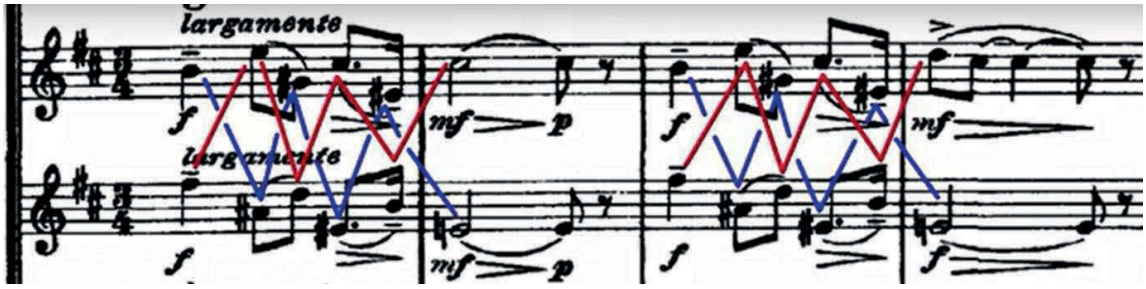


Figure 5.9 Inter-movement between musical notes. *Source*: Goss (2013)

Beethoven is one of the first composers to systematically use interlocking thematic devices to achieve inter-movement unity in his compositions (Miller 2008). Inter-movement may be considered as the linking of different melodic paths together as illustrated by the red and blue lines in Figure 5.9. These are some probable reasons that led student designer Amihay to this metaphorical source. However, the actual reason is unclear as it was not stated in the works of Casakin (2006a, 2006b).

After the creation of the metaphor, the student designer Amihay applies the powerful concept of BEETHOVEN's 9th SYMPHONY to develop the continuous dialog between the public pathway and private residences and "how to fade it away", as required by the design task. The metaphor helped the student designer reformulates the relationship between the public and the private spaces. Amihay 'softens' the existing separation

between the two spaces and strengthens the communication between them, as illustrated by Figure 5.10, just like the inter-movement in Beethoven's 9th Symphony.

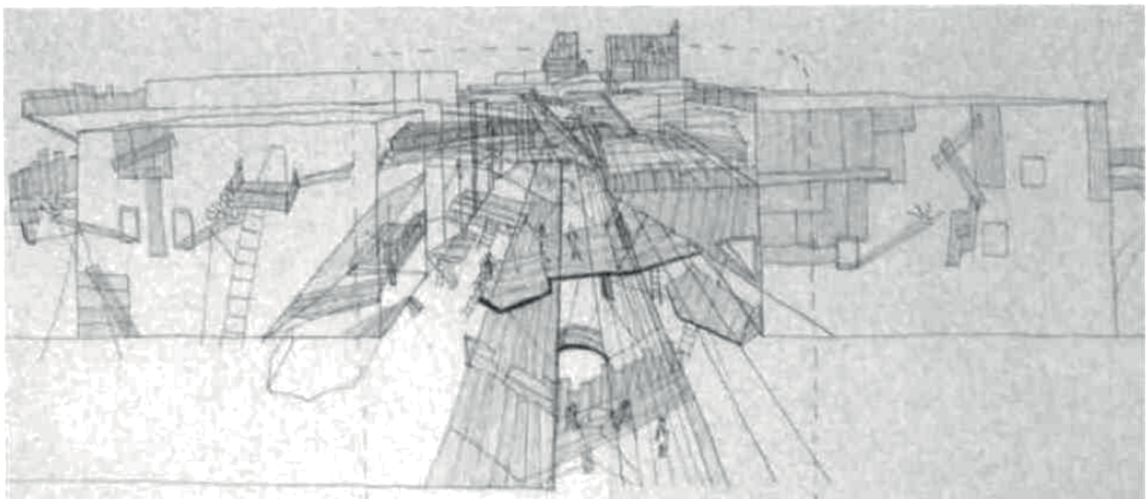


Figure 5.10 Design solution with proposed relationship between the pathways and homes. *Source:* Casakin (2006b).

In his detailed design, the student designer reorganises the space of the private residences to let the pathway to gradually penetrate into the private space while at the same time allow some parts of the residences to reach out to the public space. As a result, a new way of living is developed through "bridge-dwellings" crossing the pathway and the pathway as an interconnected vertical space for meeting visitors as illustrated by Figure 5.11. This PATH image schema is observed to contribute to both the *see* and *think* aspects of the metaphor creation process.

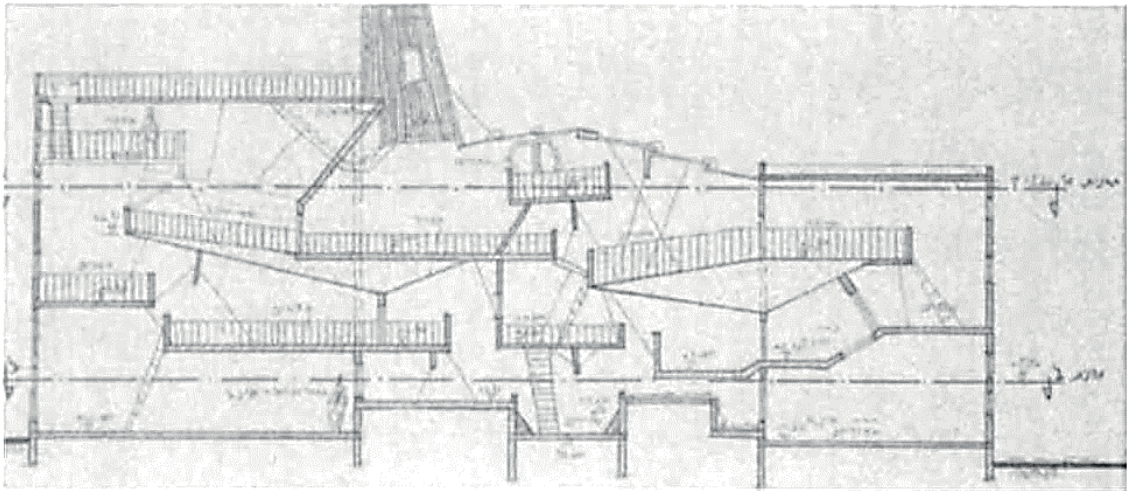


Figure 5.11 Design solution illustrating the spatial relationships between the pathways and homes. *Source*: Casakin (2006b).

Establishing a connection between a pathway to classical music might seem trivial and of little value to many. Quite the contrary, making this connection between *disparate* target and source is the core to creative practice and this is where ideas and originality in design comes from.

What is shown to be of great significance in this case study is the imaginative ability of designers to make connections through the creative use of image schemas and metaphors. Rather than being limited by pre-existing vocabulary and concepts, the imaginative minds of designers can make use of image schemas to connect previously unrelated ideas to come up with innovative design ideas using metaphors. This case study shows that creative ideas are not generated using irrational and unstructured thinking processes as commonly believed. The creative leap possess a logic and structure as can be observed from this analysis of PI metaphor creation process.

Finally, metaphors created in this case study reflect that metaphors are not literary devices. All of the metaphors created, including BEETHOVEN's 9th SYMPHONY are elaborations of the PATH image schema. In our everyday encounters, this PATH image schematic pattern contributes to the regularity and provides coherence to our experiences. This internal structure of this PATH image schema is used in this case study to help designers connect to experiences that bear similar structure.

A CAPSULE WORKSTATION AS AN EYE IN THE STORM

This case study illustrates the use of a more complex image schema to illuminate the creation process of PI metaphors. This complex image schema is developed by making use of the 'topological' and 'superposition' characteristics. All three metaphors created in this design project description by Hekkert & van Dijk (2011) are studied simultaneously. This way of analysis stands a higher chance to produce an improved understanding of the thinking processes leading to the PI metaphor creation. Of the three metaphors, the EYE IN THE STORM metaphor has already been described in Section 4.2 (Case Study 3). The remaining two metaphors produced in this project description are MAILROOM and TRAM SHELTER. Again, on the surface, the three

metaphors do not appear to be related or share any commonalities. The following analysis shows how these PI metaphors can be created through the use of a complex image schema. Transcripts for this design project are used to better illustrate the design process of PI metaphors.

In the see phase, several image schemas can be evoked from the design conversations between the student designer (S) and his two supervisors; a professional designer (D) and thinker (T). The transcripts of the complete conversation for this design project can be found from pages 86 to 114 of the book Vision in Design (Hekkert & van Dijk 2011). Some extracts from this conversation will be used to demonstrate how three particular image schemas; PATH, CONTAINER and FORCE could be implicitly triggered. These activated image schemas led to the development of two problem statements for this design problem which eventually contribute to the creation of the three metaphors (EYE IN THE STORM, MAILROOM and TRAM SHELTER). Italics fonts are added to the following transcripts to highlight the words that could trigger the image schema. The following highlights the segments that can be used to activate PATH image schema at page 102.

p102 T: …..people will be seduced into *going out* and looking around, …..

p102 T: The difference is here: having *access to all this information* and entertainment ….

p102 S: ….other factors suggest the possibilities and threats related to how the *outside world is connected to the home environment*

p102 T: I would say, not *'connects to'*, but *'enters into'*, or *'intrudes upon'*!

The above highlighted words such as "going out", "access to all this information", "outside world is connected to the home environment", "connects to", "enters into" "intrudes upon"; could be used to trigger the PATH image schema.

The following extracts of transcripts; particularly, the highlighted words in italics can be used to evoke the CONTAINER image schema. The transcripts are taken from page 102 and 103.

p102 T: …to stay close *at home*, *hide and protect themselves*; …

p102 T: …people will be seduced into *going out* and looking around …

p102 T: ….we also feel *secure at home, in our "shell"*

p102 T: … it gives the impression of openness but is also a *safe haven.*

p102 D: …*come from outside* and are predictable …

p102 S: … how the *outside world* is connected to the home environment.

p102 T: …*'enters into' or 'intrudes upon'*

p103 D: …*'working from home'*

The above highlighted words such as "home", "hide and protect themselves", "going out", "secure at home", "in our "shell"", "safe haven", "outside world", "enters into" and "intrudes upon"; could be used to trigger the CONTAINER image schema. The triggering of the remaining FORCE image schema is covered next. FORCE image schemas could be evoked from the following extracts of transcripts found at page 102; particularly, the highlighted words in italics.

p102 T: …..some factors '*force'* people to make their world smaller, …..

p102 S: ….other factors suggest the possibilities and *threats* related to how the outside world is connected to the home environment

p102 T: …*'enters into' or 'intrudes upon'*

The above highlighted words such as "force" and "threats" "enters into" and "intrudes upon"; could be used to trigger the FORCE image schema.

After triggering these three image schemas implicitly from the design situations, the three metaphors; mailroom, tram shelter and eye in the storm, are produced by the student designer at pages 104, 105 and 106 respectively.

p104 S: Well, my first thought is that I'm designing an environment, not an object … so there might be a few interactions. An analogous situation …. I'm thinking of somewhere like a

mailroom, where external messages come in and they're channelled to the right place.

p105 S: I suppose the 'partially enclosed' relates to a feeling of being sheltered, protected, but open to the world at the same time – like a tram shelter, it protects you, but lets you see what's all around …

p106 S: So how about being in the eye in the storm then – is that too passive?

Following further intensive discussions, the design team developed the following two design problem statements:

Problem Statement 1 stated in the book Vision in Design written by Hekkert & van Dijk (2011), page 103 : "…people know that they can work sustainably at home and enjoy being at home but they fear losing touch with the outside world, or that they don't have access to the challenges and excitement that the world can offer" and

Problem Statement 2 in the book Vision in Design written by Hekkert & van Dijk (2011) page 104: "People working from home experience intrusion as if they were at the centre of universe working safely and comfortably".

From these problem statements formulated by the project team, it appears that the design solution should facilitate the person working at home to experience intrusion as challenges and excitement while at the same time, work safely and comfortably. Even though the problem statement does not point to a specific solution, it provides a direction for generating some initial design ideas.

An examination of the problem statements reveals that the mention of *home*, *centre of universe* and *outside world* reflect the CONTAINER image schema while intrusion reflects FORCE and PATH image schemas, as illustrated in Table 5.6.

Table 5.6 Activation of image schemas by problem statements

Problem statements	Image schemas
...people know that they can work sustainably at home and enjoy being at home but they fear losing touch with the outside world, or that they don't have access to the challenges and excitement that the world can offer	home = **CONTAINER** outside = **CONTAINER** access = **PATH**
People working from home experience intrusion as if they were at the centre of universe working safely and comfortably	intrusion = **FORCE**; **PATH** centre of universe = **CONTAINER**

Source: Hekkert & van Dijk (2011, pp. 103-4)

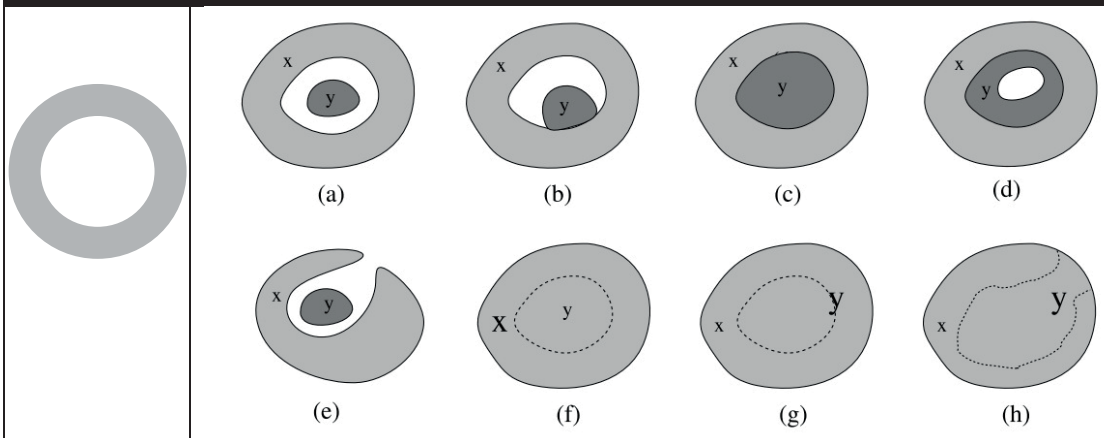
To better understand how the three metaphors; EYE IN THE STORM, MAIL ROOM and TRAM SHELTER were created, two particular properties of image schemas are applied. The *topological* and *superposition* characteristics are described next, followed by the PI metaphor creation process.

Topological Nature. Image schemas are topological in that their properties are not affected by physical variations in size, shape or materials etc. For example, the generalised topological nature of CONTAINER image schema enables many different objects as discussed in Chapter 4. In a physical container, such as a cup or bowl, there exists a particular shape and is made of specific material. However, such information is not included in a topological CONTAINER image schema representation. Only the bare essential information of a bounded space with an inside and outside is captured in the topological representation of a CONTAINER image schema, as shown in Figure 4.3.

Bennett & Cialone (2014) creatively manipulate the CONTAINER image schema in eight different aspects using the topological nature as shown in Table 5.7. Even though there exists some variations in all the containers, all of them are still considered as CONTAINER image schemas. Conceiving the CONTAINER in these various ways opens up many more probable connections to new metaphorical sources. In addition to the

more prototypical containers represented by cupboard, box and pail, the metaphors in this case study are created using CONTAINER of variations (e) and (f). Their use is described in the following section.

Table 5.7 Eight variations of CONTAINER image schema

CONTAINER

a. Y is completely within a cavity of x with no contact between them b. Y is completely within a cavity of x with contact between them c. Y fills in a cavity of x d. Cavity x is completely filled by y which has another cavity within it e. Y is completely within an open cavity of x f. X includes all of y and y does not touch the boundary of x g. X surrounds y and is part of y h. X partially surrounds y and is part of y

Source: Bennett & Cialone (2014)

This subtle creative manipulation and elaboration of image schemas through varying its topological nature make familiar patterns fresh. This topological nature provides a way to *see* the design problem in a novel way which will be explained in the following paragraphs.

Superposition Nature. Image schemas, like Lego bricks, can be combined to form a complex structure. *Complex* image schemas are built from simpler ones by combining

them through superposition. For instance, *INTO* and *OUT OF* are built from the superposition of the SOURCE-PATH-GOAL and CONTAINER image schemas, as shown in Figure 5.12.

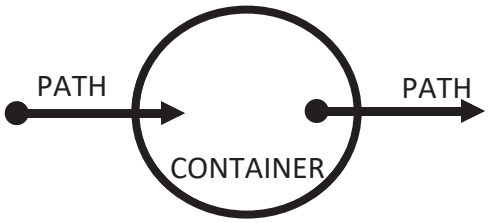


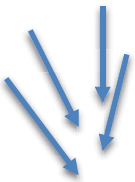
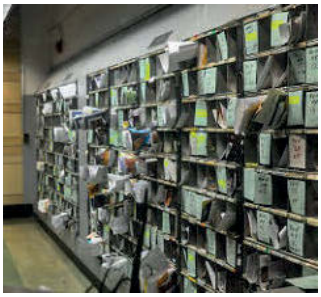
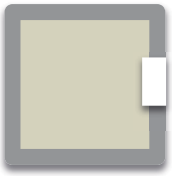
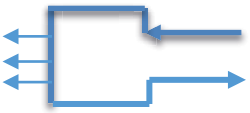
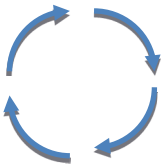
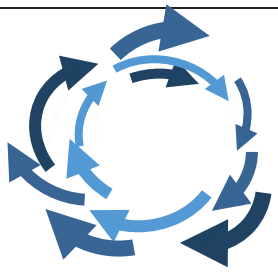
Figure 5.12 INTO and OUT OF

In this case study, the overall structure of metaphors are creatively generated through superposition and topological operations of the individual image schematic parts. Table 5.8 shows how the three metaphors; TRAM SHELTER, MAIL ROOM and EYE IN THE STORM, can be developed as described in the A CAPSULE WORKSTATION AS EYE IN THE STORM in Section 4.2 (Case Study 3).

In row 1 of Table 5.8, the container for the TRAM SHELTER is not fully enclosed but has an opening to allow commuters to walk in and wait in the shelter to seek protection from the weather. As for the MAIL ROOM in row 2, the letters enter the container in the form of a room in a non-intrusive way. These two containers are described by (e) in Table 5.7 where the room or shelter is completely within the cavity of X. In EYE IN THE STORM in row 3, there is a safe centre that is situated at the eye with turbulent forces circulating around this safe container. This CONTAINER is described by (f) in Table 5.7 where the external circulating forces do not touch the centre or eye of the storm.

The topological nature of these image schemas plays an important role in producing the metaphor. In this case study, the FORCE and PATH image schemas are topologically varied. As shown in Table 5.8, the superposition of the three topological image schemas in creative ways can lead to the creation of the three novel metaphors.

Table 5.8 Topological and superposition of individual image schemas to form overall gestalt structure

	CONTAINER	**FORCE**	**PATH**
			
TRAM SHELTER 	 Container with an opening	 Force exerted by nature in the form of rain and wind	 Paths taken by rain and wind.
MAIL ROOM 	 Container with an opening to receive mails and channelling to the right place	 Subtle forces exerted by in-coming mails to the mailroom and channelling to the right places	 Paths taken by mails entering the mail room and channelling to the right place. Path to access the mails
EYE IN THE STORM 	 Eye in the storm is situated at the peaceful centre	 Circulating forces of storm that are outside of the eye or centre	 Paths of the circulating forces

Source of photos in the left most column: Creative Commons

While this research could not uncover the exact sequence of how metaphors are created, nonetheless, the above analysis, does show that multiple design activities have to be conducted either in parallel or sequentially to create the metaphors. In this multiple step process, the image schematic structures emerging from the design space

must “click” and correspond with the gestalt structure of the metaphorical source in order for the various metaphors to emerge.

After generating the EYE IN THE STORM metaphor, the student designer develops two interaction product qualities; *peaceful submission* and *cognitive privilege*. In this think phase, the student designer applies the ontological utility function of the metaphor to generate initial design ideas. In using *peaceful submission* and *cognitive privilege* as the two interaction product qualities, the student designer develops the product idea of a device that produces an audio file for the day’s activities. This innovative product idea allows the intended user to set some priorities at the start of the day with also a choice of an audio file. The interpretation of information streaming in depends on the priorities set for the day. By listening to the audio file, the user can make sense of its meaning and interact with the information stream as and when necessary.

In summary, this case study makes use of the notion of image schema to explain how PI metaphors are created. The topological and superposition features of the image schemas throw valuable light on how a novel way of *seeing* the design situations can be achieved. Additional details the PI metaphor creation process can be found in the next section and section 6.3 (PI metaphor creation process derived from case studies).

5.6 Discussion: Logical representation of Perceptual Intuition metaphor creation process

The mysterious leap in the PI metaphor creation process is now better understood after tapping on the insights gleaned from these cross case analysis and the knowledge obtained from general literature of what an image schema is and how image schemas are applied. From the case study analysis, it is observed that design situations take on image schematic gestalt forms as a result of being perceived by designers.

It is evident from the case study analysis that design situations do not contain pre-defined image schematic gestalts waiting to be uncovered. On the other hand,

designers could not produce image schemas out of nothing. Two avenues of producing image schemas are observed from case studies. One, image schemas are produced when designers engage in project discussions as in the WORKSTATION CAPSULE AS AN EYE IN THE STORM case study. Two, image schemas are created when designers are physically immersed and interacted with the problem situations as illustrated in the PAINTBRUSH AS A PUMP case study.

From these activated image schemas, image schematic patterns are generated which eventually leads to the creation of metaphorical source. This process may be summarised as follows.

a. Evoke image schemas.
b. Generate and invent image schematic patterns using the topological and superposition features of image schemas.
c. Creation of metaphors when the image schematic structure is suggestive enough to activate the metaphorical concept.

At the same time, these steps also reflect how the image schema guides the abduction process in the *see* phase of metaphor creation. This understanding of the abductive thinking process sheds valuable light on the abductive leap as indicated by (c) above and is elaborated further in section 5.8. As similar *think* and *act* phases are also found in the Explicit Thinking metaphor creation process, only the *see* phase will be reviewed here.

Evoke image schemas

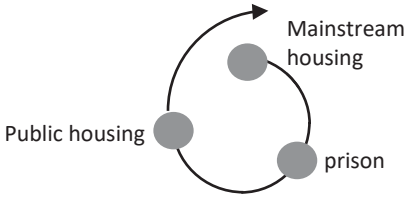
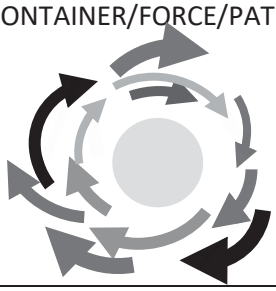
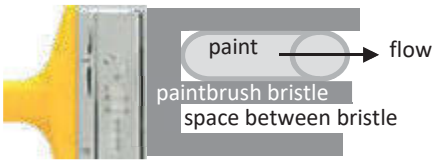
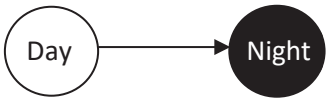
The cross case analysis reveals that some PI metaphors are created while designers are deeply immersed in the design situations such as the PAINTBRUSH IS A PUMP case study. Other metaphors such as KINGS CROSS AS JEKYLL AND HYDE, are produced totally in the design studio without any visit to the project sites.

In the PAINTBRUSH IS A PUMP case study, product researchers interact physically in the design problems as they use the new synthetic paintbrushes to paint. As they paint, they notice how the paint flows in between the bristles and how some painters vibrate the paintbrushes while they paint. It is explicitly mentioned in Schön's account of this case study that the product researchers are surprised when they realised that paint flows in between the bristles in the new synthetic paintbrushes. Therefore, these repeated observations and bodily interactions with the painting process could evoke the image schemas on-the-fly as the product researchers are busily engaged in the painting process.

For the purpose of this investigation, the immersive physical experiences are believed to be critical for drawing out underlying experiential structures present in the design problems. This similar conclusion is also shared by Schön (1993) where he explicitly highlighted the significance of the concrete painting situation for enabling the product researchers to reflect on the "gloppy paint" problem as they experiment with the new paintbrushes. Schön deduced that the cognitive work of restructuring is based on the richness of the features and relations existing in the concrete painting experiences. In this way, our embodied experiences lay the groundwork for creating metaphoric relations through the production of these image schematic patterns.

On the other hand, it has also been shown empirically that using words such as *IN* and *OUT* can also trigger related image schemas (Langacker 2002). In the same way, the explicit use of the word *pathway* in the 200m PATHWAY design problem could similarly trigger the PATH image schema. While the explicit use of words can trigger image schemas, implicit cues are also known to activate image schemas (Tseng 2007). Following this line of thinking, the use of words in thoughts and engaged reasoning are also likely to evoke image schemas. This means that both immersive project site visits and project discussions in this project investigation could be used to trigger the image schemas. The underlying image schemas that contributed to this understanding of the creation of Perceptual Intuition metaphors are listed in Table 5.9.

Table 5.9 Underlying gestalt structures that contribute to the Perceptual Intuition metaphor creation processes

	TARGET	Image schema	SOURCE
A PATHWAY AS BEETHOVEN's 9TH SYMPHONY	200M PATHWAY	PATH 	BEETHOVEN's 9TH SYMPHONY
WATERLOO HOUSING AS REBIRTH	WATERLOO HOUSING	CONTAINER/PATH 	REBIRTH
A WORKSTATION CAPSULE AS AN EYE IN THE STORM	WORKSTATION CAPSULE	CONTAINER/FORCE/PATH 	EYE IN THE STORM
A PAINTBRUSH AS A PUMP	PAINTBRUSH	FORCE/PATH/FLOW 	PUMP
KINGS CROSS AS JEKYLL AND HYDE	KINGS CROSS	Brightness/darkness 	JEKYLL AND HYDE
KINGS CROSS AS MUSICAL FESTIVAL	KINGS CROSS	Experiential gestalt	MUSICAL FESTIVAL

Even though the application of the above listed image schemas could theoretically contribute to the metaphor creation process, their use is not explicitly captured in any of the six case studies of Perceptual Intuition (Type 2) metaphor creation processes. None of the designers in these case studies expresses in explicit verbal terms that they have seen or observed a particular use of image schema. A possible reason according to Mandler (2005) is that image schemas are not accessible and, hence, can only be

discussed theoretically. While it is not empirically possible to verify the use of specific image schemas in this investigation of the creation process of the PI metaphors, it is similarly not the goal of this project to do that.

The purpose of tapping on the image schema theory in this project is to glean the knowledge needed to inform the metaphor creation process. The empirical data for this research offer a context for the image schema theory to be applied in order to uncover the metaphor creation process. It is not to prove or verify the use of image schemas in the metaphor creation process. For this purpose, an Image Schema Workshop is conducted to find out if designers are able to make use of image schemas to create metaphors and for carrying out other related design activities.

The workshop participants showed that they could identify the underlying image schemas of metaphors shared in the workshop. Similarly, all the workshop designers could also create metaphors by using pre-defined or self-selected image schemas. The description of the Image Schema Workshop can be found in Appendix B and the results are discussed in Chapter 6.

Generate and invent image schematic patterns

After evoking the underlying image schemas, the designers could proceed to invent new image schematic patterns using topological, superposition or gestalt operations such as figure-ground transformation. All these manipulations of the image schematic structures contribute to the production of a novel metaphorical source. For instance, the figure-ground transformation in bringing the flow of paint through the bristles into the foreground in the PAINTBRUSH IS A PUMP case study leads to the creation of the PUMP metaphor.

In this section, CAPSULE WORKSTATION AS AN EYE IN THE STORM case study is used to illustrate how the image schematic patterns can be innovatively generated. As shown in Figure 5.13, the activated image schematic structures in this CAPSULE WORKSTATION AS AN EYE IN THE STORM case study are interpreted in various ways through creatively

exploiting the flexible nature of image schemas that are triggered by the problem statements.

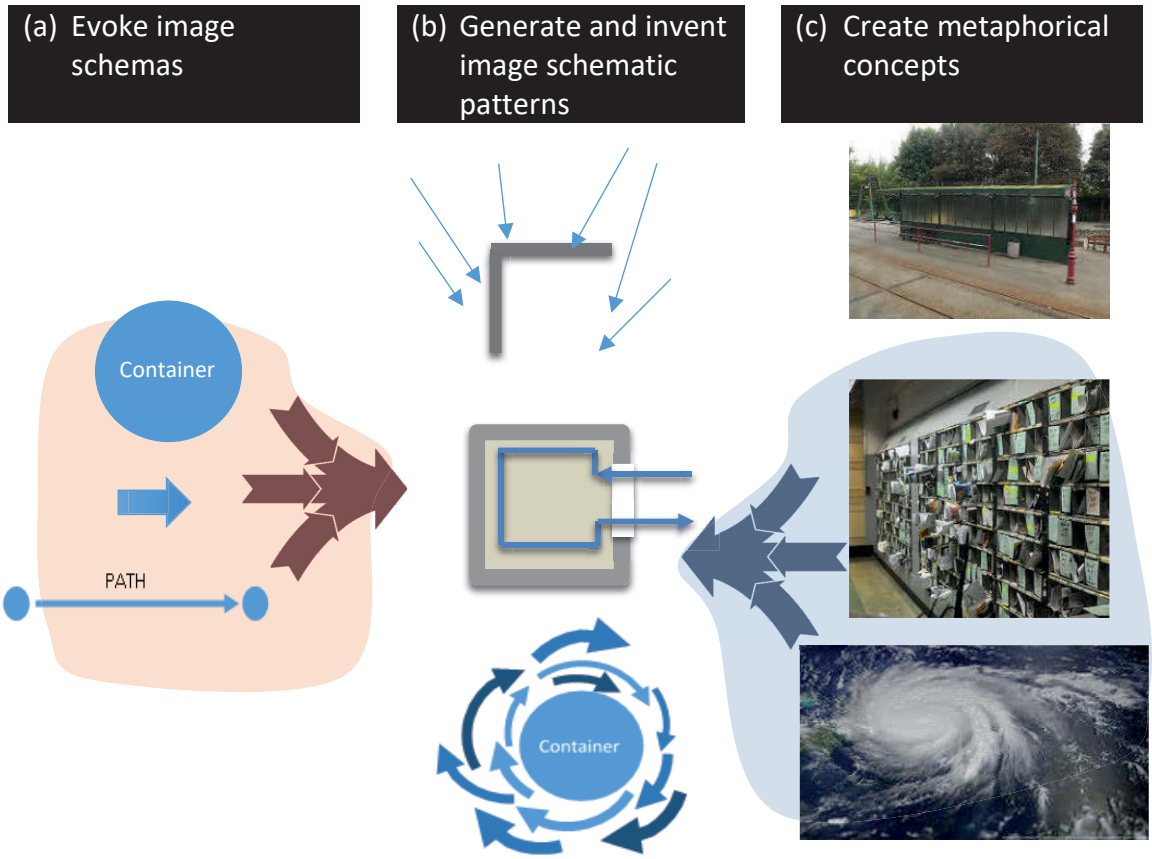


Figure 5.13 Logical representation of Perceptual Intuition metaphor creation process (*see* phase). *Source* of photos on the right column: Creative Commons

By manipulating the topological and superposition nature of the PATH and CONTAINER image schemas activated by the problem statements, a variety of metaphors such as the tram shelter, mail room and eye in the storm are produced. The generalised topological internal structure of image schemas facilitate the activation of different experiences. The various ways of putting image schemas together using superposition further increase the variety of metaphors that are created. By creatively manipulating the perceived image schematic structures drawn from the design situations, designers could *see* and construct new patterns which liberate them from habitual ways of *seeing.*

This logical representation of PI metaphor creation process offers an explanation to the insightful comments of Owen (2007) that designers do more than *recognise* patterns: they *invent* new patterns and concepts while tackling design situations. For example, in this A CAPSULE WORKSTATION AS AN EYE IN THE STORM case study, three different image schematic patterns are created which eventually led to the production of three different metaphors.

Activation of metaphor

The above sections describe how image schemas are evoked and how the gestalt structures of these image schemas are invented and produced. The final step is the activation of the metaphorical source. Data gathered in the case studies and literature research suggest that the metaphor emerges when the image schematic gestalt of target is suggestive enough to finally trigger the metaphorical source. Even though the description of the PI metaphor creation process has been carried out so far in a sequential order, a forward-and-backward sequence between the activation of the image schema and the emergence of the metaphorical source is expected, as shown in Figure 5.14.

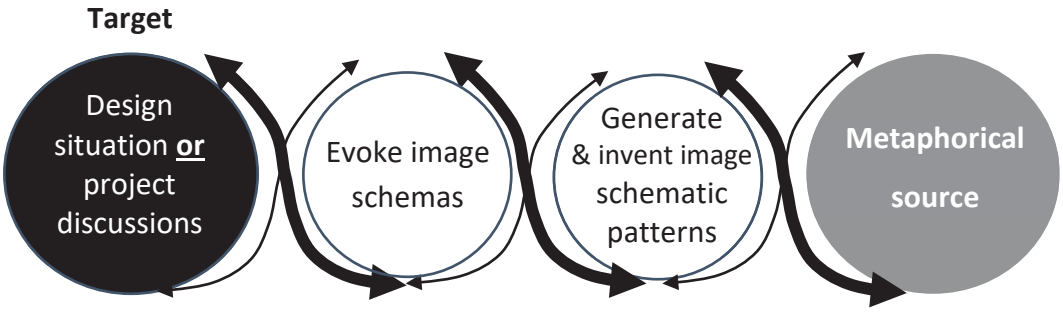


Figure 5.14 Schematic logical representation of the *see* phase of PI metaphor creation process

As mentioned earlier, the *think* and *act* phases are similar to that of Explicit Thinking type metaphors described in Section 5.3. As such, they will not be discussed here.

5.7 Exception case: SOCIAL HOUSING AS SCAFFOLDED EDUCATION

Most of the creation process of metaphors discussed in the case studies apply either explicit thinking or perceptual intuition. From the analysis of the case studies carried out, it is observed that metaphors created by explicit thinking are generally produced using similarities in symbolic concepts, while perceptual intuition metaphors are created using correlation of gestalt patterns. However, in the unique case study SOCIAL HOUSING AS SCAFFOLDED EDUCATION described in Section 4.2 (Case Study 7), the metaphor is created based on the *correlation of the symbolic structure* of two conceptual themes of AUTONOMY and CONTROL. An analysis will now be carried out to find out the differences between this and the other two types of metaphors.

After generating the conceptual themes, the team members decided to focus on the two chosen themes; autonomy and control as they affect all the stakeholders. The dissection of the two themes is shown in Figure 5.15.

Figure (a) Structure of AUTONOMY Theme

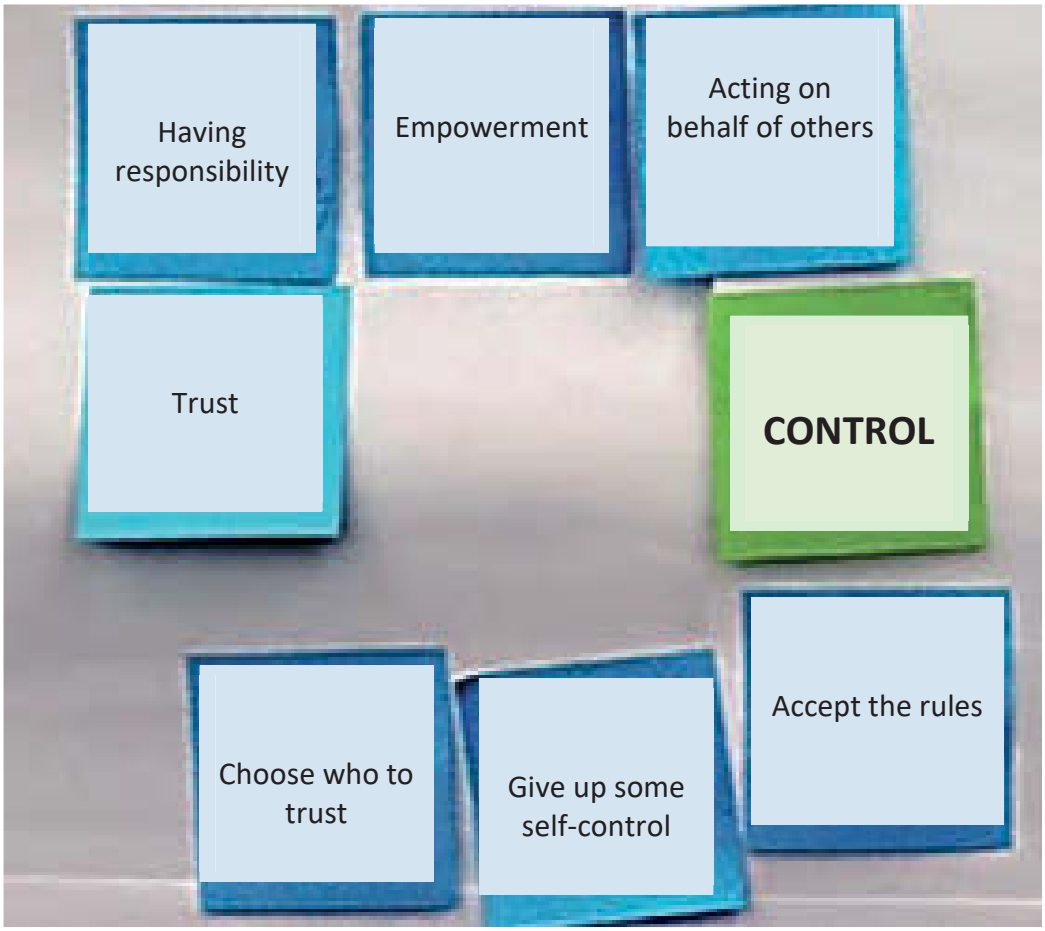


Figure (b) Structure of CONTROL Theme

Figure 5.15 Conceptual structure of AUTONOMY and CONTROL themes

After the themes are dissected, a team member notices the correlation of the conceptual structures of the AUTONOMY and CONTROL themes with SCAFFOLDED EDUCATION and suggests the metaphor to team members. In the following discussions, references are made to Table 5.10 which shows the correlation between the two concepts and SCAFFOLDED EDUCATION.

Table 5.10 Correlation of AUTONOMY AND CONTROL with SCAFFOLDED EDUCATION

Thematic analysis of autonomy and control	**Scaffolded education**
Autonomy	Autonomy of self-regulated learners
A1.Need to know what realistic options are there; having options	Independent and self-directed learners are aware of what they need. They could consult their teachers and institutions of their options
A2.Making your own choice; having choices	Self-directed learners make their own choices in their studies and there are several choices available in the education system
A3.Having resources	Teachers and school provide necessary resources and support to facilitate students' in their learning
A4.Being in control of yourself	Independent and self-directed learners are in control of their learning
Control	
C1.Acting on behalf of other people	Teachers act on behalf of students to develop the scaffold and learning conditions
C2.Empowerment	Teachers do not influence students directly. They are responsible to construct scaffolds to help students take charge of their learning. Learners take responsibility for their own learning.
C3.Having responsibility	
C4.Accept the rules	There is an established understanding between the teacher and learners about the learning support.
C5.Choose who to trust	Students trust teachers in their learning
C6.Give up some self-control	Both teachers and learners are willing to give up some of their control in working towards the common goal of developing self-regulated learners.

In SCAFFOLDED EDUCATION, independent learners are aware of their needs and know how to seek help when necessary (A1). These learners are capable of making decisions on what they want to learn (A2). Therefore, they are in control of their own learning process while tapping on necessary resources and support from the institution in furthering their studies (A3 and A4).

On the other hand, teachers act on the behalf of students to develop the necessary scaffold and learning conditions (C1). Instead of taking charge of the learning process, teachers leave the learners to be responsible for their own learning (C2 and C3). In this education system where there is an established understanding between teachers and students, both parties give up some of their control to work towards the common goal of helping students become self-directed learners (C4, C5 and C6).

The creation process of this exception case allows beginner designers to start designing by using the usual conceptual thinking process while offering an avenue to correlate experiences with similar structure. Identifying underlying structure in design situations is generally harder for beginner designers. However, the explicit characterisation and visualisation of the conceptual structure of the selected themes enables beginner designers to *see* the design situations in a structured way and that contributes to the creation of the SCAFFOLDED EDUCATION metaphorical source.

This exception case shows that mapping between two concepts need not be based on symbolic meaning. Two concepts could be linked together based on the correlation of conceptual structures. This observation leads to a new question of whether the creation process could serve as a bridge for beginner designers as they progress from creating Explicit Thinking to Perceptual Intuition metaphors. It will be useful to find out if this systematic and explicit way of training beginner designers could help develop their design skills.

5.8 Discussion

An understanding of the creation process of the two types of metaphors (ET and PI) is drawn from the cross case analysis of the ten case studies. The findings from these ten case studies show that the creation process of metaphors is neither random nor chaotic: there is a distinctive sequence and order in how each type of metaphor is created.

In the creation process of Explicit Thinking (ET) metaphors, designers make use of propositional symbols and logical inferences. In Perceptual Intuition (PI) metaphor creation, designers determine the structure of the design situations and then make use of these gestalt structures to create the metaphors. With the aid of image schemas, the PI metaphor creation process is now better understood. The analysis of the metaphor creation process, in particular that of PI metaphor shows that design o*riginality* and the *abductive leap* are observed in the metaphor creation process.

Originality

Originality in design refers to novelty or being unusual (Ozkan & Dogan 2013). Several observations made in this research project, in particular, the valuable contributions of gestalt patterns in producing original design outcomes are discussed. The contribution of these sensorimotor gestalt recurrent patterns to the creation of metaphors are illuminated by the use of image schemas. In addition, insights obtained from other originality investigations in design literature (Shende & Das 2015; Verhaegen, Vandevenne & Duflou 2012) are also highlighted to deepen understanding.

Rich and diverse stimuli. It is found from the case study analysis that designers could generate novel metaphors after rich immersive design experiences and conducting design discussions. Similarly, findings from literature research show that rich and diverse stimuli (Goldschmidt & Smolkov 2006) and textual stimuli (Goldschmidt & Sever 2011) positively impact the originality of design proposals.

Surprising unexpected observations. It is found that surprising and unexpected observations contribute to original design solutions. For example, surprising observations of the pumping action in the painting process in A PAINTBRUSH AS A PUMP case study and about the drastic difference between day and night activities in Kings Cross in KINGS CROSS AS JEKYLL AND HYDE case study contribute significantly to the creation of the novel metaphors. Whenever something unexpected occurs during the observation studies or discussions, the designers are observed to respond by reflecting on these new aspects of their experiences. This often leads to a new way of seeing the

design situation that in turn contributes to a novel metaphor. A similar observation is also made in research study by Dorst & Cross (2001b) where the 'surprising' parts existing in a problem or solution contribute to a novel design solution as surprise keeps designers away from their habitual behaviours.

Overcome fixation through transformation and abstraction. In the creation of the KINGS CROSS AS MUSICAL FESTIVAL metaphor, the original way of *seeing* the problem situation is transformed when the original focus on law and order is transformed to focus on organised fun. Similarly, a novel REBIRTH metaphor is created by applying the abstracted values derived from the needs of the ex-prisoners residents in the WATERLOO HOUSING AS REBIRTH metaphor. This research finding on overcoming fixation is supported by literature where Goldschmidt (2011) suggests the use of transformation and abstraction of the source to overcome fixation.

Overcoming habitual ways of seeing. A way to gain a new view of design problems is achieved through a direct access to the design situation that goes beyond the usual categories. This is achieved by tapping on the perceptual information of the design situations. For example, through perceptual correlation of the structure of painting experiences to that of pumping experiences encountered earlier helped the product researchers see painting as a pumping process. By tapping on image schema knowledge, the structure of the painting experiences may be represented as the FLOW, PATH and FORCE images schemas. Based on figure and ground transformation and different ways of combining the image schemas, the product researchers could see the painting process as a pumping process.

The image schemas in the various case studies can be produced using the imaginative powers of the designers as they interact with the design situations by means of immersive experiences or design discussions. This reinforces the importance of the *rich and diverse stimuli* and the importance of *surprising unexpected observation* in design process (Suwa, Gero & Purcell 2000). By evoking and combining sensorimotor recurrent patterns which are different from the habitual ones, designers could see the design situations in novel ways.

These observations are broadly reflected in design literature where designers are aware that some extra “ingredient” must be added to produce an original solution. According to Levin (1966), this extra ingredient is an “ordering principle” which Alexander (1964) has also identified as the pattern-constructing feature, which is known to lie at the core of design activity.

The above discussion highlights the important role that image schema plays in achieving originality in metaphor creation process in design. This role of image schema is further elaborated in the following discussion on the creative leap.

Creative leap

Designers bring together disparate ideas; such as paintbrush in the painting process and pump in the pumping process, in a creative leap during the PI metaphor creation process. An improved understanding of the creative leap is achieved through the application of the knowledge of abduction and image schemas onto the creation process of the PAINTBRUSH AS A PUMP metaphor.

The designer’s ability to *see* and then invent patterns to facilitate connection across disparate ideas in abductive thinking contributes to the creative leap. Many of these patterns are generated by abduction through perceiving intrinsic connections present in the design situation, and then giving it a formal structure (Turner 2009). The knowledge of image schemas will now be applied to gain an improved understanding of the creative leap.

In this paintbrush case study, the leap is first initiated when the product researchers notice the flow of paint along the channels in between the surface of the bristles. Uncovering these patterns affect and change their understanding of the painting experiences. As shown in Figure 5.16, the perception and interaction with the painting experience enable the product researchers to discover these recurrent patterns highlighted as (a). This redirects their attention to focus on the path and forces acting on the paint that flows in between the bristles.

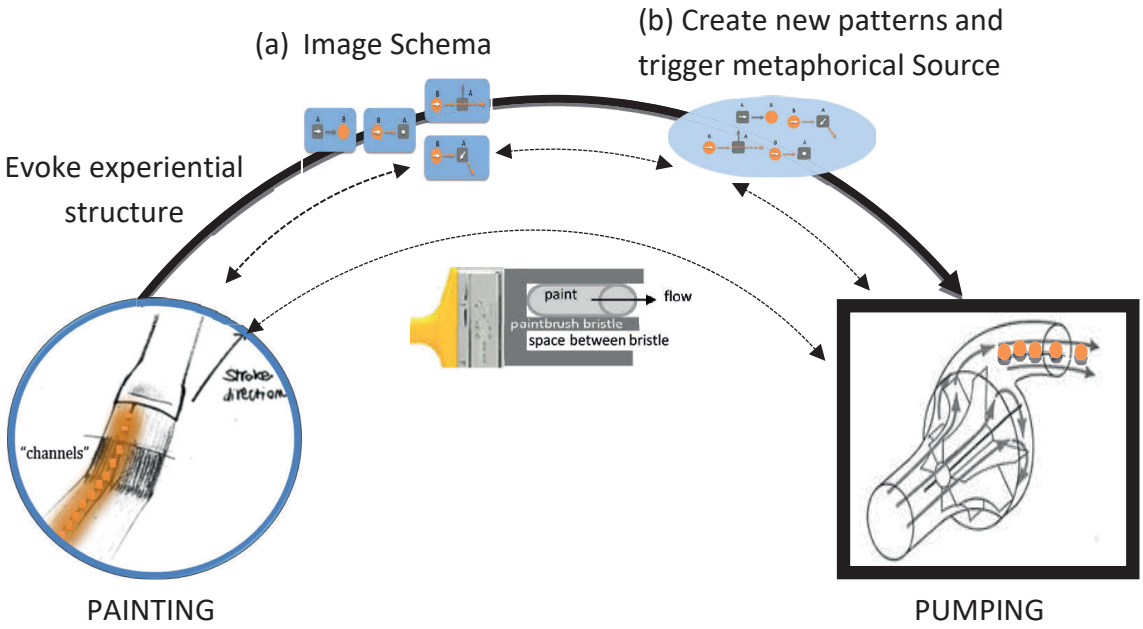


Figure 5.16 Creative leap

In the metaphor creation process, product researchers could 'play' with the various image schematic elements evoked from the design situations to produce a plausible form. This overall gestalt structure of the painting process is produced as designers manipulate the topological and superposition natures of the various image schemas. The PUMP metaphorical source is produced when the image schematic structure of the painting process, as indicated by (b) reminds the designers of the image schematic structure of the pumping process. It is likely that designers could activate the metaphor once the structure is suggestive enough. This deduction is based on our daily experiences of object recognition. Most of us could identify an object even when we do not have a "complete picture" of the object.

While the above description of the leap is expressed explicitly and in sequential order, the design activities that occur during the leap are carried out implicitly and iteratively. The search for and the creation of new patterns in design cognition are likely to be enmeshed and carried out iteratively by co-evolution as indicated in Figure 5.16 using the dotted arrows. A similar observation is made by Popovic (2003) where expert designers apply both backward and forward reasoning in design processes which involved perceptual skills.

In this section, an improved understanding of the creative leap has been achieved through the use and knowledge of image schema. The use of image schema for bridging between concrete sensorimotor experiences in the immersive painting experiences and abstract reasoning in the production of the PUMP metaphor has shed valuable light on the creative leap. However, additional research has to be carried out to uncover the finer details such as the forward and backward reasoning. This discussion on further research is found in Chapter 6.

5.9 Conclusions of cross case analysis

Two research questions are answered in this cross case analysis. The first research question "*Which types of creation processes of metaphors can be identified?*" is answered by analysing the attribute values of the five dimensions. It reveals that there are **two** main types of metaphor creation processes: explicit thinking (ET) and perceptual intuition (PI).

In general, metaphors are created by drawing targets and sources together by establishing relationships that are not encountered previously. While the targets are design problems, the sources are often tapped from experiences or knowledge. These sources are represented as propositional symbolic form or gestalt form depending on the type of metaphor creation process. The details of the metaphor creation process and corresponding representation form are found in the answer to the second research question *"How can the logical representation of these respective creation processes be described?"*

Logical description of the creation process of explicit thinking (ET) metaphor

The analysis of case studies in the ET case reveals that ET metaphors can be produced by first finding a unique characteristic of the target design situation. ET metaphors can be produced by activating the sources that possess similar features or structures as the target. For example, the *featural* themes of *safety, responsiveness* and *well-being* led

the design team to create SUPPORT OF VICTIMS OF CRIME AS AMBULANCE SERVICE ET metaphor.

The thinking process underlying the creation of the ET metaphors resembles our intellectual cognitive processes. It follows our everyday manipulation of propositional symbols in the pre-determined web of knowledge. The propositional symbolic targets and sources are drawn together through the use of propositional symbolic features or structural relationships using propositional content.

Logical description of the creation process of perceptual intuition (PI) metaphor

It is found that the use of image schematic structure contributes significantly to the understanding of PI metaphor creation process. From the immersive design situations and project discussions, designers could perceive the recurrent sensorimotor representation of the design situations. This eventually contributes to the creation of the PI metaphors. For example, the PI metaphor creation process is well illustrated using the PATH image schema derived from 200m PATHWAY design problem which eventually leads to the creation of the 200m AS BEETHOVEN's 9^{TH} SYMPHONY metaphor.

In addition, complex metaphors such as A CAPSULE WORKSTATION AS AN EYE IN THE STORM can be produced by creative manipulation of the topological and superposition characteristics of the activated image schemas. This analysis reveals that the cognitive processes and cognitive structure applied in PI metaphor creation are different from the use of propositional symbolic processing in ET metaphor creation. The understanding of PI metaphor creation process is illuminated through the application of image schemas. Through the manipulation of topological and superposition characteristics of image schemas, the image schematic structures are creatively generated which leads to the creation of novel PI metaphors. This use of image schematic elements contributes to a better understanding of how PI metaphor creation process is intuitively created and sheds valuable light on the mysterious leap in design process. The implications of these findings are discussed in Chapter 6.

6 Conclusions, implications and future research

This dissertation is a journey through three studies to answer two research questions. In this concluding chapter, an overview of the research aims is presented in Section 6.1; significance of work is discussed in 6.2; contribution and advancement of knowledge are highlighted in 6.3 and their implications for design practice and education are discussed in 6.4 and 6.5, respectively. Reflection on research approach and recommendations for further research are offered in 6.6 and 6.7. Finally, some concluding comments are discussed in section 6.8.

6.1 Overview of research aims

The study is motivated by the need to find out the core of creative practice and, more specifically, where originality comes from. From design literature, it is found that the creative leap is considered as the real crux of the act of designing that results in new design ideas. Abductive thinking offers a mechanism of discovery to help designers see patterns and form relationships that facilitate the leap. Finding out about this creative leap in abductive thinking could illuminate how designers generate novel ideas. In design, abductive thinking is applied to create new frames to tackle design problems. Metaphors are often used as frames to provide structure, facilitate understanding of unfamiliar situations and offer new directions for action. A focus on the use of metaphors in framing could contribute to this research on the creative leap in design thinking.

Unfortunately, little is known about how metaphors are created in design practice as it is not well researched because expert designers tend to produce metaphors in an intuitive way using their tacit knowledge. As briefly discussed in Section 4.3, tacit knowledge in this project investigation refers to the notion of image schemas following the work of Lakoff & Johnson (1999). Empirical research is needed to find out more about the creation process of metaphors in framing. This study focuses on the types of creation process of metaphors that help produce frames.

Research Goal

The goal of this study was to investigate the creative processes in design by studying how metaphors are created. The study was directed by the leading question: "What are the key creative processes in metaphor creation?" and the research questions were:

Question 1: *"Which types of creation processes of metaphors that help produce frames can be identified?"* and

Question 2: *"How can the logical representations of these respective creation processes be described?"*

Even though the original context of the research questions were based on production of frames, the results discussed in this chapter are applicable for metaphor creation in general.

6.2 Significance of work

This investigation achieves a new understanding of what designers do in their creative practices to come up with original design ideas. Of particular significance is the finding obtained from analysing the PI metaphor creation processes. Research reveals that gestalts arising from designers' embodied experiences in the design situations contribute to the creation of PI metaphors. Conceptual metaphor theory is applied to facilitate the understanding of how bodily experiences activate image schemas. Image schemas are used to structure many of the interactions encountered in design situations. This aids designers to make sense of design situations, and this forms an important basis for a new understanding of the metaphor creation process. For example, the activated image schemas after arranging in a new pattern in the PAINTBRUSH AS A PUMP case study led the product researchers see the design problem situation as a pumping process rather than the original painting process. This

is a significant finding that sheds valuable light on how designers *see* something *new* out of an existing design situation. As discussed in section 5.6, designers may invent new image schematic patterns by making use of the topological and superposition properties of the image schemas. The activation of gestalts and formation of patterns that eventually lead to the creation of metaphors are building blocks of design cognition. In other words, thinking in design practice encompasses bodily cognition in addition to the usual thinking that is carried out. The characteristics and properties of image schemas gleaned from fields outside of design further illuminate what designers do in their practice.

This crucial link established between the metaphor and design fields has shed valuable light on some aspects of *designerly* thinking. This includes abductive thinking, and the co-evolution of the problem and solution spaces. As designers "shuttle between design problem and solution" (Dorst 2007) as also captured in the PI metaphor case studies, the image schematic patterns reflecting the design situations evolve and develop in the co-evolution process. These image schematic patterns could have served as one of the avenues that provided the intuitive feel of the design situations. These image schemas serve as one type of tacit knowledge which aid designers in creating the PI metaphors through abductive thinking. This is a similar observation made by Shotter (2008) who notes that image schemas may be "carried across" to seemingly different situations from where they originated. This carrying across is reflected by the production of metaphors in this investigation. This significant finding offers an improved understanding of designerly thinking and the contribution of image schema as a form of tacit knowledge used in design practices.

6.3 Contribution and advancement of knowledge

This research study contributes significant theoretical understanding to the metaphor creation process in design practice. New knowledge about metaphor creation is gained through the systematic analysis of the cross case studies. Details of contribution are as follows.

Types of metaphors from literature investigation

Literature research is conducted to find out the existing types of metaphors in order to identify the types of creation processes of metaphors that help produce frames. Two insightful findings are obtained from the literature research investigation detailed in Chapters 1 and 2. First, there are *various types* of metaphors. Second, these metaphors are likely to be created in different ways (MacCormac 1986) even though they share similar *see, think and act* phases as will be elaborated further in the next section. That means a *general* understanding of the metaphor creation process will not be adequate as it does not reflect the unique creation processes of each individual type of metaphors.

To identify the types of metaphor creation processes that help produce frames, it is required to determine the characteristics of those processes. To do that, metaphors created through similar processes are grouped together as a type for a closer examination of its creation process.

***See-think-act* phases in metaphor creation**

It is found from literature analysis that metaphor creation comprises three phases: *see, think* and *act*. Having the *see* phase as starting point for this research introduces data and literature that are often glossed over in other similar research studies on what designers do. Most researchers focus on the cognition process - how designers *think* in the design process. The *see* phase provides a window to observe how designers perceive the design situations, capture patterns from the situations and interpret them to create metaphors. The finding of how sensorimotor data are used to create metaphors deepens understanding of how designers *see* design situations. The *see-think-act* phases facilitate new insights and prove to be a fruitful framework for this study.

Characterisation of the creation processes of metaphors

A typology is chosen to characterise the creation processes of metaphors. A metaphor typology comprising 5 analysing dimensions and related attribute values is developed from the literature analysis. These 5 dimensions influence the *see-think-act* phases of metaphor creation.

Dimension 1, *basis of connection*, refers to how the source is triggered and drawn to the target. Its two attribute values are *resemblance* and *correlation*. Dimension 2, *forms of representation*, refers to the various ways in which targets and sources are represented. The two attribute values in this dimension are *gestalt* and *symbolic* representational forms. Dimension 3, *connecting element*, specifies the element that links target to source. The two attribute values in this dimension are *feature* and *structure*. Dimension 4, *origins of sources,* refers to where the source comes from. The three attribute values of this dimension are experiences, knowledge and culture. Dimension 5, *cognitive utilities provided by sources*, refers to the cognitive utility of the source to enable understanding of the target. The cognitive utilities provided by the metaphorical source can be ontological, structural or orientational.

Identification of the attribute values of the 5 respective dimensions

The single case study analysis produce descriptions of the creation processes of metaphors in the ten case studies and identifies the attribute values for each of the five dimensions of each case study, as shown in Table 5.1 in Chapter 5. Nine observations described in Section 4.4 are drawn from the single case study analyses and attribute values. These nine observations concern the general metaphor creation process, the influence of designers on metaphor creation, and metaphor creation using gestalt representation forms.

Identification of the types of creation processes of metaphors that help produce frames

In response to the first research question, two types of creation process of metaphors that help produce frames are identified using cross case analysis. The two types are: *Explicit Thinking Type* and *Perceptual Intuition Type* as shown in Figure 6.1.

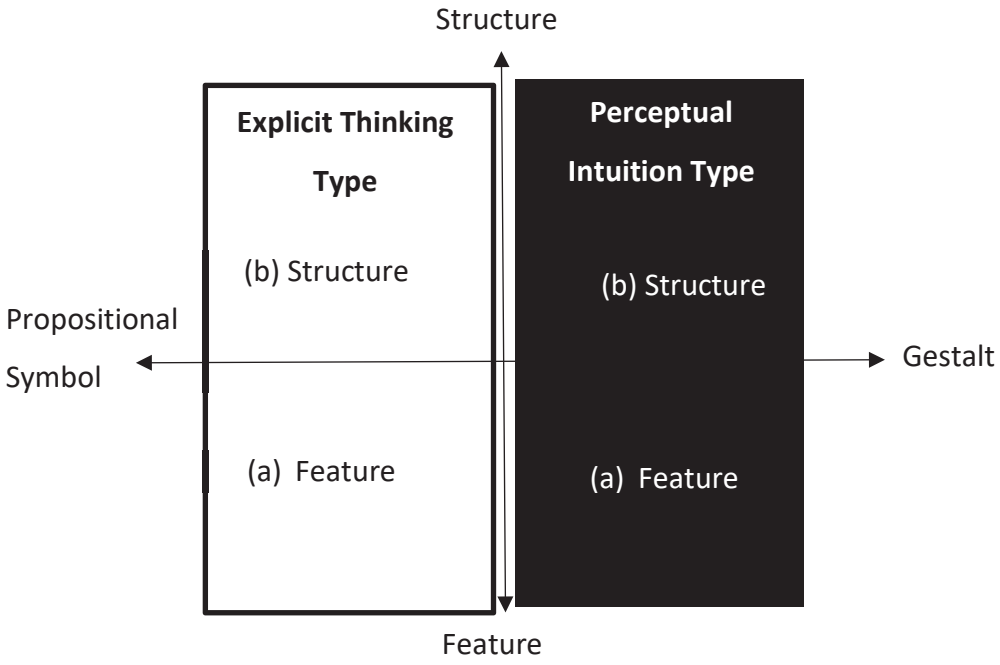


Figure 6.1 Two types of metaphor creation processes

The *explicit thinking type* metaphors are created by design processes in which the design steps are explicitly stated; the *perceptual intuition type* metaphors are intuitively created. The creation processes will be elaborated in Section 6.3. The creation of *explicit thinking type* metaphor uses propositional symbols as the representation form, while the creation of *perceptual intuition type* metaphor uses gestalt forms, particularly, the image schemas. Each has two sub-types that refer to either (a) feature or (b) structure. The difference in representation forms influences the ways in which cognitive activities are conducted in the *see* phase of the creation processes as is elaborated next.

Logical representations of the two types of metaphor creation processes

In explicit thinking type metaphor creation processes, propositional symbolic target and source are drawn together by how they are associated in propositional symbolic features or structural relationships in terms of propositional content. The thinking steps for creating explicit thinking type metaphors involve the process of sorting and connecting predefined information in a pre-determined way. In this creation process, designers have to navigate their ways through fixed and unambiguous meanings that are pre-assigned to concepts and objects. Even under such rigid conditions with very little flexibility as all the symbolic concepts are connected in a pre-determined way, designers can successfully *see* the design situations differently through new ways of *understanding* the design situations.

Perceptual intuition type metaphor creation processes are based on image schematic forms. As image schemas are more flexible topologically and may be combined more flexibly compared to the relatively rigid symbols used in explicit thinking type metaphors, designers can use the ambiguity offered by image schemas in perceptual intuition processes to develop innovative metaphors. *Seeing* in perceptual intuition creation process involves *seeing* the underlying image schematic structures of experiences encountered in the design situations, and then creatively exploiting its flexible nature to come up with innovative metaphors.

The third study, which is the cross case analysis, reveals the underlying steps present in the creative leap of the metaphor creation process. The creative leap is particularly noticeable in the creation of Perceptual Intuitive Type metaphors. To clarify the creation process of Perceptual Intuitive Type metaphors, image schema theory is applied, as the cognitive processes are unclear even though a distinctive pattern is detected. The purpose of using image schema theory is to tap on the necessary knowledge it offers, not to prove or verify its use in the metaphor creation process. As it is not empirically possible to verify the use of image schema in the creation process of Perceptual Intuitive Type metaphors in the case studies, the Image Schema Workshop (described in Appendix B) is conducted to find out if designers are able to

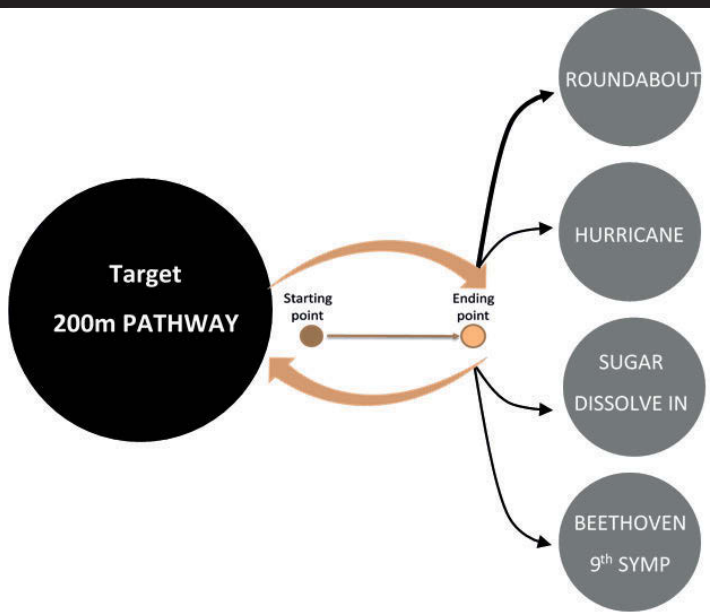
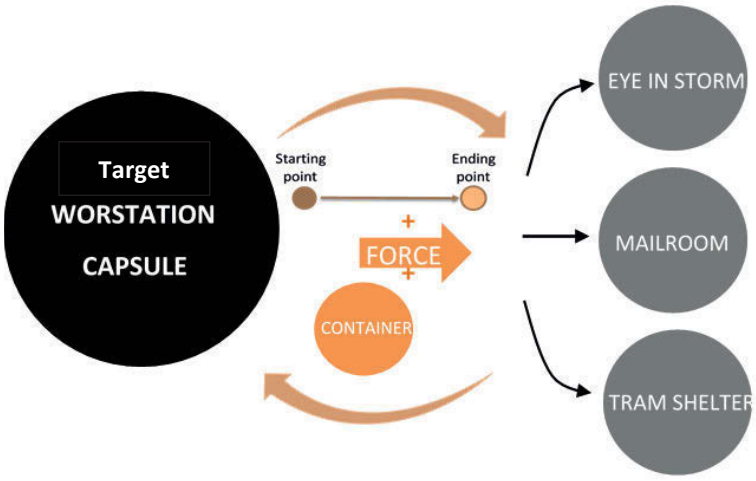
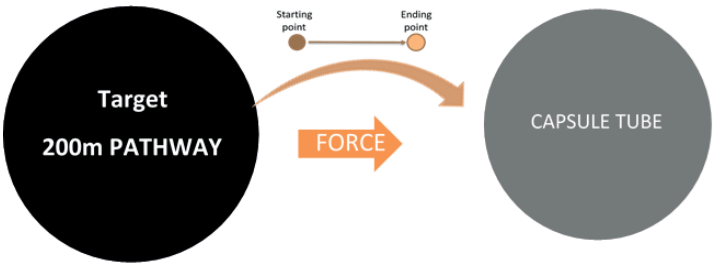
make use of image schemas to create metaphors or to facilitate general design activities.

PI metaphor creation process derived from case studies

The application of image schema knowledge on the PI metaphor creation process illuminates how designers create PI metaphors and novel ideas in a systematic way, rather than haphazardly via brainstorming or random association. Novel PI metaphors are created by *changing* or *manipulating* the flexible nature of image schemas in order to intentionally restructure design problem and solution spaces. This knowledge of image schema contribute to the understanding of how PI metaphors are created, as summarised in Table 6.1. It is found from this investigation that designers could produce novel PI metaphors in at least three ways.

The first row of Table 6.1 shows that the topological nature of image schemas could help designers come up with novel metaphors. Several student designers in Casakin's class are able to generate different metaphors with the same PATH image schema by making use of its topological nature. The second row shows that both the topological nature of image schemas and a creative superposition of the schemas enable the designer to produce innovative metaphors and design solutions for the capsule workstation. The third row of Table 6.1 illustrates that an intentional attempt to change the PATH image schema to FORCE image schema that helps the designer in the Image Schema Workshop to generate the CAPSULE TUBE metaphor and then generate new design ideas for the 200m PATHWAY problem.

Table 6.1 Ways in which image schemas contribute to the creation of PI metaphors

a. Topological Nature of image schema	
	A PATHWAY AS ROUNDABOUT A PATHWAY AS HURRICANE A PATHWAY AS SUGAR DISSOLVING IN WATER A PATHWAY AS BEETHOVEN's 9TH SYMPHONY
b. Flexible combination and topological nature of image schemas	
	A WORKSTATION CAPSULE AS EYE IN THE STORM A WORKSTATION CAPSULE AS MAILROOM A WORKSTATION CAPSULE AS TRAM SHELTER
c. Change of image schema : PATH --> FORCE	
	A PATHWAY AS CAPSULE TUBE

Use of image schemas for producing Perceptual Intuition Type metaphors

Four designers are invited to participate in the two-hour Image Schema Workshop conducted on 27 April 2017. A photograph taken during the workshop is shown in Figure 6.2. The four designers are selected based on their practice-based design expertise and their familiarity with metaphors and frame creation process. In this two-part workshop, the designers are first exposed to the image schema concept using the PAINTBRUSH AS PUMP metaphor case study (Schön 1967, 1993). They are then asked to do a short workshop exercise followed by a group interview. Details of the participants, schedule of activities and questions asked are described in Appendix B.

Figure 6.2 Image Schema Workshop

The results from the workshop reveal that all four designers are able to apply image schemas to help them carry out the required design activities which include the creation of metaphors. After learning about image schematic structures, the four designers are able to identify the underlying PATH image schema in the workshop exercise on the PATHWAY AS BEETHOVEN's 9th SYMPHONY metaphor. All of them can also change the existing image schematic structures at will to *see* the 200m PATHWAY using other image schemas. For example, one designer intentionally applied the FORCE image schema for the 200m PATHWAY design problem and that led him to produce the CAPSULE TUBE metaphor, as indicated by row 3 of Table 6.1.

The 2-hour workshop ended successfully with several findings of which the following are the most significant:

1. All the designers said that they are implicitly applying image schemas in their design practices, even though they are unaware of the concept of image schemas.
2. All the designers can identify the underlying image schemas present in the metaphor described in the workshop.
3. All the designers can create metaphors using pre-assigned or self-selected image schemas.

Further research should be aimed at a more elaborate investigation of the explicit application of image schema theory in design education. This is further discussed in Section 6.5.

6.4 Implications for design practice

This project study reveals two findings that have implications for design practice: 1) existence of various types of metaphors and how each type is created in design practice and 2) use of image schemas to create metaphors in design practice.

Types of metaphors and how they are created

The knowledge that there are two types of metaphor creation processes and that they can be created by manipulating the attribute values in the 5 dimensions can be used by designers to broaden their repertoire of metaphor creation skills and, in a more tactical way, to trigger new metaphors while in the midst of a design project.

The knowledge that there are two types of metaphor creation processes could be used to raise the awareness of one's current repertoire of metaphor creation skills. Designers who are keen to broaden their repertoire can identify the types they are not

conversant with and work at developing the required skills and experience or knowledge to create them.

At the project level, it is useful to be able to intentionally produce the specific types of metaphors that can lead to innovative results. Different types of metaphors offer different views and opens up alternative ways of *seeing* the design issues. To generate a different type of metaphor, the designers must first identify the type that are already produced. They can then strategically manipulate the 5 dimensions to create different, more promising types.

Use of image schemas to create metaphors in design practice

As discussed in Chapter 1, metaphors are widely used in design practices to aid designers in understanding design situations in new ways and to restructure the design problems. The knowledge of image schema acquired from literature and results of this project investigation have uncovered how metaphors are created from image schemas. This finding has important implications on how this valuable image schema thinking tool directly affects the creation of metaphors in design situations as described in the following.

Image schemas are abstracted patterns obtained from repeated sensorimotor experiences and designers are susceptible to being primed by the design situations to trigger particular image schemas. It is found empirically by Martínez (2007) that some specific image schemas are activated while listening to music after participants are primed with animations that represented the respective image schematic gestalts. It is important for designers to be aware of priming as it biases them towards certain design directions in producing certain types of metaphors. Awareness of this bias sharpens their cognition explicitly so that they can resist being led to produce standard range of metaphors.

Related to the above, it is not uncommon for designers to find themselves in a stuck situation in the design process. Very often, designers are stuck due to 'design fixation'

which is defined as the adherence to a set of ideas which restricts the outcomes of conceptual design by Jansson & Smith (1991). To avoid or overcome fixation, Crilly & Cardoso (2017) propose the use of support tools that provide feedback and the development of indicators of creative effort. In that work, they also described the creation of a software program that provides designers with inspirational stimuli. For example, the use of 'Ask Nature' web site which prompts users to unlock creativity through new stimuli that provoke them to think of new ways. An alternative that arises from this research is to use image schemas as a reflective tool to help designers out of a stuck situation. By reflecting on and then intentionally changing the underlying image schema of the design situation, new metaphors can then be created. These new metaphors can help designers untangle themselves by thinking in a new path.

Increasingly, problem issues are complex, ill-structured and chaotic. As many of these problem issues are new and without precedents, designers often encounter difficulty talking about them as they have no personal experience or appropriate language to fall back on. Under such circumstances, designers can abstract and represent the complex, ill-structured design situations in image schematic forms which can then be used to produce appropriate metaphors to help articulate the problem issues.

While the implicit use of image schemas have benefitted designers in metaphor production, as observed from the case studies, explicit and intentional use of image schemas could also potentially contribute to metaphor creation and design practice in significant ways. This is a suggested area for further research as highlighted in Section 6.7 (Recommendations for future research).

6.5 Implications for design education

The findings on the two types of metaphors and the *see-think-act* aspects of the metaphor creation process can help student designers get started in their design projects.

Teaching metaphor creation process

Even though the *see-think-act* aspects of metaphor creation happen simultaneously and intuitively during design practice, each aspect requires specific design skills. A systematic curriculum can be developed to teach students to *see* in various ways using propositional symbolic and image schematic representation forms, then *think* about how to carry out mapping effectively, and to *act* by applying the knowledge and structure present in the metaphorical source to the target to develop design solutions. A corresponding training programme for design tutors will be needed to facilitate such a curriculum.

It is useful to note that in training student designers to create metaphors based on the process uncovered in this research, students will be learning the ability to *see*, which is considered as a Stage 3 Competency level based on the adapted *Dreyfus model of skill acquisition* by Curry (2014). That means beginner designers can speed up their learning process by spending less time in Stage 1: Novice and Stage 2: Advanced Beginner which tend to be conducted in context-free environments.

Students could be trained to produce metaphors in a systematic way through the progression of learning how to create ET metaphors first, followed by the exception case (metaphor creation process described in case study 7: SOCIAL HOUSING AS SCAFFOLDED EDUCATION) and finally the PI metaphors. This facilitates the natural progression of learning process from explicit to intuitive.

Developing corresponding creative design skills and image schematic cognitive structures

Just as one does not become a better chess player simply by learning all the rules of the chess game, so too being aware of the various aspects and types of metaphor creation processes alone does not help the beginner designers produce better design solutions. Student designers need guidance and actual experience in executing the many steps it takes to produce a fruitful metaphor. Possessing a repertoire of what

Lawson (2004) calls design schemata and patterns of design solutions is more likely to help beginner designers produce good design solutions.

Unfortunately, it is beyond the classroom to provide all such necessary prior experiences. It is equally a challenge to develop skills to manipulate image schemas because they are tacit and, hence, difficult to communicate. Furthermore, it is difficult to teach these handling skills to beginner designers as they do not yet possess image schema knowledge. One way to develop these tacit skills is to train them to intentionally create *perceptual intuition* type metaphors.

This research shows that it is useful to develop a formal curriculum that introduces image schemas and how they contribute to metaphor production. The curriculum can include the identification of image schematic structures present in design situations, manipulating image schemas topologically and combining them in different ways, and intentional change of image schemas for metaphor production. However, the effects of introducing image schemas in producing metaphors to design students are not yet validated by design practice even though the interview responses from the Image Schema Workshop are positive, as captured in Section 6.3 (sub section on “Use of image schemas for producing Perceptual Intuition Type metaphors) and Appendix B. There is a need for further research to understand the impact of teaching image schemas for producing metaphors in design education before formally introducing it into the curriculum.

6.6 Reflection on research approach

Though proponents and advocates of case study research consider it a valuable form of inquiry (Eisenhardt 1989; Stake 1995; Voss, Tsikriktsis & Frohlich 2002; Yin 2014), the small sample size of case study research is often cited as a weakness when it comes to generalisation to a larger population. Indeed, this research study with ten cases has its limitations and its purpose is not to uncover *all* types and sub-types of metaphor creation processes. Rather, the empirical findings reveal two fundamental

types of metaphor creation processes that are similar to those found in literature. Investigating more cases is not likely to add new types of metaphor creation processes. Additional cases may, however, lead to the identification of sub-types of metaphor creation processes not required for this present research study.

Besides reflecting on the number of cases and data points, it is noted that one significant strength of case study research is its ability to develop a "situationally grounded understanding" and "thick descriptions". These rich descriptions of the complex creative design processes in their natural design settings are a fertile source for analyses. In this research project, they are used in a cross case analysis for uncovering empirical patterns. The patterns observed led to theories that illuminate how originality is achieved in the design act.

As discussed in Chapter 3, design experiment was another research methodology considered for this project. It was passed over in favour of case study and typology, because design experiment might exert unknown influence on the metaphor creation process.

6.7 Recommendations for future research

Findings from the three studies conducted in this research project answer the research questions set out at the start of the project and raises further questions and recommendations for future investigations.

Study of design firm practices using the model of two types of metaphor creation processes

Tapping on the metaphor typology and the understanding of how metaphors are created, further studies can be conducted to find out how design firms use and displace their design concepts. A two-step study can first establish the types of metaphors that form part of the firm's current practice or culture. With that

awareness of its current practices, the firm can then make an intentional attempt to shift those practices or develop new practices to raise its design and innovation capabilities.

The study would include how the firm's designers access their source domains. Making explicit the implicit act of accessing source domains can enable the firm to propose new practices through the use of the model of 2 types of metaphor creation process and help professionalise design practices.

Extension and modification of the metaphor typology model

The 5-dimension typology of metaphor is developed through an extensive literature investigation. While the typology has contributed to the successful identification of the two types of metaphor creation processes in this investigation, further research will be necessary to determine if modification or extension of the typology is required for other use.

Specific image schemas underlying metaphors produced in design use

As highlighted in earlier chapters of this thesis, the origins of image schema lie in the fields of philosophy and cognitive linguistics. The image schemas developed by cognitive linguists are reflected in the use of PATH, CONTAINER and FLOW for the production of metaphors of this research project. However, design practice has its unique requirements and this is illustrated in the attempt to create a "social interaction" image schema by a participant designer in the Image Schema Workshop. This participant designer wished to create a design-related 'social interaction' image schema to help him develop new metaphors for the design of a PATHWAY. Research into specific image schemas applied in produced metaphors existing in design practice can encourage the adoption of image schemas in design practice.

Furthermore, since image schematic structures directly influence the metaphorical sources triggered in metaphor creation, finding creative ways to change or modify

image schematic structures can contribute significantly to *seeing* the design situations in novel ways. One research direction can be to investigate ways of inventing novel structures using basic image schema components that are combined into patterns. These patterns may in some ways be considered similar to Christopher Alexander's pattern language. The appropriate pattern language is applied to a specific domain and context to produce relevant image schemas. Another research direction is to first distil and then creatively manipulate the image schematic structures of the identified source in order to produce novel metaphors.

Further work is also needed in the gestalt structures underlying metaphors such as KINGS CROSS AS MUSICAL FESTIVAL discussed in Section 4.2 (Case Study 5). In this investigation, the notion of *experiential gestalt* is adopted following the work of Lakoff & Johnson (2003), but no further exploration was conducted into this *experiential gestalt* structure. It would be useful to find out how experiential gestalts contribute to metaphor creation and the relationship between these experiential gestalts and image schemas.

Teaching image schemas for producing metaphors in design education

Metaphors and image schemas are particularly useful for beginner designers who do not yet have their own design experience. Without design schemata and design precedents of their own, these beginner designers can tap and learn from the rich experiences of expert designers. But how do beginner designers tap on such expertise without stifling their own thought processes and original design ideas? This leads to the following four directions for further research.

a. Experimental research to understand and evaluate how image schemas support or stifle creativity in metaphor creation.
b. Fine grain research to investigate the forward and backward reasoning using image schemas and metaphors as the underlying thinking mechanisms. This recommended study builds on the present research investigation which has uncovered the broad strokes of what designers do in their creative practices. A

finer grain investigation may reveal specific techniques and innovative thinking steps of creative designers.

c. Research to study the effects of implicit versus explicit teaching of image schemas in training student designers to produce metaphors.
d. Research to develop a bank of existing image schemas that can be accessed by design students to draw on or to "jolt" their thinking for metaphor production. Items in the bank can be in scenario, dramatic structure or graphic format. The research requires the analysis of image schemas into their underlying schematic structures and their integration into design education.

In line with the above directions, the following specific design activities could be used in design lessons to develop metaphor creation skills from tapping on image schema knowledge.

a. Developing perception skills. Exercises to sharpen senses and to observe bodily experiences, to discover new senses and mental patterns. This helps to see design situations.
b. Developing discernment skills. Exercises to help designers realise how information is received and transformed, how a person moves from one thought to another. This helps designers discern the flow and to distil the structure of the design situations.
c. Learning to see design situations in multiple ways through different underlying image schemas. This will also help students overcome fixation of viewing design situations in only one particular way.
d. To bring to awareness the habitual ways of seeing, that is, to identify the prevalent image schemas used for seeing design situations. Once students can identify their habitual ways of seeing, they can then disrupt this original way of seeing and move one step closer to a new way of seeing.
e. Building storehouse of image schematic patterns through reading and physical embodied experiences. Before we can perceive patterns, there is a need to first recognise patterns. Therefore, reading books and being sensitive to bodily experiences are useful to build up a repertoire of image schematic patterns.

f. Clustering precedents by similar image schematic structures. This will help students in triggering the desired metaphorical sources once an image schema is activated.

g. Use of topological and superposition to create new schematic patterns which could contribute to the creation of new metaphors. In addition to seeing the design situations differently by a new image schema, a different image schematic structure could also be produced from creative manipulation of topological and superposition characteristics of image schemas.

These recommendations need to be tested and researched before they can be implemented in a class. Some of the above suggestions could also be adopted for creative thinking training as the principles are similar for generating novel concepts.

6.8 Concluding comments

This research attempted to uncover the core of creative practice through an investigation of what takes place inside the creative leap. To tackle this question, the project investigates the way in which designers create metaphors as a means to frame their design problems. Through the understanding of metaphors as cognitive mechanisms in design problem solving, valuable insights of the metaphor creation process are gleaned by uncovering two types of metaphor creation processes. In particular, the PI metaphor creation process and image schema illuminate the mystery underlying the creative leap. The findings led to an improved understanding of creative practice of designers and contribute to useful support development for design practice and design education.

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8 Glossary

Abduction or abductive thinking

It involves an interpretative leap that brings together disparate ideas in new combination (Zapf 2014).

Analogy

An analogy is 'a mapping between two represented situations in which common relational structure is aligned (Gentner & Bowdle 2008).It is considered as an inductive form of reasoning where there is a probability that 2 entities are similar in other aspects if they are found to be are similar in one or more aspects initially (Danesi 1999). For this project, analogy and metaphor are considered to be similar.

Comparison view

The *comparison* view is considered a special case of the *substitution* view (Black 1962, 1977). The *comparison view* of metaphor depends on the principle of an *analogy* or *similarity* to transform a literal expression(Black 1962). For example, the literal expression "Richard is brave" may be translated to the metaphorical sentence RICHARD IS A LION in which the understanding of the metaphorical sentence depends on seeking out the common feature (bravery) shared by Richard.

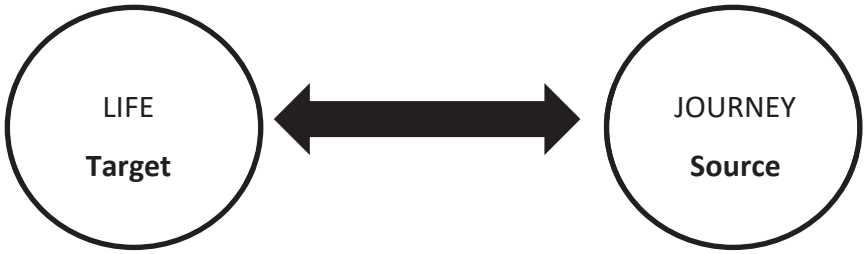
Classical metaphor theory

In classical metaphor theories, metaphor is a linguistic phenomenon, in which the link between target and source is usually based on similarities in entities or properties or analogies. There are three views of metaphors in the classical metaphor theories, namely, the *comparison*, *substitution* and *interaction* views.

Contemporary theory of metaphor/Conceptual metaphor

The contemporary theory of metaphor proposes that metaphor is pervasive in our everyday life, not only in language but also in thought and action. This means that metaphor should be understood as a property of conceptual systems and not merely as a property of language (Katz et al. 1998).

The conceptual metaphor LIFE IS A JOURNEY helps one reason about life in terms of journey. This metaphor maps some aspects of journey which is considered as the source onto life, the target so as to generate a better understanding of what life is.



Conceptualising *life* in terms of *journey* enables us to map structures of journey onto aspects of life, as indicated by Table.

Source : JOURNEY	**Target : LIFE**
Traveller	Person Leading A Life
Motion Along A Path	Leading A Life
Routes	The Means For Achieving Purposes
Destinations	Life Goals
Itinerary	Life Plan
Impediments To Travel	Difficulties Experienced In Life
Guides	Counselors
Distance Traveled	Progress
Landmarks	Things You Gauge Your Progress
Crossroads	Choices In Life
Provisions	Material Resources And Talents

Source : Kövecses (2005); Lakoff & Johnson (1999); Lakoff & Turner (1989)

Correlation

Correlation refers to recurring co-occurrences of experiences. For example, Intimacy and warmth, where intimacy and warmth are tightly correlated.

Design worlds

Design worlds are the environments that designers occupy while conducting their designs (Schön 1988).

Explicit Thinking metaphor

Explicit Thinking type metaphor is created by drawing together target and source that share similar symbolic features or structures.

Feature

Features are characteristics or properties which are generally considered as *attributes,* based on the terminology applied by most scholars (Kluge 2000; McKinney 1966)

Frame

A problem frame provides *a way of looking at the problem situation; it organises the knowledge and reconstructs it to give new meanings or realities that guide actions*(Schön 1993) while *a solution frame* is used to define potential solutions in broad strokes which leads designers to relevant knowledge or domain specific entities and processes that may be used for generating solution ideas (Duncan 2007).

Frame creation

Frame creation focuses on the ability to create new approaches to the problem situation and not on the generation of solutions.

Frame Innovation Model

Frame Innovation Model (Dorst 2015b) provides a systematic approach to frame creation in which the problem solver is guided through explicit thinking

instructions. The model identifies nine distinct but overlapping phases: Archaeology, Paradox, Context, Field, Themes, Frames, Futures, Transformation and Integration.

Framing

Framing is commonly used for the creation of a novel standpoint from which a problem situation can be tackled. This includes perceiving the situation in a certain way, adopting certain concepts to describe the situation, patterns of reasoning and problem solving that are associated with that way of seeing, leading to the possibility to act within the situation (Dorst 2010).

Gestalt

Gestalt forms are commonly associated with *visual* images obtained from embodied experiences of interaction with the physical world. Other examples of gestalts derived from perceptual experiences include a visual image of a house; an auditory image of a cry; a kinesthetic image of a punch; an olfactory image of the smell of a rose; the sensational image of being stressed (Turner 1993). In a gestalt experience, the whole is perceived first followed by its parts.

Image schema

"An image schema is a recurring, dynamic pattern of our interactions and motor programs that gives coherence to our experiences"(Johnson 1987). They are believed to be a kind of mediating level of cognitive processing that operates between perceptual images and concepts (Snyder 2000; St Amant et al. 2006).

Interactive view of metaphor

The interactive view of metaphor highlights an inter-play between target and source of the metaphor. During this juxtaposition of target and source, not only does the target domain become more like the source, it also creates similarity the other way around. In the interaction process, the target is seen through the 'filter' of the source where the source selects, hides, highlights and organises

the features of the target (Black 1962). At the same time, the source can also be seen through the filter of the target.

Logical representation

The *logical representation* of how metaphors are created is a generalised representation of how metaphors are created and not how particular metaphors are created in a specific context.

Metaphor

In classical view, metaphor is viewed as a manifestation of *analogy* (Danesi 1999). On the other hand, metaphor is also considered as a primary mental tool which humans use for creating analogies and thinking about otherwise unknowable things. Metaphor is a unique ability of human mind to connect ideas (Danesi 1993).

Perceptual Intuition metaphor

Perceptual Intuition metaphor is created using the gestalt structure of design situations.

Propositional symbolic form

A propositional symbolic form or concept is a general idea or understanding of something in everyday life. The traditional view of rational thought is based on mental representations using disembodied symbolic forms. Propositional symbols are arbitrary and meaningless by themselves. These symbols get their meanings from their relation to things, properties and relations which exist objectively in the world (Johnson 1987).

Representation form

Representation form reveals different aspects of the information contained in the dataset (Rogers & Earnshaw 1991).

Resemblance

In resemblance based metaphor ACHILLES IS A LION, it is the perceived resemblance of courage and ferocity that lead to the association between Achilles and a lion.

Structure

Structures are patterns or gestalt structures that recur in our sensory and motor experiences, perceptual interactions or cognitive operations.

Substitution view

Substitution view considers metaphor to be a literal statement that has been "transformed" such that understanding a metaphor is like deciphering a code (Mitchell 2013). For example, the substitution metaphor MAN IS A PUPPET can be reduced to the literal expression of 'man is without free will' (Kjärgaard 1986).

Topology

The term *topology* originates from geometry. It may be referred as spaces divided into areas that do not consider the actual dimensions, shape or material (Oakley 2009). For this project, image schemas are topological in that they can be patterns of various shapes and sizes (Brower 2008) such as PATHs, CONTAINERs etc.

Typology

Typology is the study and classification of types and is often used to reduce complexity through identification of similarities and differences in a variety of types, characterisation of types and detecting patterns (Bailey 1994; Buddemeier et al. 2008; Maru, Langridge & Lin 2011).

9 Appendices

9A. Research data of metaphor creation

A. Literature

		Metaphor
A1	**Schön's paintbrush innovation**	**A PAINTBRUSH AS A PUMP**
A2	**Architectural Design Student's project**	**200m PATHWAY AS BEETHOVEN's 9 SYMPHONY**
A3	**VIP Product innovation**	**A CAPSULE WORK STATION AS THE EYE IN THE STORM**

B. Retrospective Cases

		Metaphor
B1.	**Law and Order**	**KINGS CROSS AS MUSICAL FESTIVAL**
B2.	**Sydney Opera House**	**PROTECTING THE "SAILS" AT SYDNEY OPERA HOUSE AS SPIRITUAL UPLIFT**

Cases in bold are the ones selected for investigation.

C. Empirical Observation

C1. Passive observer

Improving the Justice System: Crime Prevention Workshop (24 June 2014)

The Justice System for victims of crime workshop aimed to develop clear and deliverable changes to the criminal justice system. By putting the victim at the centre of the justice system and mapping their experience, the workshop aimed to create optimal user journeys for victims of a number of crime types. 2 workshops were conducted on 24 and 26 June 2014.

	Metaphor	Type of observation
C1	SUPPORT FOR VICTIMS OF CRIME ASGOOD LIVES PROGRAM	Passive observation
C2	SUPPORT FOR VICTIMS OF CRIME AS THE BANK & SUPER FUND	Passive observation
C3	SUPPORT FOR VICTIMS OF CRIME AS LEARNING A NEW LANGUAGE	Passive observation
C4	SUPPORT FOR VICTIMS OF CRIME AS MARTIAL ARTS	Passive observation
C5	SUPPORT FOR VICTIMS OF CRIME AS BACKYARD BBQ	Passive observation
C6	SUPPORT FOR VICTIMS OF CRIME AS RATING SYSTEM	Passive observation
C7	SUPPORT FOR VICTIMS OF CRIME AS TRANSPORT SYSTEM	Passive observation

Improving the Justice System: Crime Prevention Workshop (26 June 2014)

	Metaphor	Type of observation
C8	SUPPORT FOR VICTIMS OF CRIME AS MUSIC	Passive observation
C9	SUPPORT FOR VICTIMS OF CRIME AS COOKING DINNER	Passive observation
C10	SUPPORT FOR VICTIMS OF CRIME AS LEARNING A NEW LANGUAGE	Passive observation

C11	**SUPPORT FOR VICTIMS OF CRIME AS POSITIVE PARENTING PROGRAM (PPP)- Selected** SUPPORT FOR VICTIMS OF CRIME AS GIRL SCOUTS	Passive observation
C12	**SUPPORT FOR VICTIMS OF CRIME AS AMBULANCE SERVICE - Selected**	Passive observation
C13	SUPPORT FOR VICTIMS OF CRIME AS MARDI GAS SUPPORT FOR VICTIMS OF CRIME AS MENTOR	Passive observation

TAFE (April 2014)

TAFE NSW commissioned the UTS Design Innovation research centre to deliver an introduction to Frame Creation. The aim of this workshop was to raise awareness of the Frame Creation method within the Strategy and Policy unit, while at the same time interrogating a problem faced by that unit.

	Metaphor	Type of observation
C14	BIRTH/REBIRTH PHOENIX	Passive observation
C15	GUILD THE BIG BAND	Passive observation
C16	CAN TOO	Passive observation

MUTUAL OBLIGATION		
	Metaphor	Type of observation
C17	**SOCIAL HOUSING AS SCAFFOLDED EDUCATION**	**Passive observation**

C2. Participant Observation

Healthcare <Practice Workshop> 29 Sep2014		
	Metaphor	Type of observation
C18	HEALTHCARE AS SCHOOL OF FISH	Participant observation
C19	HEALTHCARE AS NURSERY	Participant observation

Service Station <Project DOC13006>		
	Metaphor	Type of observation
C20	SERVICE STATION AS MARSHALL	Participant observation
C21	SERVICE STATION AS RELATIONSHIP	Participant observation
C22	SERVICE STATION AS "CUSTOMER – CUSTOMER COMMUNICATION"	Participant observation
C23	SERVICE STATION AS "HOTEL LOBBY"	Participant observation

Frame Creation Model Training Workshop – WATERLOO SOCIAL HOUSING		
	Metaphor	Type of observation
C24	**WATERLOO HOUSING AS REBIRTH**	**Participant observation**

BCII Prep Workshop		
	Metaphor	Type of observation
C25	**KINGS CROSS AS JEKYLL AND HYDE**	**Participant observation**

9B. Image Schema Workshop

B1.0 Workshop design

The goal of the workshop is to find out if designers can apply image schemas in their design practices after learning about them in this workshop. The 2-hour workshop is conducted at the UTS Design and Innovation Research Centre on 27 April 2017 with four designers.

B1.1 Participants

Four participants are invited to the workshop on the basis of their practice-based design expertise and their familiarity with the frame creation process:

a. Mr W: Has more than 15 years of professional design experience in product development of industrial and consumer goods. He possesses in-depth experience in the development of Child Restraint System and medical devices.
b. Mr B: Master of Industrial Design with more than 15 years of experience. His design research interests focuses around the application of emerging and traditional methods in the development of new approaches to complex form making within the context of small batch production in Australia
c. Mr D: Master in Design with more than 50 years of experience in a range of design expertise that includes product design, consumer products, design for the environment, industrial design, design and crime, product innovation, design and the law, ergonomics, invention, development of new products, design education and industrial design.
d. Mr T: Bachelor of Industrial Design with more than 10 years of design experience. He is interested in design for positive social outcome and has worked on a range of international projects to raise awareness of social design in Australia.

B1.2 Format

The workshop is conducted over 2 hours and comprises two parts. The first part is a sharing of the concept of image schema, using Schön's A PAINTBRUSH AS A PUMP case study. The second part is a workshop exercise and group interview. The complete sequence of the workshop is shown in Table B1. I facilitate the workshop and chair the discussions. The workshop is documented using both audio and video recorder. After the workshop, the recordings are transcribed and analysed.

Table B1. Sequence of workshop activities

Time	Activities	Duration
14:00	Overview of workshop session. Pose 2 opening questions: Q1. Do you use metaphors in your work? Q2. Can you share some of them?	10 minutes
Part 1 Explain image schema and illustrate using Paintbrush case study		
14:10	Explain concept of image schema	15 minutes
14:25	Illustrate the use of image schemas in the PAINTBRUSH AS PUMP case study	15 minutes
Part 2 Workshop Exercise and Group Interview		
14:40	Go through the four case studies for the workshop	50 minutes
	Questions Q1. What underlying image schema(s) do designers use to develop the metaphor in this case study? Q2. Can you come up with one or more new metaphors for this design problem (e.g. 200m PATHWAY)? Q3. Can you identify the underlying image schema for the metaphor that you have just have created? Q4. Can you think of other image schemas for the design problem (e.g. 200m PATHWAY)?	
15:30	**Group Interview**	30 minutes

	Q1. After gaining an understanding of image schemas in this workshop, do you see yourself applying them in your design practice? Q2. If yes, how would you use it? If no, why not? Q3. Can you share some of the underlying image schemas in the metaphors you created in your previous projects? Q4. Any comments or questions about the use of image schemas in metaphor creation?	
16:00	End of session	

B1.3 Materials provided in the workshop

Power-point slides are used for sharing what image schemas are and how image schemas contribute to the creation of metaphors. In addition to the power-point slides, Table B2 which is a compilation of commonly used image schemas is provided to aid designers in creating metaphors during the workshop.

Table B2. Commonly used image schemas grouped by similarity

Group	Image Schemas
BASIC SCHEMAS	SUBSTANCE, OBJECT
SPACE	UP-DOWN, LEFT-RIGHT, NEAR-FAR, FRONT-BACK, CENTER-PERIPHERY, STRAIGHT-CURVED, CONTACT, PATH, SCALE, LOCATION
CONTAINMENT	CONTAINER, IN-OUT, CONTENT, FULL-EMPTY, SURFACE
IDENTITY	FACE, MATCHING
MULTIPLICITY	MERGING, COLLECTION, SPLITTING, PART-WHOLE, COUNT-MASS, LINKAGE
PROCESS	SUPERIMPOSITIONS, ITERATION, CYCLE
FORCE	DIVERSION, COUNTERFORCE, RESTRAINT REMOVAL, RESISTANCE, ATTRACTION, COMPULSION. BLOCKAGE, BALANCE, MOMENTUM, ENABLEMENT
ATTRIBUTE	HEAVY-LIGHT, DARK-BRIGHT, BIG-SMALL, WARM-COLD, STRONG-WEAK

Source: Hurtienne & Blessing (2007)

B2.0 Questions to address

Two sets of questions are used to lead the discussions. The first set pertains to a workshop exercise on the 200m PATHWAY design problem; the second set is used in the group interview to find out whether the four designers intend to apply their understanding of image schemas in their design practices and how they would do it.

B2.1 Workshop exercise: 200m PATHWAY Design problem

Participants are presented with the 200m PATHWAY AS BEETHOVEN's 9th SYMPHONY case study taken from one of the ten cases in the single case analysis and summarised in Section 4.2. The following information is shared with participants in preparation for the exercise:

a. Design brief

b. Information that led to the creation of the 200m PATHWAY AS BEETHOVEN's 9th SYMPHONY metaphor.

c. New design ideas and solutions generated using the 200m PATHWAY AS BEETHOVEN's 9th SYMPHONY metaphor.

After going through the brief for the case study, the four designers are led to answer the following four questions.

Questions for workshop exercise

Q1. What underlying image schema(s) do designers use to develop the metaphor in the case study?
Q2. Can you come up with 1 or more new metaphors for this design problem?
Q3. Can you identify the underlying image schema for the metaphor that you have just created?
Q4. Can you think of other image schemas for the design problem?

Participants are given about ten minutes to think through the questions by themselves and each of them are then given time to share their responses. Time is also allocated for participants to raise questions and any further discussions.

B2.1.1 What underlying image schema(s) do designers use to develop the metaphor in this case study?

All participants answer this question very easily. They identify the following underlying image schemas from the metaphor created:

a. PATH
b. LINK
c. ENABLEMENT
d. MERGING
e. MOVEMENT and LOCOMOTION
f. FLOW
g. FAST/SLOW

B2.1.2 Can you come up with one or more new metaphors for this design problem?

B2.1.3 Can you identify the underlying image schema for the metaphor that you have just have created?

B2.1.4 Can you think of other image schemas for the design problem?

It is originally intended for the participants to answer the remaining three questions separately (B2.1.2 to B2.1.4). As we cannot help but think in an associative way, the participants lump their three answers together during the workshop. Therefore, the answers to the three questions will be described together in the following.

During the sharing of their answers, most designers started with the metaphors they have developed followed by the underlying image schemas. It is clear from the responses offered that they can identify the underlying image schemas existing in

metaphors. In addition, they are all able to generate metaphors fluently based on pre-assigned image schemas or image schemas determined by them.

For instance, Mr W generated 4 different metaphors for the 200m PATHWAY in this exercise. In applying the FORCE/PROPULSION, MULTIPLICITY and LOCOMOTION image schemas, Mr W generated the HYPERLOOP, LEAF/BRANCH and PERISTALTIC-INTESTINE metaphors respectively. In using the attributes of hard/soft, Mr W developed the PAVEMENT/FOREST metaphor. Figure B1 shows the answers Mr W generated in response to the questions in workshop.

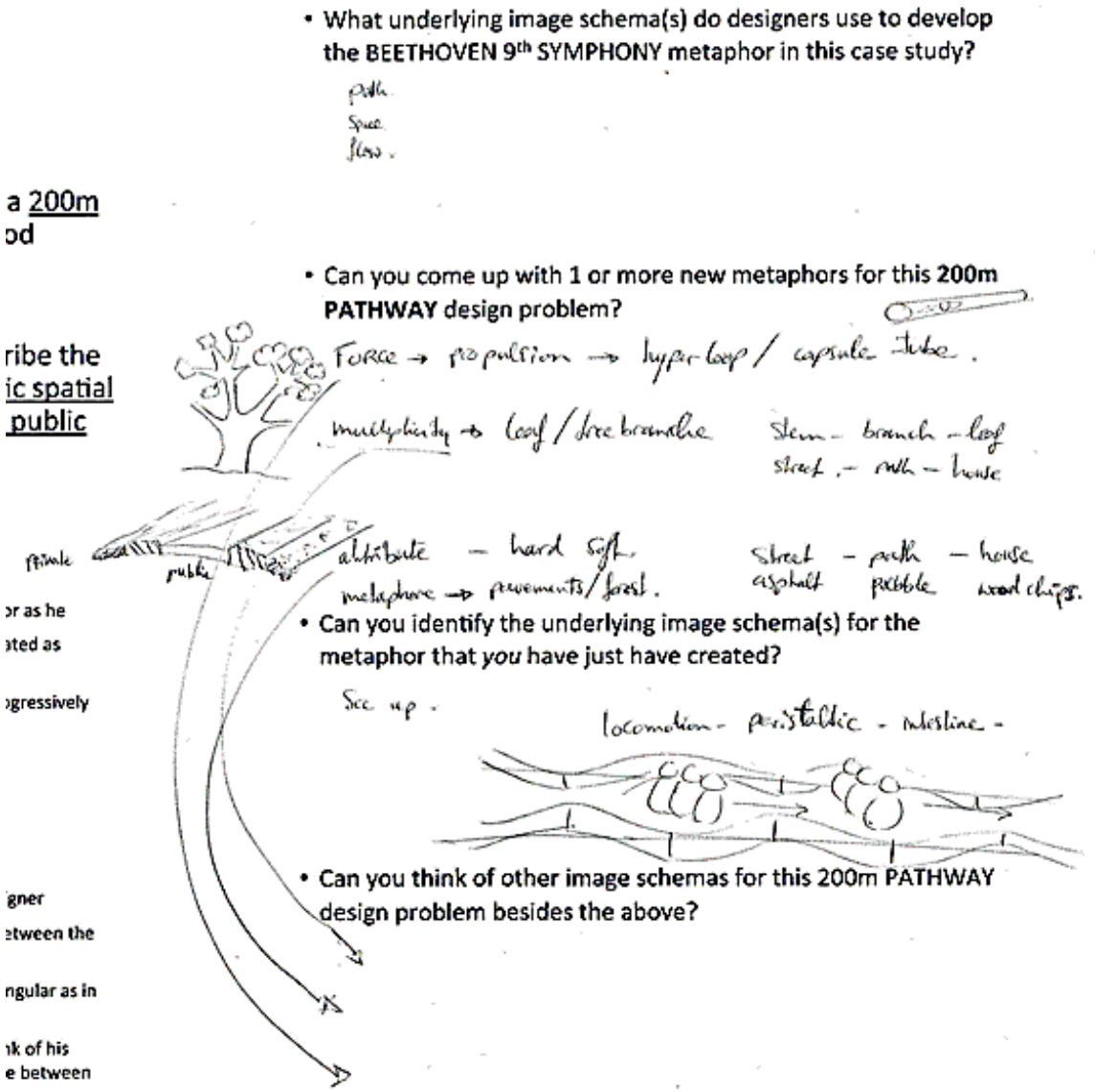


Figure B1. Worksheet responses by Mr W

Similarly, the rest of the participant designers generated metaphors and corresponding image schemas very fluently in the workshop. Table B3 is a compilation of all the answers provided by the designers. It clearly shows that all of them can identify underlying image schemas present in a metaphor, create a metaphor based on a given image schema or self-determined image schema. What is unclear is the sequence in which this design process is accomplished. It is not possible to determine from the results obtained whether the designers created the metaphor first and then derived the underlying image schema from it, or whether the image schema is first determined then used to help them create the metaphor. Additional research is needed to verify which comes first.

Table B3. Metaphors and underlying image schemas generated by designers

Image Schema	Metaphor
PATH	RAILROAD
CONTAINER	HOLIDAY
"SOCIAL INTERACTION"	PIAZZA DESERTED BEACH MARKET PLACE
FORCE	HYPER-LOOP or CAPSULE TUBE
MULTIPLICITY	TREE WITH BRANCHES
HARD/SOFT	The middle of the PATH will be hard concrete while the side nearer the house will be softer.
PATH/FLOW/CONTAINER	INTESTINES with PERISTALIC MOVEMENT
CONTAINER	VISITING
TENSION	PUBLIC/PRIVATE SPACE
HIGH/LOW	STADIUM
PATH	MENU
PATH	FLOWER ARRANGEMENT

B2.2 Group interview

After completing the workshop exercises using the four questions in Section B2.1, the following four questions are used to find out if designers would apply image schemas in their future design practice and how they plan to do so.

Questions for group interview

Q1. After gaining an understanding of image schemas in this workshop, do you see yourself applying them in your design practice?

Q2. If yes, how would you use it? If no, why not?

Q3. Can you share some of the underlying image schemas in the metaphors you created in your previous projects?

Q4. Any comments or questions about the use of image schemas in metaphor creation?

B2.2.1 After gaining an understanding of image schemas in this workshop, do you see yourself applying them in your design practice?

The four designers unanimously respond that they are "already applying" image schemas in their design practices tacitly and the workshop has made them aware of the concept of image schemas and how they operate.

B2.2.2 If yes, how would you use it? If no, why not?

The following are some ways in which the participant designers plan to apply image schemas in their work:

a. Design cognition

- Trigger for metaphors.
- "First principles" of design just like engineering where there are first principles which engineers often go back to.

- Tool to support abstract thinking when embarking on something new.
- Tool to get out of a stuck situation. The stuck situation can be due to a path of thinking that cannot proceed further or due to confusion encountered in a team situation.
    - Image schemas can help clarify the path of thinking or propose a new line of thinking. For instance, after exhausting ideas using FORCE image schema, the more experienced designer can propose for team members another image schema, such as FLOW. This new image schema can set team members off in a new direction of thinking.
    - Image schemas can also help clarify whether a stuck condition is due to disparate paths of thinking among different team members.

b. Design training and practice
    - Incorporation of image schemas into design curriculum to be formally taught to student designers so that beginner designers can apply them automatically in their design process.
    - Practice tool by designers for developing skills in generating metaphors.

c. Design selection
    - Selection tool to choose between design options or opposing design ideas.
    - Structure or tool when contemplating alternative metaphors.

d. Design direction
    - Prompt to set designers off in a particular direction
    - Teaching tool to help students get started on their project, such as 20-minute classroom design exercises using a specific assigned image schema.

e. Other general use

- One of the designers envisages that he can use image schemas to better articulate his project in a post situation so as to provide a rationale for the project and also to reflect on decisions made and where everything come from.
- Sharing the story of the design project, because “telling a simple story is important” as it is often not useful to relate the “whole journey” of the project.
- Lens to look at existing products.

B2.2.3 Can you share some of the underlying image schemas in the metaphors you created in your previous projects?

Mr W shares that his project team generated a GPS system metaphor for which he can easily identify the underlying PATH image schema. He also mentions the use of NAVY SEAL and STAR TREK metaphors, for which he recognises the use of relationships, but cannot find an existing image schema that is immediately applicable. The discussion leads to the need to create a list of image schemas for design applications.

Any comments or questions about use of image schemas in metaphor creation?

Two questions are raised by participants:

a. Is there a better name for image schema for use in design practice?

b. What are the differences between image schemas and mental models?

The group discuss the matter, but is unable to arrive at any conclusion.

B3.0 Observations

In addition to answering the original set of questions in this workshop, I observe several participant behaviours which contribute to a deeper understanding of how image schemas can be applied in design practice.

How designers change their way of seeing using image schemas

I observe that designers use a variety of means to change how they view the problem situation. Designers can change how they see by being very *intentional* in changing the original image schema used. For instance, by changing from PATH to a FORCE/PROPULSION image schema, as described in B2.1.4, Mr W is able to generate a new HYPERLOOP metaphor. Other designers, such as Mr D, are more subtle in their approach. Mr D tries to get away from the PATH image schema by thinking of the pathway as FLOWER ARRANGEMENT. Instead of applying a totally different image schema, Mr D makes a less drastic shift and "tries to find ways to make it more exciting".

How participants intend to apply image schemas in their design practice

One of the ways Mr W proposes is to practise selecting the appropriate image schema for a given design situation. By this, he means coming up with an image schema that can actually help identify a more favourable direction even though it may have its own negative effects.

Some designers intentionally seek the "bookends or tension" present in the design problem so as to "stretch" their thinking. Feature based image schemas can be used to come up with these bookends. For instance, one of the designers uses the high/low feature based image schema to think about tension between public and private spaces.

While the natural inclination of some designers in the workshop is to use image schemas in an intentional way to develop metaphors and design ideas, others who are more reflective and contemplative, have other ways of using image schemas. Mr B who relies on reflection, contemplation and serendipity to guide his design, considers the use of image schemas to articulate his projects in a "post situation". He believes this provides a stronger foundation not only to his projects, but also to reflect on his decision making process so that he becomes more aware of where his ideas come from. He considers his use as a "slightly backwards" way.

Insight on the use of metaphor to convey image schematic structure

Mr W comes to the valuable insight that some designers resort to metaphors to convey the image schematic *structure*, as they do not yet possess the necessary image schema knowledge. For instance, instead of using the FLOW or PATH image schemas, knowledge which most designers do not yet possess, designers convey it as pouring of coffee or water into a cup. In his opinion, this can lead to misunderstanding that often result in fiery design discussions as the intended FLOW structure ended up as the concrete form of pouring of coffee or water.

Creating a particular set of image schemas for design use

During the workshop discussion, two designers find the list of image schemas in Table B2 lacks elements they require for their design purpose. Mr B cannot find an appropriate image schema to represent *social interaction* while Mr W notes that *relation* is not presently in the list. There is a need to explore and create a list of image schemas for design use. The list is likely to be based on a combination of basic image schemas such as CONTAINERS, FLOW, PATH, etc.