Using Image Schemas for Supporting the Development of the Metaphors in Product Design

by

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Abstract

Metaphor is a powerful device, especially when it is realized the conceptual metaphor is at the core of human's cognitions. Design is a domain filled with creativity and communication, which could use metaphor in many ways. Metaphors employed in the products would be one of them, for examples, to reduce required cognitive loads for the product use; to ascribe or emphasize qualities to or of the product. The image schema, as one of main notions of the conceptual metaphor, is implied to be a good foundation for design approaches regarding the employment and the development of the metaphors and the products to be more practical. After reviewing and analyzing the structure and the framework of designing a product with employed metaphor, two parts of where the image schema can join product development are spotted, which are: the searching for potential entities to be employed to the product in order to establish the metaphor, and, how two entities (the product and the discrete entity going to be employed) are going to be fused in order to reasonably be one artifact. A process is proposed for the development of metaphors in product design, with tools regarding image schemas and others.

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Now, a milestone is about to be hit. Looking forward to tomorrow morning for myself. And, thanks, my audience, as if you just got interested.

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Chapter 1 Introduction

1.1 Problem Statement

Metaphor has been recognized and talked about for a very long time. In terms of Western literary and linguistic traditions, Aristotle "is generally regarded as the first thinker to elaborate a theory of metaphor" (Punter, 2007, p. 11). In the east, there are massive examples of metaphors in ancient texts. As technology and culture develops, there are more and more opportunities to design multi-media communication or novel artifacts. Thus, the potential hidden carriers of metaphors have become more important. Metaphors employed in product design is one such case.

There are many benefits to employing metaphors in products. They can help with communicating a conceptual model. They can also help with triggering rich experiences. For example, "for designers, visual metaphors are important in making new technology comprehensible" (Krippendorff, 2006, p. 95). And as for rich experiences, it is not so hard to imagine that a real-world design project aiming at attractiveness or novelty would produce an artifact with the appearance of a discrete entity, e.g. an animal, a plant and more. Not just the attractive appearance, but interactions can also be interesting if a metaphor is aptly employed.

Unfortunately, the lack of highly practical methodologies and design tools is a problem. Some studies are guidelines that are too general. Some are empirical studies focusing on existing design practices, without strong support from core theories about metaphors, which could cause struggles with the significant scope, diversity and complicatedness of metaphor and its characteristics. There still is gap between them and practicality. Generally, they are not deep enough and fail to really solve the vagueness of generating metaphors for products.

Metaphors are much more important than merely a figure of speech (or rhetorical device). They actually root a human's conceptual system fundamentally and are pervasive in everyday language and thought rather than just rhetorical device (Lakoff & Johnson, 1980). Some further theories are proposed that make the underlying mechanisms a bit clearer. However, the theoretical foundation is not sufficiently studied and applied in the domain of product design. The studies are especially lacking when taking advantage of these mechanisms of conceptual metaphors. There is one recent vein of research claiming to be "one of the first attempts to systematically include metaphor generation as a research subject in the product design domain" (Cila, 2013, p. 66). Even this rare systematic research does not touch the core mechanisms enough. Besides, it has limitations on some type of design projects or metaphors (e.g. functionality) and on specific design phases (e.g. form giving), which demands further research. In sum, the lack of practical methodologies and design tools in some aspects could hold designers back from effectively employing quality metaphors in products.

1.2 Need for Study

The theory of conceptual metaphors says the metaphor is about understanding one thing in terms of another, and especially for abstract concepts, humans understand them through concepts from the concrete world (Lakoff & Johnson, 1980). Image schemas are the structures enabling metaphorical understandings (M. Johnson, 2013). To date, image schemas as part of core mechanisms have not been well utilized for developing metaphors in product design, which promisingly can make the design process of developing metaphors for products more practical.

Though the image schema has potential, it may not be a magic bullet covering all aspects or purposes of metaphors employed in products. The characteristics and effects of metaphors are so diverse. There are different angles for generating metaphors. So, studies are needed to clarify

the relations between different angles and what parts image schemas can competently play. Then, a practical approach is expected so that image schema actually can contribute to the practicality.

1.3 Objectives of Study

The fundamental goal of this thesis/research is to make the development of product metaphors a bit more practical. Specifically, objectives are: first, to study and organize the different angles for and the approaches to developing metaphors; then, to derive a roadmap for designers to practice mainly from case studies; at the same time, to spot some missing but essential parts of design tools according to this organization, and construct them. There are some objectives below:

- to study why metaphor is an important subject for product design;
- to study the reasons and factors for developing metaphors employed in products;
- to link metaphor effects to design theories;
- to understand conceptual metaphors and image schemas;
- to understand image-schema-related design approaches, even though some are not for physical product and some do not end up with clear metaphor, along with which other approaches are going to be understood;
- to study cases of successful or unsuccessful metaphors employed in products;
- to demonstrate the process and tools through design projects.

1.4 Definition of Terms

The base shape of a product. The base shape contains only the most essential components that relate directly to how a user completes the task(s), like the primary components that comprise a functioning prototype. Nothing but the obvious tasks would be associated with it easily. It is more a conceptual shape but less a concrete and literal shape. A change of this shape

could mean a change of product category/type. To add values, which evoke noticeable mental activities that are not so necessary to the tasks, makes the product going beyond the base shape. (first used in 2.3)

The *figure* (of the source) means the image or impressions (of the source entity), from which an entity can be recognized. This is not limited to visual clues.

Form-giving as a design activity is not just visual aspects regarded in this thesis, since metaphors can be embodied across different modalities of sensory clues.

Generation process for metaphors (if not specified to be for verbal metaphors). Along the thesis several concepts are mentioned: metaphor development, developing metaphor in product design, the development of the metaphors in product design, generating metaphors for products, product metaphor generation, design metaphors for products and etc. They refer to the same process, which is the development of the metaphors in product design.

Imagery mapping refers to an activity: when associating two entities in the image metaphor, we map features between two entities by following image schemas.

Metaphors employed in products. Along the thesis several types of metaphors are mentioned: metaphors employed in products, product metaphors, metaphors manifested or embodied in products. They refer to the same subject, which is the product with a clear image of another entity outside of the product which can help users draw inferences.

Physical fusion is an absent step in verbal metaphor, but necessary for metaphors to be employed in products. The figure of source and the target are blended together in order to get a product solution.

The *source*, the source domain and the source entity have the same meaning and are used alternatively to each other. The same applies to the *target*. Source-target model is one way to describe the structure of a metaphor.

1.5 Assumptions

Assumptions are made for this thesis that:

- Readers of and who apply the thesis have basic understandings of product design;
- Designers are able to realize the power of metaphors;
- It is possible to establish practical design tools for developing metaphors, in other words, metaphors are developable (or, designable);
- Enough major systematic approaches have been seen, and current in-topic research depth can be represented by them;
- For many details of research and in-process actions not specified or left out, readers have the ability to fill them in; and,
- As for case studies with no information of actual design process, the product successfully meets the designer's main expectations, so that we can trace back initial intentions and objectives according to what we see from the product.

1.6 Scope and Limits

Scope:

- This research focuses on roles of individual users, products and designers but does not consider factors like manufacturing or other stakeholders.
- This thesis is within the scope of an everyday use product, but not for professional products that require great expertise or strictly accurate and specialized knowledge.

- Though some virtual products are involved, this thesis is mainly for physical products. And though metaphors can also be effective in an abstract way, this thesis focuses on products with clear image of a discrete entity outside of the product
- In reviewed approaches for generating metaphors, there could exist all kinds of inadequateness, and this thesis mainly is concerned with image-schema-related ones.

Limitations:

- As studies from other researchers about recognition, product design and more advance from time to time, this thesis possibly needs revision, further research or even substantial reformulation.
- The case studies in this thesis rely much on the writer's understanding, so that they can be more feasible as this research is more of an initial start. Experimental studies are welcomed but are beyond the amount of content this thesis can cover.
- The demonstration is not a full product design project but ends at a stage that all major decisions about the development of the metaphor are already effectively demonstrated. The demonstration is a simulated project.

1.7 Procedures and Methods

Step 1. To investigate the basics of the metaphor in general and in regard to product design; and to link design theories to some main effects brought by metaphor. Literature about linguistics, general design thinking and theories, and specifically "product metaphor" are reviewed.

Step 2. To understand mechanisms of conceptual metaphor and address how image schemas can contribute to the practicality of employing metaphors in design. More linguistic literature is reviewed, specifically about conceptual metaphor and image schemas.

Step 3. To review approaches to metaphor development, and approaches related to underlying mechanisms of conceptual metaphor or image schemas. These approaches are from design literature.

Step 4. To propose a framework based on the review, through which different angles of approach can be compared. The part played by image schemas in the metaphor development can be addressed with the help of the framework.

Step 5. To conduct case studies for testing the proposed framework, and for acquiring materials used for constructing a general process of metaphor development, tools regarding image schemas.

Step 6. To derive a practical process from materials of case studies and reviewed literature; to construct practical design tools regarding image schemas; and then to apply them to projects in order to demonstrate their validity (or non-validity).

1.8 Anticipated Outcomes

A *framework*. The framework can help designers with the comparison of different approaches and route them into different design paths according to their purpose of design projects. Further research and novel approaches could be put into the framework and compared together with old ones.

A *process* and some specific design *tools* regarding image schemas used in the process. In order to fulfill the problem addressed, i.e. the practicality of current approaches, the process and tools are expected.

Chapter 2 Literature Review

2.1 Overview

In this chapter, some design and cognitive linguistic literature is reviewed, as well as some approaches to the development of metaphor, or approaches related to underlying mechanisms of conceptual metaphor or image schemas.

At the end, a framework is proposed based on the review, through which different angles of approach are compared, and the parts played by image schemas are addressed.

2.2 A Brief Introduction to Metaphors in General and in Product Design

Metaphor has long been used in poetic or rhetorical expressions. It also brings benefits to a wide range of creative activities other than those expressions. Design is one of these creative activities, and there are many different ways in which design could benefit from metaphors. Products having metaphors embodied in them is one of those ways.

2.2.1 Metaphor in Literature

Traditionally, the metaphor is understood as a technique of rhetoric which creates tensions in expressions. The word *metaphor* comes from a combination of Greek *meta* and *pherein* (Online Etymology Dictionary, 2019), which means “over/across” and “to bear/carry” respectively, and together it means “a transfer”.

A metaphor was considered to have two parts: tenor and vehicle (Richards, 1976), or source domain and target domain (Lakoff & Johnson, 1980). In *Oxford English Dictionary*, metaphor is defined as a figure of speech, “in which a name or descriptive word or phrase is transferred to an object or action different from, but analogous to, that to which it is literally applicable” (“Metaphor, n.,” n.d.). In a metaphoric expression, one term is borrowed from a distinct linguistic category, in order to describe another that currently is talked about. The tenor is

the borrowed one and the vehicle is the one being talked about. Human, animal and physical objects are some of major tenor categories (Madsen, 1994).

2.2.2 Metaphor in Creative Activities

Metaphors are employed in many fields, including creative activities. They have been investigated in many areas broadly, such as art, architecture, cartoons, advertising, even mathematics etc. (Hekkert & Cila, 2015). As metaphors can offer novel views and experiences, product design is one such area that can take advantage of them. Metaphors could be applied in a great range of phases in the design process. As summarized by Hekkert and Cila (2015), it can help designers with framing problems, breaking out from problem constraints, making better judgments on decisions, coordinating with user's understandings, etc. Metaphors implemented in final products are also key manifestations. One major reason is that metaphors can help users in interpreting abstract concepts from the tangible properties of a product (Hekkert, 2006).

2.2.3 Roles of Metaphor in Design Practices

Torgny (1997), Saffer (2005), Hey and Agogino (2007), and Hekkert and Cila (2015) mention several roles that the metaphor plays in design activities.

Framing the problem. Metaphors can partially or holistically bring a novel perspective to the design team. As an example, a slum can be viewed as an area needing to be cured, or, it can be viewed as a place with originality and naturality such that proper preservation is a better way to handle it (Schön, 1993). In addition, designers can get lost when judging if an objective is proper or not for the whole structure of a design and the ecology of it. A metaphor can assist designers in understanding the value of an objective by mapping users' understandings, activities and reactions to the design (Hey, Linsey, Agogino, & Wood, 2008). In this way, designers might feel it is easier when making decisions and judgments. For instance, a cafeteria can be

considered as an oasis in the city by consumers. It provides not only the sense of values but also guidance of what the cafeteria could be like and what meaning it could convey.

Research tool. When researching, difficulties are often found as designers confront subjects that they don't know much about. Creative activities include many new concepts and unfamiliar objects. Without new or unfamiliar inputs in design activities, it is unlikely that creativity can thrive. People can learn through metaphors, which assists designers in understanding unfamiliar inputs.

Communication tool. Communication is the most conventional arena for metaphors. Designers will face unfamiliar knowledge when researching, as well as communicating with team members and interviewees. Today, collaboration plays an increasingly important part in design practices, especially within interdisciplinary collaborations. Developing common visions within a team on issues and where the project leads is important. Given the negative effects of jargon, lingo, and etc., the communication of detailed ideas and knowledge deserves attention as well. By taking advantage of metaphors, ideas can disperse to others more easily.

Naming concepts. During the design process, actions or concepts are named by using metaphors. For instance, "Code is 'tested' to find 'bugs'" (Saffer, 2005). This function of metaphor is common and enables our ability to name intangible concepts after physical things. By comparing rather than simply naming something with random symbols, metaphors are meaningful and can provide conceptual systems for the target domain, through applying a series of related concepts together.

Inspiring designers. A Pump and Brush example (Schön, 1993) was given. In this example, a design project was conducted for improving the performance of a paintbrush made of synthetic bristles. During the design process, designers (researchers) observed and explored

differences between traditional natural bristles and synthetic bristle. Then the expression, “a paintbrush is a kind of pump”, came up. After that, a set of concepts as vocabulary from the domain of a pump, e.g. capillary actions, were brought to this brush project, for designers to perceive and understand the brush from a radically different perspective (Krippendorff, 2006). Design-by-analogy is a subject that has the same power. Some theories work to unify (or partially unify) metaphor into analogy, because metaphor and analogy have a similar or even the same performance in many situations and share overlapped cognitive mechanisms.

Metaphors for design itself. There are also metaphors that actually describe the design. Benefiting from this, designers can understand the design process in new or better ways. For example, the design process can be seen as an information-processing system, with inputs and outputs. The design process can also be seen as a risk-control-and-managing mechanism, from which designers can have an inference that the improvement of usability will reduce the risk of the system (Eppinger & Ulrich, 2015). Problem-solving and problem-setting (Lanzara, 1983) are some other perspectives to understand the design process. These are all metaphors helping designers to understand design.

Branding. Using metaphors in advertisements can influence how customers perceive the brand. Apt metaphors and their apt use allow customers associate attributes that are positive for the brand.

Metaphors embodied in products. Metaphors can be integrated tangibly into products for different types of intentions. From an empirical point of view, there are five reasons to use metaphors this way and particularly two categories, which are pragmatic intentions (“Identification” “Use and operation”) and expressive intentions (“Prose and poetry” “Ideology” “Fun and wit”) (Hekkert & Cila, 2015, pp. 200–203). Metaphors integrated into products for

pragmatic intensions help users in relaxing from cognitive workloads when comprehending functional aspects of a product, whereas the experiential intention commonly involves emotional experiences (Hekkert & Cila, 2015). There will be detailed discussion about metaphor integrated into products in the next section.

Metaphors can emerge in many stages or tasks in design process. This thesis focuses on the last one mentioned - metaphors embodied in products.

2.2.4 Product Metaphor (Metaphors Embodied in Products)

The Definition

In one recent vein of research (Hekkert & Cila, 2015), the product metaphor was given a definition as such: "any kind of product whose design intentionally references the physical properties (e.g., form, sound, movement, smell, and so on) of another entity for specific, expressive purposes" (p. 199) It explains that the entity being referenced is the carrier of functional, social, psychological, and cultural meanings, and then, through the mechanism of metaphors, those meanings can be expressed and communicated, which fulfills specific, expressive design purposes. This definition follows the definition of *conceptual metaphor*: "The essence of metaphor is understanding and experiencing one kind of thing in terms of another" (Lakoff & Johnson, 1980, p. 5). This notion (i.e. conceptual metaphor) approaches the metaphors' underlying mechanism in a deeper way than merely recognizing metaphor as a rhetorical device, which is a more general understanding of metaphor than conventionally. The research by Hekkert and Cila follows this notion, which refreshes how designers could approach product metaphor. Conceptual metaphor will be talked about in later sections. Right now, we shall still be looking at the background knowledge about metaphors embodied in products.

This definition stands from the perspective of designers, which could restrain the participance of user's views while designing. In the notion of the essence of metaphor addressed by Lakoff, using words like "experiencing" and "understanding" implies a standing point of a recipient, while the definition by Hekkert and Cila is looking at "purposes" of employing the metaphor. This could lead to design practices that put too much attention on whether or how a metaphor is generated and formed by the sender (i.e. designer) and to some extent overlooking users' understanding. It is important for product metaphor to be understood smoothly and properly, since in contrast to a verbal metaphor, opportunities for designers to explain the metaphor are limited, and users' failure of reading a metaphor could lead to bad consequences. With human-centered design being a common practice for designers today, the words, "specific, expressive purposes", could better be used with noting that designers are serving not just themselves but both sides.

Despite whether it is good or not, this vein of research "intend[s] to lay a foundation for future study to obtain an overall understanding on metaphor generation" (Cila, 2013, p. 66) and "is one of the first attempts to systematically include metaphor generation as a research subject in the product design domain" (Cila, 2013, p. 66). Moreover, they do provide a notable amount of valuable studies and insights. So, to begin the conversation about product metaphor, this research vein is taken as the primary viewpoint at this point of this thesis.

Pragmatic Intentions and Experiential Intentions

Five reasons (or purposes) for making metaphors embodied in final products were identified by Hekkert (2008), which later has been categorized into two kinds of intentions (Hekkert & Cila, 2015): the *pragmatic intentions* (including *identification* and *use/operation*) and the *experiential intentions* (including *prose/poetry*, *ideology*, and *fun/wit*). All these

intentions and reasons are not exclusive to each other (Hekkert & Cila, 2015). Designers can have different intentions in one design at same time. The following are some brief explanations of the five reasons.

The aim of *pragmatic intentions* is "to reduce the cognitive load associated with gauging the instrumental meaning, function and use of a product", which would make products more comprehensible ones (Hekkert & Cila, 2015, p. 200). These intentions correlate to products' functionalities. *Identification* means a product metaphor is utilized for people to rapidly understand what a product is about. If a trash bin in public space looks like the cigarette, it likely is a cigarette receptacle. *Use/operation* means to provide clues of how a product can be approached and interacted with, so people can take advantage of their previous experiences relating to those clues. For design examples, the desktop metaphor is used for graphic user interfaces.

Experiential intentions aim at "promoting rich sensorial and emotional or meaningful product experiences" (Hekkert & Cila, 2015, p. 201). *Prose/poetry* involves the assignment of "abstract symbolic meaning" to a product, for example, using metaphor for storytelling. *Ideology* means a product has "ethical, social or moral message" embedded. *Fun/wit* refers to composing a product providing "surprising, unexpected or incongruent" metaphorical association which pleasing users. This is a large category, and many uses of metaphors in products fall in this.

2.2.5 On the Approach of "*Metaphor We Design By*" (MWDB)

This vein of research provided a systematic (though not complete) approach to the generation of product metaphors. Many approaches and studies are documented in the dissertation titled *Metaphor We Design By* by Cila (2013) (in the rest of this thesis, the title is shortened as MWDB for convenience). There are three phases in the process of this approach:

defining meanings to express, generating and selecting the source, and mapping the source to the product. More detailed reviews will be in later sections along with other approaches (see 2.6).

However, one thing should be mentioned in advance: defined meaning, which MWDB relies on, is not the only possible directive specification for generating a metaphor. There are other approaches, which rely on visual resemblances, image schemas or else. Here is one example of MWDB being insufficient but other approaches improve upon it: the main purpose of MWDB is *the aesthetics* of product metaphors (see *UMA*, n.d.), but when it comes to product functionality, MWDB's approach is not as capable, more specifically, defined meanings to be the directive specification can be ambiguous as functionality tends to require more precise and controlled design actions and decisions. It would be better to have other measures that are more capable than defining meanings in this case. In short, MWDB is not sufficient for designers to counter some major cases in product design. Other explorations are needed.

To be active in exploring new possibilities, theoretical details about metaphor, especially product-functionality-related aspects of metaphor, would be informative. This clue leads to further discussion in the literature review, about the conceptual metaphor and especially the image schema, which are talked about in later sections, but before which, some design theories and thinking following the two intentions are talked about.

2.3 Relevant Design Theories and Thinking

Following the two different intentions (i.e. pragmatic intentions and experiential intentions), some relevant design theories were reviewed to prepare for exploring more about how designers can develop the metaphors in products. Aligning with these two intentions, two levels get touched upon, respectively the product use (or product functionality) and what lies beyond functionality.

To specify, the lower level is about *the base shape of a product*. It contains only the most essential components that relate directly to how a user completes the task(s), such as the primary components that comprise a functioning prototype. Nothing but the supposed tasks would be normally associated with it. It is more of a conceptual shape but less a concrete or literal shape. A change of this shape could mean a change of product category/type. Then, beyond that level is adding values to the base one, due to which the product can evoke some mental activities of users that are not so necessary to the tasks. This is a level the product goes beyond the base shape.

2.3.1 Product Use

Usability

Usability is defined as the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 2009, p. 3). Currently, in the age of human-centered design (HCD), usability is an important measure for describing how appropriate a product is.

Since pragmatic intentions aim at high comprehensiveness of products and low cognitive loads required by product usage, usability would be reinforced if those intentions are fulfilled. As some examples show, good product metaphors can fulfill these intentions, so usability could be adapted to be a measure for product metaphors for pragmatic intentions.

The Conceptual Model

The conceptual model is another term related to the product use. "A conceptual model is an explanation, usually highly simplified, of how something works", which enables anticipations for how a design could behave (Norman, 2013, p. 25). Users hold conceptual models (or *mental*

models) so they can explain and predict behaviors of products, and then users would know how they can interact with those products.

The conceptual models held by a user (i.e. mental models) are inferred by the user and they are not restricted to be the same as inferred by other users (Norman, 2013, p. 26). They are not necessarily complete and correct regarding underlying physics or chemistry (Norman, 2013, p. 28). While a product is being used, the product can "suggest wrong conceptual models" (Norman, 2013, p. 30), as well as satisfactory ones.

As Norman stated, the conceptual model is "perhaps the most important" one of six "fundamental principles of interaction" including affordances, signifiers, constraints, mappings, feedback and conceptual model (Norman, 2013, p. 10). Understanding which parts (if there are some) the metaphor is playing in the conceptual model could help designers in using product metaphor to fulfill pragmatic intentions.

2.3.2 Beyond Functionality

Design as Communication

The scope of communication can be broad. Since the design practice involves intentional evocation on users, it can be considered as a communicative act (Crilly, Good, Matravers, & Clarkson, 2008a). As for many products being mass-produced, other than the artefact itself there are limited channels to communicate, so the artefact (i.e. the product) becomes the main medium for the communication, and this communication is a mediated communication (Crilly, et al., 2008a). As a medium, functionality is just part of what the product can bring to users.

According to Crilly et al. (2008a), designers and users (or consumers) could and possibly would reach a good extent of correspondence. MWDB is following this model as a framework,

which reflected in the terms “pragmatic intentions” and “experiential intentions”. The basics of the model are summarized and rephrased as follows:

> In the communication, users interpret the artifact. The artifact is the guide of how users use or experience itself, while designer intend to trigger effects through it. Interpretations are constructed by users, which may or may not differ from designers’ intentions. When designers design a product, they consider much about the ways and possible results of how users interpret the artifact and their intentions. These considerations influence what intentions designers could hold. Same at the users’ side. Users would have the awareness of designers and designers’ intentions. Then inferences are drawn with this awareness, which affects their interpretations. At the same time, the artifact, which interpretations strongly rely on, are already under influences of designers’ intention. So, users’ interpretations are under designers’ influences as well, though they are not determined by designers. In addition to the influences between each other, both designers and users want the product to be effective, thus there are motivations for them to try matching intentions and interpretations. In short, designers’ intentions and users’ interpretations are what these two groups have of artifacts (the medium), where they can be possible and expected to achieve a good level of correspondence.
>
> (Crilly et al., 2008a)

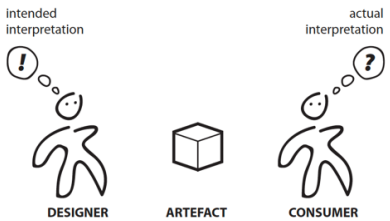


Figure 2.1 Basic structure of a communication-based model of design (Crilly, Maier, & Clarkson, 2008b).

While intentions and interpretations can go towards each other, there are many factors affecting intentions and interpretations respectively, which possibly tie the level of correspondence down, e.g. as for interpretations, factors could be the artifact itself, the cultural context and personal characteristics (Crilly et al., 2008a).

Product Semantics

In linguistics, semantics refers to the study of meaning. Later, this perspective was brought to product design with the same mission. It is suggested that the meaning of artifacts is the key for users to approach and interact with artifacts, as the axiom stated: "Humans do not see and act on the physical qualities of things, but on what they mean to them" (Krippendorff, 2006, p. 47).

Sense, Meanings, and Actions:

In *The Semantic Turn* (Krippendorff, 2006), one's understanding of an artifact is depicted as a triangle of sense, meanings, and actions (see Figure 2.2). Among the triangle, meanings are "a network of expected senses", and "a set of possibilities" that guides one's actions on things and people, which are constructed by the person (Krippendorff, 2006, p. 56). One can have anticipation of senses basing on meanings. In one's understandings there can be different meanings refer to a single artifact. The context of product constrains currently active meanings that are going to unfold into actions. One can also have anticipation of senses based on actions because actions will lead to consequences.

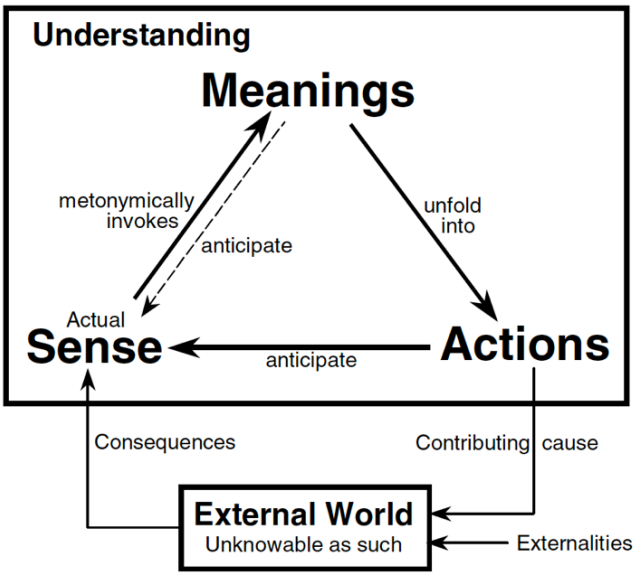


Figure 2.2 Sense, meanings, and actions (Krippendorff, 2006).

User Conceptual Model (UCM), again:

The conceptual model is an important part in the theory of *the Semantic Turn* (Krippendorff, 2006) as well, which is termed as *user conceptual models* (UCMs). Mental models and UCMs are not identical notions but substantially the same, in a practical sense. "A UCM is a network of operational concepts assumed to tell its beholder how an artifact could work, when to do what with it, and what to expect consequent to any actions taken" (Krippendorff, 2006, p. 105). "UCMs constitute an inventory of the meanings of users have available, can easily acquire, and are likely to enact, given the possibilities that artifacts suggest" (Krippendorff, 2006, p. 108).

Krippendorff notes that the UCMs are designer-constructed understandings of users' understandings: the "constructions of what users are capable of doing and learning" (Krippendorff, 2006, p. 105). So, UCMs can differ from the actual users' understandings. This is what designers may want to be aware of when uncovering conceptual models held by users.

Semantic Layers:

"All artifacts have different meanings at different times and for different users" (Krippendorff, 2006, p. 132). The mechanism is covered inside the product, layer by layer. Different layers are for different audiences. For example, a repair man could access into the second layer and deeper by still knowing the meaning of what he saw, while designers and engineers know more in deeper layers, while ordinary users don't need to know things like those for daily use. In this case, the meanings offered by the outer layer are not necessarily aligned with how the product really works, which gives designers some degrees of freedom but also can bring conflicts between different parts of meanings if designers are not careful enough.

Back to Meaning:

The Semantic Turn understands both functionalities and added values of a product by taking meaning as the foundation. It should not be hard to understand the part of added values. As for the part of functionality, it is argued that meaning of an object can be enhanced if the function of the object can be embodied and expressed by its properties (Hekkert, 2008). So, by taking meanings as the approach, MWDB seems to have a foundation that is capable of both functionalities and added values. However, the argument mentioned earlier still holds: MWDB is not good enough for designing product metaphor for pragmatic intentions. To clarify, first, when talking about capability of an approach, we are standing at the view of how practical or executable it can be. But gaps seem to exist between meaning and functionality in the actual practices (e.g. some kinds of defined meaning could be too cohesive and lack decomposability, which could constrain the applicability of the meaning in terms of functionality and the variety of design solutions). Second, other possible measures are not necessarily departing from meanings in nature, as they could be different explanations, perspectives or aspects but still of

meaning. So, making use of other measures does not mean a conflict with *The Semantic Turn* or other theories which use meaning to understand product functionality.

2.4 Conceptual Metaphor

The way we look at the concept called "metaphor" changes, though not frequently. Traditionally it is recognized as a literary means. However, in recent time, it was realized what is behind metaphor is beyond being literary, and actually lies widely in human's daily life (Lakoff & Johnson, 1980).

2.4.1 A Broader Scope of Metaphor

The scope of a metaphor could be broader than just being a rhetorical device. Without a doubt, metaphors are active in literature. In the traditional sense, the metaphor was claimed to be special and ostracized that stands out from ordinary life time (Lakoff & Johnson, 1980). However, around the 1980s, cognitive linguists proposed a theory that the metaphor not only lies in words and sentences people saying and writing, but also widely exists in people's daily life and their daily thoughts. The metaphor is not so special to be limited to poetic language, but normal in language, and ordinary in life, as it is a cognitive level activity (Lakoff & Johnson, 1980). "Our ordinary conceptual system, …, is fundamentally metaphorical in nature" (Lakoff & Johnson, 1980, p. 3). The term "conceptual metaphor" was coined for this broadened understanding of metaphor.

Since then (around 1980), the metaphor came to be broadly studied from a perspective of cognitive-level activities. After reviewing some summaries by Tendahl and Gibbs (2008), and by Cila (2013) in literature, it mentions many theories trying to (fully or partly) explain/unify the working mechanism of conceptual metaphor, which include but are not limited to CMT (Lakoff & Johnson, 1980), theory of conflation (C. Johnson, 1999), theory of primary metaphor (Grady,

1997), neural theory of metaphor (Narayanan, 1997), theory of conceptual blending (Fauconnier, Turner, & Goldberg, 1996), class-inclusion (Glucksberg & Keysar, 1993), and interaction theory of metaphor (Black, 1962). As cognitive-level mechanisms were added, studies on metaphors in cognitive linguistics and philosophy have been developed broadly. It spreads into many disciplines, like art, music, advertising, math, gestures, politics, etc. (Hekkert & Cila, 2015).

Because of the same underlying cognitive foundation, studies of metaphor in different disciplines are great resources to provide insights for product design, especially when the domain of verbal metaphors has already accumulated a large amount of material. “Many principles that apply to linguistic metaphors seem to have their analogy in the domain of product design” (Hekkert, 2008, p. 1). Many studies also showed evidence that product design is a domain where theories of the conceptual metaphor can be adapted.

2.4.2 The Theory of Conceptual Metaphor

Conceptual metaphor was defined as such: “The essence of metaphor is understanding and experiencing one kind of thing in terms of another” (Lakoff & Johnson, 1980, p. 5). Using words, phrases and sentences to metaphorically express is considered to be the realization of a metaphor (Lakoff, 1993, p. 1).

In the book called *Metaphors We Live By* (Lakoff & Johnson, 1980), Conceptual Metaphor Theory (CMT) was presented and it argued metaphor permeates in human life and thoughts. Contemporary Theory of Metaphor (CTM) (Lakoff, 1993) is a theory developed from conceptual metaphor theory. According to CMT and CTM, *metaphor* refers to a *cross-domain mapping in the conceptual system*, through which people comprehend or think about one thing by associating it with another. These two things, or mental domains, are called *source domain* and *target domain,* which align with *tenor* and *vehicle* in literature respectively. To refer to

entities in source domain and target domain in a metaphor, source entities and target entities will be the term used in this thesis. There are other theories having different ways to depict the form of conceptual metaphor. For an example, Figure 2.4 shows what *conceptual blending* argues, that there are four spaces in the activity of metaphor. This thesis will not delve into the area in whitch those theories differentiate from each other, as it mainly uses the model of the source and the target.

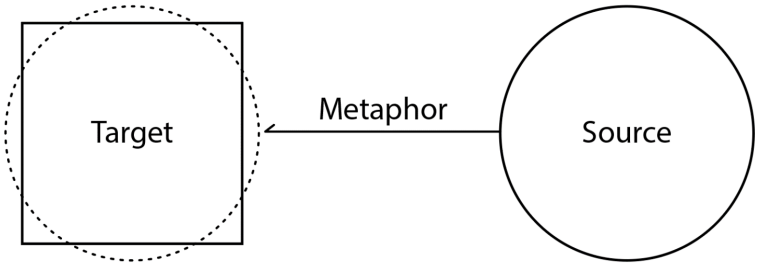


Figure 2.3 A basic model of cross-domain-mapping (illustrate by Hey et al., 2008).

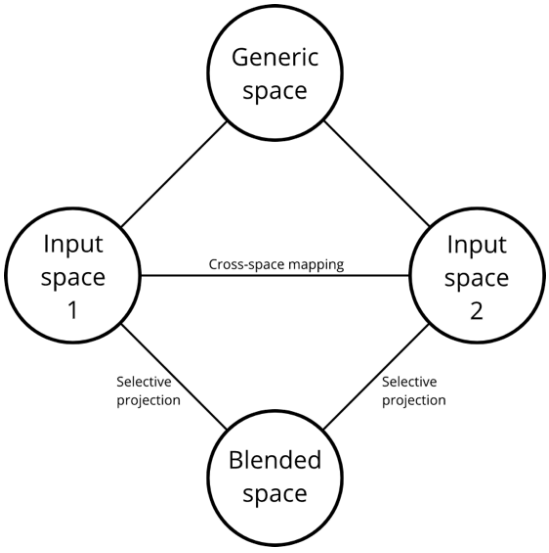


Figure 2.4 The network model of conceptual blending ("Conceptual Blending," 2021).

The Conceptual Metaphor Theory uses many examples to demonstrate that metaphor permeates in human life; here are some of them:

- "When you *have* a good idea, try to *capture* it immediately *in* words." Here the idea cannot be literally "had" in our hands or somewhere; "capture" is the same; words are not an area but "in" is used to establish the relation.
- "I can't keep up with the *pace* of modern life." Life is not a person and doesn't move forward by steps. "Pace" is a metaphor.
- "We're approaching the *end* of the year." Year is human defined phase and recognized as a string, path, or etc., where the very last second of it belongs to the "end" part of a year. And this explanation introduces even more metaphors, such as "belongs" "part".

The examples are countless: *falling* in love, the deadline *pushes* me, our mood can be *depressed* sometime, turn *up* the volume, etc. And many of these are communicating abstract domains, such as time, love and etc. The majority of these expressions can be commonly seen in our daily lives.

2.4.3 Metaphor and Abstract Concepts

After studying many examples, the authors of *Metaphors We Live By* noticed something about abstract concepts. Metaphors come from our concrete experiences and become the way we construct a great many abstract concepts (Lakoff & Johnson, 1980). For example, time is an abstract concept people use metaphor to understand and talk about, e.g. the end of time. Some other examples are mentioned in 2.4.2.

The Concealment

As for everyday products, being abstract becomes an important character. As mentioned earlier, designers put covers over physical mechanisms of the product. This helps designers to achieve goals like semantic layers, which also makes the inside components abstract to users since the actual working mechanisms are concealed. Digitalization and computers make the

concealment even more unavoidable. Users need to conceptualize these products so that they can reason about how these products work and how they can interact with these products.

Since metaphors allow humans to reason about a great many abstract concepts (Lakoff & Johnson, 1980), the metaphor could play a big part when users confront a product with concealment. For instance, when a user presses a key on the computer keyboard, the user doesn't have to know the mechanism inside the key. When the user constructs conceptual models of how the key works, he/she could be imagining there is a spring in it. Here, the spring is not necessarily the actual mechanism but the metaphoric understanding of the mechanism. Therefore, the metaphor should be a noteworthy subject when it comes to product design and concealment. In addition, the unnecessity of knowing the actual working mechanism aligns with an argument about the conceptual model by Norman (2013).

2.5 Image Schema

2.5.1 What Are Image Schemas

"An image schema is a recurring, dynamic pattern of our perceptual interactions and motor programs that gives coherence and structure to our experience" (M. Johnson, 2013, p. xiv). For example, the UP-DOWN orientation is picked up countless times as we repeatedly experience this structure in our everyday perceptions, such as the level of water in a cup, our height as we grow, and so on. In the Figure below is a list of common image schemas summarized by Hurtienne (2011).

Group	Image schemas
BASIC	OBJECT, SUBSTANCE
SPACE	CENTER-PERIPHERY, CONTACT, FRONT-BACK, LEFT-RIGHT, LOCATION, NEAR-FAR, PATH, ROTATION, SCALE, UP-DOWN
CONTAINMENT	CONTAINER, CONTENT, FULL-EMPTY, IN-OUT, SURFACE
MULTIPLICITY	COLLECTION, COUNT-MASS, LINKAGE, MATCHING, MERGING, PART-WHOLE, SPLITTING
PROCESS	CYCLE, ITERATION, SUPERIMPOSITION
FORCE	ATTRACTION, BALANCE, BLOCKAGE, COMPULSION, COUNTERFORCE, DIVERSION, ENABLEMENT, MOMENTUM, RESISTANCE, RESTRAINT REMOVAL, SELF-MOTION
ATTRIBUTE	BIG-SMALL, BRIGHT-DARK, FAST-SLOW, HARD-SOFT, HEAVY-LIGHT, SMOOTH-ROUGH, STRAIGHT, STRONG-WEAK, WARM-COLD

Figure 2.5 A list of image schemas (from Hurtienne, 2011).

2.5.2 Invariance Principle

While metaphors are being studied, the *invariance principle* proposes the logic for image schemas as one way to establish this notion (i.e. the image schema). The invariance principle says, “metaphorical mappings preserve the cognitive topology (that is, the image-schema structure) of the source domain, in a way consistent with the inherent structure of the target domain” (Lakoff, 1994, p. 54).

Along the logical thread, Lakoff (1994) mentioned two arguments that are important to this thesis. The first one is the significance of image-based reasoning: “image-based reasoning is fundamental and abstract reasoning is image-based reasoning under a metaphorical projection to an abstract domain” (p. 68). This claim is in line with metaphors that we understand abstract in terms of physical. And image schemas play a role in these activities.

The second one is about imagery mapping: when associating two entities in the image metaphor, features are mapped between two entities by following image schemas. Here is an example from Lakoff (1994, p. 69): when a metaphor is told like this, “My wife ... whose waist is an hourglass” (written by André Breton), people would map between the waist and the middle

part of the hourglass, and map between the whole human body and the whole hourglass, which follows the PART-WHOLE image schema. Moreover, after the imagery mapping, additional knowledge could be mapped from the source domain to target domain as well (Lakoff, 1994). The meanings to be added to the original product, which are talked about in MWDB, should be in line with the additional knowledge mentioned here.

2.5.3 Why Image Schema

The image schema has capacities regarding product metaphors. The following two concepts can bridge into two aspects of the design of product metaphors.

Imagery Mapping

Absent to verbal metaphors, physical fusion is a special character of product metaphors (Hekkert & Cila, 2015). In verbal metaphors, details like properties from the source usually need not be pointed out, whereas the product requires the properties from the source to be physically applied to the target. Because of this character, the imagery mapping is worth considering in order to having a convening result of physical fusion. Since the Invariance Principle and relevant studies provided a theory considering image schemas as preserved structures between two entities in an image metaphor, it gives us the opportunity to explore approaches relying on image schemas, which would be different from approaches relying on visual resemblances, etc.

Depicting the Conceptual Models of How Product Works

Image schemas are structures for us to organize bodily experiences, so that we can use those experiences to understand abstract domains metaphorically (M. Johnson, 2013). “If the invariance principle is correct, the way to arrive at a general-level schema for some knowledge structure is to extract its image-schematic structure” (Lakoff, 1994, p. 75). According to the two arguments above, the structures of image schemas could be the extractable structures of

conceptual models regarding how product works. And then, designers can use image schemas to depict those conceptual models, then making use of product metaphors as representations of how product works. With noticing the ubiquity of image schemas, Hurtienne (2011) has a similar argument that image schemas can be developed into a metalanguage for user interface design, and can "be used to describe users' mental models, …" (p. 53).

Keys on computer keyboards are an example, again (see 2.4.3 for the previous example). The conceptual model could be like it is shown in Figure 2.6. Springs are one of things partially sharing the same model/structure, i.e. the UP-DOWN and RESISTANCE image schemas.

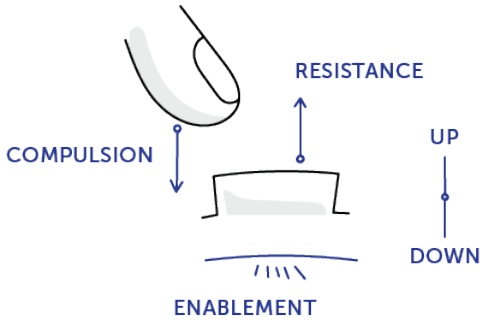


Figure 2.6 The image schema depicted conceptual model of keys on computer keyboard.

2.5.4 Lists of Image Schemas

The list of image schemas could hardly ever be complete (Hurtienne, 2011). There are different ones regarding different purposes or definitions. M. Johnson in his book (2013) provided his list and mentioned the extent of the list could be different since how people understand image schemas are not quite the same even for understandings from the same definition of image schemas. A list by architect Christopher Alexander was taken as an example in that book, which contains 253 "recurring" patterns.

Liu (2016) reviewed several lists or categorizations of image schemas, respectively from M. Johnson (2013), Croft and Cruse (2004), Evans and Green (2006), and Hurtienne (2011). Liu (2016) mainly adapted Hurtienne's list for her studies.

This thesis follows Liu's reason and takes the list by Hurtienne as the base of study. Besides, Hurtienne already developed much based on that list, including guidance to the intuitive use of user interface and etc., which shows the adequacy of the list. The list by Hurtienne (2011) was drawn from inventories given in M. Johnson's work (2013), and other linguistic analyses, psychological studies and existing user interfaces. The list is as shown in Figure 2.5.

2.5.5 More Characters of Image Schemas to Bear in Mind

There are some noteworthy aspects of image schemas and metaphors.

Subconsciousness

In Liu's research it was mentioned that image schema level information is processed on the subconscious level, which requires little amount of mental resources and shows a high level of automaticity. If representations of image schemas are contained in received information, they will be spotted and evoke effects automatically.

Multimodality

The metaphoric manifestations of the image schema structure or of meanings can be multimodal. The multimodality can be understood in two levels. First level is the multimodality of physical transference (i.e. mapping). Hekkert and Cila (2015) pointed out several means/modes to transfer properties from source entities to target products, including form, interaction, sound, movement, material/texture, smell/taste, the name of a source, and graphics. Properties of a single source belonging to different modes can be mapped onto a target at the same time.

The second level is that a single meaning or image-schema structure can be embodied in multimodal metaphors. Not only visual modality is present, but also auditory modality, touch and kinesthetic senses (Hurtienne, 2011). To take *fast* as an example, it can be embodied in an animation, as it can also be embodied in some high frequency rhythm. To take UP-DOWN as another example, it can be embodied in a visual diagram, as it can also be embodied in sound with different pitches.

Additional reaserch

Liu (2016) has reviewed several more properties/characters of image schemas that could be helpful in understanding image schemas better. Since many properties/characters are not very close to this thesis, the re-explanations here are more brief than Liu's original texts.

Experiential: Image schemas come from daily experiences, which have a strong link to the concrete world. This strong link allows us to re-experience or recall previous perceptions or knowledge when image-schema structures are evoked.

Imaginative: Image schemas are abstracted from experiences, and those structures are projected to different domains. These activities are creative and needs imaginations.

Both abstract and concrete: Image schemas are abstract and concrete at the same time. Image schemas are abstract patterns, but at the same time they come from the concrete world. Image schemas are not randomly paired with phenomena in the concrete world, at all. Being abstract enables a high extent of freedom for design, and being concrete preserves the reasonability of the design (Hurtienne, 2011; Hurtienne, Klockner, Diefenbach, Nass, & Maier, 2015).

Dynamic and static: Image schemas can represent both dynamic and static actions or status. Taking NEAR-FAR as an example, it can represent different positions of some entities, or, it can represent one entity moving from near to a far position and vice versa.

Subconscious: (see the characters talked in this section).

Multimodal: some experiments confirm the multimodality (respecting the first level mentioned earlier).

Pre-conceptual: Image schemas are acquired before complex concepts. By making use of image schemas, designers could jump out of the box from fixed concepts.

Universal: Many image schemas are cross-cultural, cross-language and cross-physical-sense. This offers benefits to inclusiveness and acceptance.

Robust: Since images schemas are from repeated experiences of countless times, they are relatively stable. In addition, they root deeply in our mind which costs little cognitive resources when being activated. If a product is designed properly regarding image schemas, users would make less errors.

Structural: Most image schemas are named in structures, and those are simple structures consisting of few elements and relations. E.g. CONTAINER has *inside, outside* and the *boundary*.

Nonpropositional: Unlike propositional symbol systems such as some symbols used in logic and math, image schemas as nonpropositional structures of experience are meaningful by nature.

2.5.6 On Design Approaches Relying on Image Schemas

The above sections have talked about potentials of image schemas. So, are design approaches relying on image schemas good enough to be the substitute for approaches relying on

defined meanings? The answer would be that both image schemas and defined meanings could be directive specifications for designing product metaphors, but in different cases. They do not have the same advantages. For example, while in some cases image schemas might be more applicable for depicting conceptual models than meanings, in some other cases, if designers already have clear and accurate meanings to be expressed, those defined meanings can be a more straightforward starting point for finding a source entity for the metaphor. By "straightforward", it means using image schemas to decompose defined meanings that could lose "information" or become an extra step for finding the source.

The following are some main approaches as representatives, which are product-metaphor-related and based on theories of image schemas, including *Image Schemas and Design for Intuitive Use* by Hurtienne (2011), *Expressions - Embodiment In The Experience Of Design* by Van Rompay (2005), and *From Perception to Meaning - The Research on Design Applications of Image Schemas and Metaphoric Extensions* by Liu (2016). Ahead of their detailed reviews, some general introductions and/or their limitations are given respectively.

As for Hurtienne's (2011) research, first, this approach focuses on computer interfaces, the bulk on virtual ones. It is not general enough for covering the whole product, especially when it comes to expressive aspects. As a result, for example, Hurtienne's method for defining image schemas could lack compatibility when it comes to the physical fusion of source and target. Second, as mentioned, defined meanings can be a more straightforward starting point in some cases, but Hurtienne's is not covering the "meanings" part. Actually, Hurtienne's is about intuitive use, which is mostly in line with pragmatic intentions. This is a part of what metaphors can do, and what not is being covered is metaphors can add values to products for emotional and

experiential purposes. The combination of Cila's (2013) and Hurtienne's could be worth exploring.

Van Rompay's (2005) research aims at bridging between forms and expressions using image schemas. Forms are explored and created in a way of deriving from image schemas. It's a more abstract way for image schemas to manifest, which does fall into the scope of metaphor if the definition of metaphor is loose. That is saying Van Rompay's research barely covers typical types of product metaphor. Besides, the deliberation on product functionality is not a part that Van Rompay's research aims to provide.

The priority of Liu's (2016) research is to enhance creativity and expanding varieties of design results, but not about the communication of certain meaning nor functionality. This approach could be more suitable for design practice with less serious goals, e.g. to explore design candidates for attractiveness, but less adequate for more serious situations, e.g. to find a metaphor that can properly communicate some certain product functions.

2.5.7 On the Purpose of This Thesis

So far, approaches relaying on meanings and on image schemas have got some slight touches. Besides these two, there are more approaches. For example, an instinctive option is using visual resemblances as the approach to the development of product metaphors, which should be a vigorous approach for handling visual aspects like the recognition of source entity in a product metaphor. Another instinctive one is to imitate existing product metaphors or other forms of metaphors directly, or to draw patterns directly from existing product metaphors without much reference to theoretical research. There is design literature taking these types of approaches as well.

The range of ways that metaphors could contribute to product design is so wide, that it facilitates many approaches of different angles to the employment of metaphors in product design. However, the relations between those angles and approaches are not sufficiently discussed. In other words, the different approaches are not adequately organized. Given that different approaches can fulfill different aims of employing metaphors in products, and, in the meantime, they could be insufficient for other aims of employing metaphors, the organization of approaches could provide clearer and more organized understandings of product metaphors. It can help designers with deciding which angles to follow in a single design case. It can also remind designers what aspects need attention. It could implicate some inspiration on research directions as well. In terms of this thesis, the organization could bring insights about what role image schemas can play in supporting the development of the metaphors in product design. Accordingly, some vacancies or insufficiency of design tools could be spotted.

So, the fundamental goal is to make the development of product metaphors a bit more practical. On top of that, a specific mission of this thesis can now be put forward, which is to provide discussion and studies on the relations between approaches of different angles. A brief roadmap is expected, which is for designers to practice and should be able to be derived from these discussions and studies. Besides this mission is the mission in the title. After approaches are organized, and some missing but essential parts of design tools are spotted according to this organization, the thesis continues to develop the image-schemas-related tools for the missing parts.

2.6 Some Current Approaches

Currently there are different approaches to product metaphor in design literature. On account of practicality, these approaches are categorized by the means they are relying on. Some representative ones of approaches and relevant research will be reviewed in more detail.

2.6.1 Relying on Meaning

Metaphor We Design By

Metaphor We Design By (Cila, 2013) is a set of studies on product metaphors. It is claimed by the researcher that this set is one of the first attempts in the design field that systematically covers metaphor generation and makes it one of main research subjects. Since MWDB has been used for entering this research, their definition of product metaphor and the reasons for employing metaphors in products has been reviewed in 2.2.4.

Metaphorical Communication Model:

A metaphorical communication model based on Design as Communication (Crilly, et al., 2008a) has been formed by Cila (2013), which describes the relations between designers, products and users regarding product metaphor (see Figure 2.7): users and designers both hold conceptions of each other, depending on their expertise, experiences, beliefs, motivations, capabilities and culture, and the product metaphor mediates in-between users and designers. Designers hold intentions for the experiences to provide users through the product, and users interpret the product to infer designers' intentions.

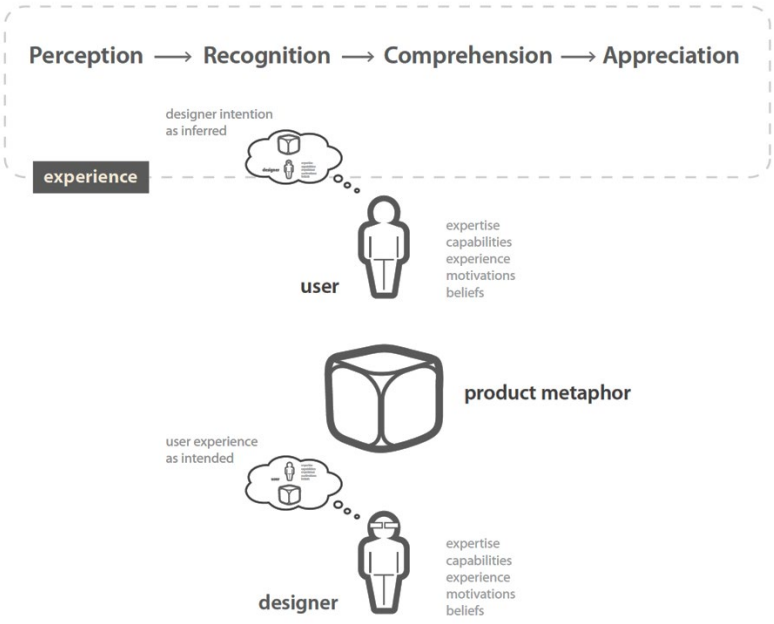


Figure 2.7 The basic model of metaphoric communication (graph from Cila (2013)).

Along this basic model are users' experience process and designers' generation process. The experience process consists of stages as such: perception ("perceiving that a metaphor has been employed in a product"), recognition ("recognizing its target and source"), comprehension ("comprehending why these particular entities are brought together"), and appreciation ("appreciating (or not) this association") (Cila, 2013, p. 43; Cupchik, 2003). The generation process is for designers to practice the development of product metaphors, which is reviewed next with emphasis.

The Process of Metaphor Generation:

Based on the literature and some new studies, a set of consecutive phases for the generation of the product metaphor is addressed by Cila and her co-workers, which includes: intention and meaning ("A designer has a particular intention to attain through the target and

comes up with a meaning to convey accordingly"), source ("finds a source that can assign this meaning to the product"), and mapping ("creates a mapping from this source to the target") (Cila, 2013, p. 127; Cila, Hekkert & Visch 2010). The paragraph below is the summary of their reasoning:

The generation process of verbal metaphor is a process to conceptually seek source candidates and then select one of them for the metaphor. In a verbal metaphor, when people generate a metaphor, they depend on the meaning or attitude they want to attribute in the communication, for which a good exemplar that can carry the meaning or attitude will be selected (Glucksberg & Keysar, 1990). After evaluating and selecting a source conceptually, the verbal metaphor is put forward into the communication. Findings from several studies about meaning showed evidence in line with this process. This verbal metaphor generation basis is taken as great inspiration for developing a process for the product metaphor development. However, as for a product metaphor, as well as pictorial metaphors and other visual metaphors, there is a special and major thing, which is the physical mapping. For the generation of product metaphors, there should be a task that conducts the tangible application of the source entity to the target product. This is a successive step to the generation of verbal metaphor, and has impact on its preceding phases, which is the evaluation and selection phase. By finishing the physical mapping step, the generation of a product metaphor is complete.

In Figure 2.8 is the generation process proposed by Cila (2013). In her MWDB, further reasonings and studies regarding the process are conducted for details that can help designers in generating product metaphors. In this figure, the terms shown under the phases are from these further studies. Next are recapitulations of MWDB about three phases and detailed findings, and a bit beyond the three phases.

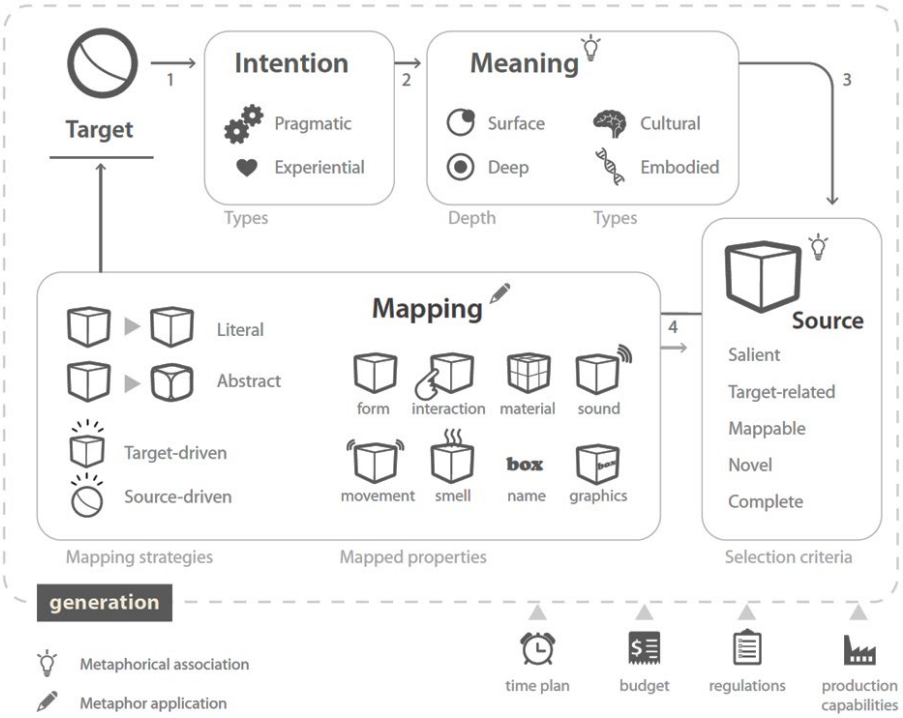


Figure 2.8 The generation process (graph from Cila (2013)).

Intention and Meaning:

Some important or good qualities (including capabilities) of a product could be hidden from users' experience or actually missed in the product. The five reasons/intentions to employ a product metaphor (see 2.2.4) cover a great range of intentions held by designers, which drive designs' determination on what qualities of a product the metaphor should emphasize on. In this first-phase, the meaning corresponding to those aimed qualities is defined and is waiting to be attributed to product.

In MWDB, the "depth of product metaphors" (or the "depth of a metaphorical association") is studied, which can be a tool to know the better choices of aimed-for qualities. The depth is from "surface" to "deep", where the surface metaphors are easier for users to see a

target-source relationship in the product than deep metaphors. According to the studies and findings, “designers emphasized a salient quality of the target (and thus generated surface metaphors) when they had a pragmatic goal, whereas they sought non-salient qualities when their intention was experiential” (Cila, 2013, p. 81). Besides, expert designers tend to come up with design results that are deeper than what novice designers do.

Besides, MWDB also mentioned the different types of meaning by where they come from. Some meaning refer to innate or sensorimotor, while some are learned, and the metaphor linked to these meaning are respectively the embodied and cultural metaphors.

Source:

After intentions and meaning are determined, a source entity is selected from candidates to be a good exemplar of the meaning. According to the findings in MWDB, there are several criteria that need to be considered for the source search and selection, which are salience, target-relatedness, mappability, novelty, and completeness. Salience and relatedness are the two with the most significance among them. The five criteria become part of recommendations to designers, which will be quoted later.

Mapping:

The “conceptual mapping” refers to an association between source and target established conceptually, whereas the “physical mapping” is the tangible association. The term “mapping” here refers to the latter one, i.e. the tangible integration of a product metaphor, which is not involved in a verbal metaphor generation process. In this phase, physical properties are transferred from the selected source entity and physically fused into the target product. It is mentioned specifically in an article (Hekkert & Cila, 2015), what transformed/transferred are the salient properties of the source entity. There are various modes to do the physical transfer, which

can be categorized into form, interaction, sound, movement, material/texture, smell/taste, name, graphics.

In MWDB, two dimensions are established for describing different mapping strategies, which are literal vs abstract, and target-driven vs source-driven. The target or source driven refers to the final design solution, which will appear more like the target entity or source entity. And the literal and the abstract mean the driving entity is realized more by conforming with the real appearance of the source or more in a simplified form of the source.

Aesthetic Preference:

The research suggests several measurements in order to let designers develop design results with better aesthetic value. One pair of terms is novelty and understandability, which is for balancing the conceptual association between source and target. The other pair is identifiability and subtlety, which describes the visible cues in the product for users to identify the source.

Recommendations:

Cila summarized her studies and turn the findings into a list of recommendations for designers. Each of the three phases (intention and meaning, source, mapping) got touched. Here is a list quoting from MWDB.

In “Finding an apt source” section, each of them relates to one of the five criteria for the phase of “source” mentioned earlier, respectively from top to the bottom are salience, relatedness, mappability, novelty and completeness.

"

Finding an idea:
Choose a hidden quality of the target to highlight
Keep in mind your intention to use a metaphor
Finding an apt source:
Use a source that has the meaning you intend to convey as a salient property
Use a source that is optimally related to the target
Evaluate the applicability of a source
Choose a source that is novel but understandable
Choose a source that makes a functional contribution to the product
Applying the metaphor:
Keep the reference to the source subtle but identifiable
Match the inherent target properties
Tailor the source properties to blend with target properties
Always map salient properties of a source
Do not necessarily transfer “everything” from a source
Consider all the modalities
Remember that there are different ways to apply the metaphor

"

Figure 2.9 Recommendations for designers (texts quoted from Cila (2013, p. 137)).

Discussion:

MWDB brings a good structure for the development of metaphor, which consists of three phases including (intention and) meaning, source and mapping. And detailed tools for the source searching phase should be practical and capable for meaning-based projects. However, when it comes to the mapping phase, some measurements provided by MWDB are indistinct and less practical. The writer of MWDB was also asking for further studies on mapping.

There is another noticeable limitation of this approach. Relying on defined meanings are not sufficient for achieving some of the intentions, as mentioned. For example, when functionality is the reason for employing the metaphor, meaning is not a very compatible mode to represent functionality. Meaning could be too constrained or could cause confusion, and as a result the searched source would be limited and sometimes cannot represent functionality accurately.

By Edward Anthony Dorsa

In the thesis by Dorsa (1986), the author studied semiotics, especially semantics and the metaphor. An approach is proposed so that designers could allow a design provide experiences that another entity originally provides, by borrowing elements from this another entity and applying them to the design. This approach is more the experiential orientated but has less functionality. Here in Figure 2.10 is quoted from the thesis and shows the process. Generally, this process aligns with a structure of four stages, including to research on clients and users, to define the intended attributes ascribed to the design, to generate source entities, and to apply the elements from the source entities. Details will not be included here. But some are very helpful for the practicality, e.g. the ranking action, the avoidance, some regularly used methods mentioned, etc.

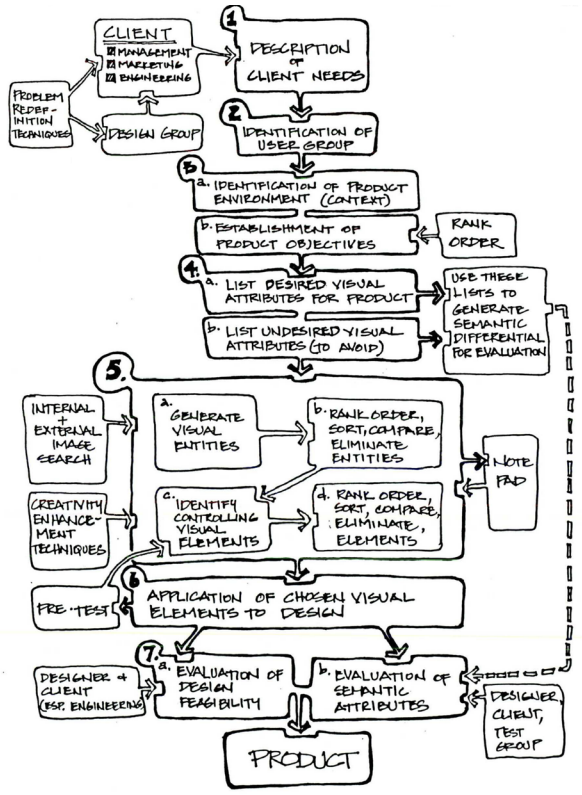


Figure 2.10 Visual Metaphor Generation Diagram (Dorsa, 1986, p. 55)

The approach in MWDB is much like this one. For instance, transferring attributes is the main purpose, where this approach relies on attributes (equivalent to meaning) for the source searching. And, the process is structured as, inaccurately, define-search-apply, which is in line with MWDB.

2.6.2 Relying on Image Schemas

By Hurtienne and Related

The literature about this approach includes Hurtienne's (2011) dissertation and several articles he published. Among these articles, two are summative: Hurtienne et al. (2015) and Hurtienne (2017). Besides the research directly by Hurtienne, there are other noticeable successive research studies, e.g. Tscharn (2019). All these can be considered as the same vein of research. There are other studies on specific subjects around this vein, such as forms, colors, textures and etc.

In Hurtienne's (2011) dissertation, two fundamental research questions are stated. The first one is about "using image schemas for convey abstract information in user interfaces" (p. 3). Several studies are conducted and the result shows that "more effective, mentally efficient, and satisfying" (p. 3) interactions can be achieved when the interfaces "conform to image schema theory" (p. 3). The second one is about "the practicability of image schemas as design language for designing intuitive use" (p. 3). It turns out the agreement of using image schema vocabulary is high to medium, and the image schema is "especially useful in the process of translating requirements into design solutions" (p. 3). And because the image schema is abstract, it allows a lot of room for creativity. Further from these, in a later article the statement become clearer that designing with image schemas is a good resolver for the tension between innovation, inclusion, and intuitive use (Hurtienne et al., 2015). The inclusion is focused on in Tscharn's (2019)

research, especially the age-inclusion. The research concludes “the image-schematic metaphors are an applicable and effective method for innovative user interfaces that can be used regardless of prior technological knowledge” (p. v). In addition to the conclusion, the design process used originally in Hurtienne’s dissertation and the 2015 article is revised a bit.

The Process:

This process takes Contextual Design as the main thread, for the purpose of better sticking to current industry design practices, where additional steps regarding image schemas are attached to Contextual Design. The main thread consists of four main stages, contextual interviews and interpretation, affinity diagram, wall walk and visioning, paper mock-up interviews and interpretation. And additional steps include (image schema training,) image schema tagging, image-schematic metaphor, metaphor clustering, and using metaphors for inspiration. Figure 2.11 shows how they are put together. Following is a brief introduction of this process, and for details please refer to the original literature (Holtzblatt, Wendell, Wood, 2005; Hurtienne et al., 2015).

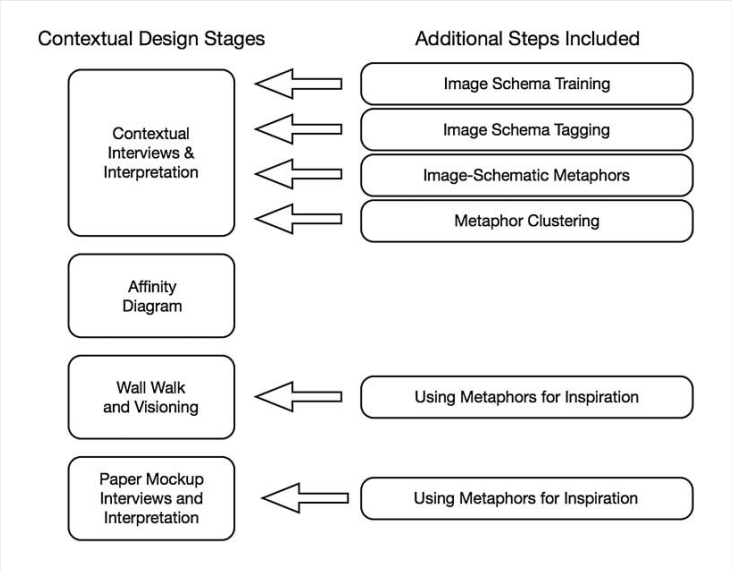


Figure 2.11 The process graph from the 2015 article (Hurtienne et al., 2015).

Contextual interviews and interpretation. In this stage, methods such as interviews and observations are conducted in context (i.e. target products being used and target tasks being proceeded). After the interviews, designers should have some descriptive information like users' utterances. Then designers extract image schemas from these materials in order to construct the structure of users' mental models. This sub-task is *image schema tagging*, and before making these image-schema-related tasks possible, designers need a *training* about all these. After the extraction, the target concepts (or entities) that the image schemas are associated to by users in their utterances are addressed and made explicit by designers, where the pairs of target concepts and image schemas are called *image-schematic metaphors*. Then these metaphors are "clustered according to the requirements and functionality described in the use case" (Hurtienne et al., 2015, p. 243), which is the task called *metaphor clustering*.

Affinity diagram. In this step, affinity notes, which are created during interviews, are going to be clustered by affinity into a hierarchical diagram. In the Hurtienne et al. (2015) article, the top hierarchy is context, needs and pragmatic quality. This is a step of contextual design but not an image-schema-related-or-required task.

Wall walk and visioning. The affinity diagram is pinned on a wall-like panel. The wall walk and visioning refers to an ideation activity, with the help of the information from this affinity diagram and image-schematic metaphors hung next to the affinity diagram.

Paper mock-up interviews and interpretation and *Prototype refinement and implementation*. During these steps, ideas are going to be transformed into mock-ups and prototypes. Some image-schematic metaphors will be visualized in the mock-ups and prototypes.

Discussion:

The core of this approach is contextual design, which is a user-centered design processes and in line processes like double-diamond and etc. Thanks to the power of image schemas, this is a strong approach to making interfaces effectively communicate abstract concepts.

However, this is not an approach to employing an additional metaphor into the product but realizing the metaphors already in users' minds or conceptual models. The final appearance of the product could have no clear figure of an entity from another domain and is allowed to be abstract visualization of image schema structures.

Nevertheless, the task about user utterances and extraction aligns with depicting the conceptual models by using image schemas. And it is an effective way to get the model/structure. But, extracting from user utterance is not essential for every time depicting the conceptual models.

By Van Rompay

In Van Rompay's (2005) PhD thesis, the expressions of products are studied. He tries to find out the possible mechanism or pattern behind the linkage between certain forms and certain users' experiential understandings, in order to support the form-giving when designers intend to enable users' experience of certain expressive characteristics (e.g. humble, secure and etc.) through the forms. After his reviewing the literature about expressions in products and conducting experimental studies, the results support an argument to be valid in product design domain that "Objects are perceived as expressing abstract characteristics due to recognition of a structural similarity between the spatial-relational (i.e., image schematic) structures characterizing our own previous interactions with the world and spatial-relational structures presented by objects" (p. 119). This means if users can perceive certain image schematic structure from the product form, previous experiences associated to the same/similar structure

can be evoked. Deriving from this argument, studies focusing on the practical sense are conducted, where a design process is proposed and suggested to be less than good enough by the results of studies.

The Process:

In the thesis (Van Rompay, 2005), the process is documented to have four stages, including description, reenactment, collage and design solution. The starting information for the process is an expressive word of experience, e.g. security, dominance, involvement. Then, *description* refers to describing several interactions that designers think could raise the experience. The result of this stage is some descriptive sentences of specific interactions in designers' previous experiences. *Reenactment* refers to reacting and characterize these interactions described. Designers act out these interactions, and details in the acting like bodily postures and reactions will be paid special attention to. *Collage* refers to express the characteristic features in a collage. Each individual designer creates one collage that he/she considers the best to express the most essential or illustrative characteristics from all interactions. Then the collages are analyzed in order to define the image schematic structure held across these collages. Design solution, which is the final stage, is easy to understand, which is to use the structure to generate the form of the product.

Discussion:

The approach from this research does not correspond well to developing a metaphor with a clear image of the source entity, since the approach pursues outcomes having abstract embodiment of image schemas. The image schema structure is a bit too simple so the design results would be relatively easy to imply undesignated experiences. In addition, this approach

actually starts with meaning but not image schemas or conceptual models, which is trying to use image schemas for expressing designated meaning.

By Liu

Liu (2016) does an extensive literature review in his/her research. The research aims at addressing the possible relationship between users' perceptions and users' understandings about the artifact, in order to enable designers to practically connect human's recognitive patterns and the "design language". Image schemas are the bridge with high potentials. Two kinds of findings emerge in terms of design methods. Both of them can enhance the product effectiveness, and more fruitfully, expand the creativity and the variety of design solutions. However, one of them approaches the expansion by basing on the conventional forms (or clichés), which provides designers different ways to modify the clues on a product and reach different effects, whereas the other one approaches it by basing on the user conceptual model, which tells different ways the product form adapts to the user conceptual model. These methods are not design processes but more of a list of considerations and possible design options.

Ways to modify the clues on a product:

The research provides a table (Liu, 2016) that marks potential clues to be modified and the possible ways to modify them. For example, fog can imply FAR-NEAR; gestalt principle can affect outlines and further implies PART-WHOLE; etc. Clues are categorized by image schemas. Different modifications lead to different effects. The effects are many and diverse, so they are not included in this literature review.

Ways to decide how the product form adapts to the user conceptual model:

Liu proposes a framework of product (see Figure 2.12, translated from Chinese with possible imperfection) by following the "surface structure" and "deep structure" proposed by

Chomsky (1965, 1972). The interface where the deep structure transformed into the surface structure enables room for designs to have options. As showed, basically the options are compliance, violation and parallel. According to the examples used by Liu, image schemas are the primary element of the user conceptual model, meaning it is mostly the image schemas to be complied, violated or parallel to. *Compliance* refers to designing the product from that conforms to image schemas in the user conceptual model. *Violation* refers to the clues that conventionally conforms to image schemas are replace so that the clues imply the opposite of image schemas instead. *Parallel* refers to bringing image schemas that are new to the product, and then making them manifest together with original ones by the product form.

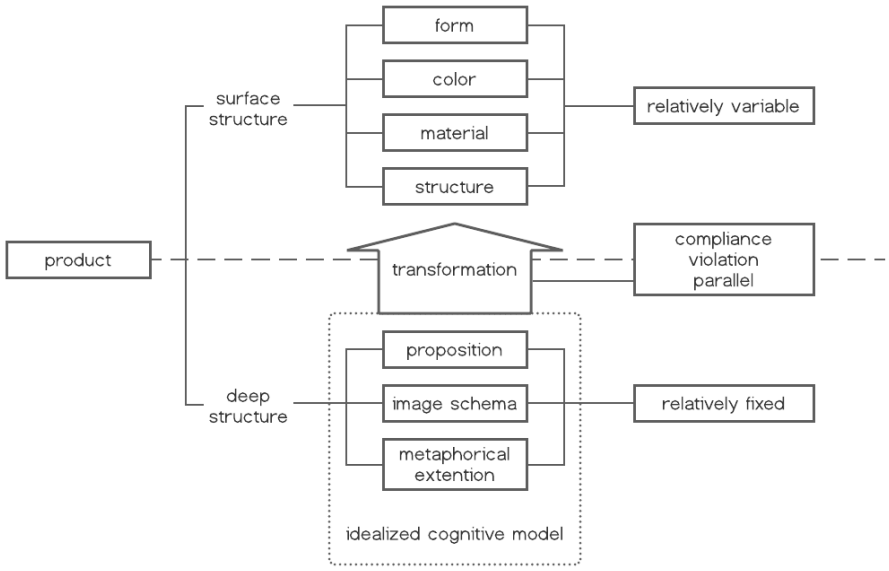


Figure 2.12 The surface-and-deep structure of product design (Liu, 2016, p. 294).

Discussion:

Liu is proposing a methodology aimed at creativity. The creativity is enabled by the modifiability brought by image schemas. The research investigates the image schemas grounded

or embodied in artifacts. Understandings for image schemas are deepened with this research. However, it is not much about metaphor, especially the employment of metaphors in products.

Some Notes for All Three Reviewed above

Across the three approaches, there are some things that need to be noted:

- Tools for depicting conceptual models are insufficiently studied.
- These approaches are not ready for instructing analysis during physical fusion.
- The approaches related to image schemas are not strictly about metaphors, since a metaphor with clear image of the source entity is not their primary goal. The approach to using image schemas for supporting the development of the metaphors in product design needs studies.

2.6.3 Some Outlying Research

There is much other research on the product metaphor, some of which are not systematic, thorough or deep enough but still valuable. Most are based on earlier research.

Madsen (1994)

A process with sets of guidelines is presented in an article called *A Guide to Metaphorical Design* (Madsen, 1994) and consists of three activities, which are *generating*, *evaluating*, and *developing*. This process generally aligns with the process in MWDB. The article also summarized a list of characteristics of the role of metaphors in design domain. The guidelines are included in this thesis through Figure 2.13. The characteristics and the nature are not included here because most of them are already talked about in other parts of this thesis. Besides, the article mentioned several categories for source entity: “animate, inanimate, human, animal and physical objects” (p. 57), which could be some inspirational keywords.

"

Generating Metaphors
Listen to how users understand their computer systems.
Build on already existing metaphors.
Use predecessor artifacts as metaphors.
Note metaphors already implicit in the problem description.
Look for real-world events exhibiting key aspects.
Evaluating Metaphors
Choose a metaphor with a rich structure.
Evaluate the applicability of the structure.
Choose a metaphor suitable to the audience.
Choose metaphors with well-understood literal meanings.
Choose metaphors with a conceptual distance between the source and the metaphorical meaning.
At least have one bridging concept.
Do not necessarily explicitly incorporate the metaphor in the final design.
Developing Metaphors
Elaborate the triggering concept.
Look for new meanings for the concept.
Restructure the perception of reality.
Elaborate assumptions.
Tell the metaphor's story.
Identify the unused part of the metaphor.
Generate conflicting accounts.

"

Figure 2.13 Guidelines for "metaphorical design" (quoted from original text (pp. 59-61)).

Saffer (2005)

In a thesis titled *The Role of Metaphor in Interaction Design* (Saffer, 2005), the author studies metaphors mainly from a perspective of virtual user interfaces. In addition to the thorough analysis on roles of metaphors, the thesis also provides guidelines for how designers can use metaphor appropriately. Be aware, the guidelines are not only for metaphors employed in the final design solution. Here is the list of the guidelines.

"

Metaphors are cultural.
Metaphors are contextual.
Fit the metaphor to the functionality, not the other way around.
Use metaphor to uncover otherwise hidden aspects of the material.
Discard process metaphors when necessary.
Don't let your metaphor ruin key features.
Choose metaphors that are appropriately scalable.
Let your metaphors degrade and die.

"

Figure 2.14 Guidelines for the metaphor usage (quoted from original text) (Saffer, 2005).

2.7 Applying These Approaches

2.7.1 A Continuum

This thesis proposes a continuum that could make some improvement on the organization of different approaches to the development of product metaphor. As mentioned in 2.5.7, it would be beneficial if relationships between different approaches are well resolved, and this continuum could be one step closer to achieving such. More important is that the continuum might suggest the parts the image schema can play.

The Continuum, and the Two Ends of It

This organization is practice-oriented, meaning it should help designers with deciding which approach(es) to follow in a single design case. This implies the organization should become a platform with mutual and basic concepts of these approaches, so that designers can analyze the intentions and information they have through these concepts and then pick an approach or construct a design process accordingly. Since the source-target model of a metaphor is the fundamental, the source and the target are two mutual and basic concepts across approaches. However, these two are not the causes for employing metaphors, which are not meaningful enough for distinguishing approaches with different strengths. Concepts closer to causes are desired. Deriving from the source and the target, two concepts come into play, which will be called the *extrinsic messages* and the *intrinsic messages*. Thanks to "design as communication", the word message is borrowed from the vocabulary regarding communication. *Messages* are information conveyed through the product. Designers have some of them for searching a source entity for the product metaphor. The extrinsic and intrinsic are for describing two kinds of messages. In this thesis a target entity follows the definition of the base shape of a product (see 2.3). Following this, *extrinsic* messages are messages from outside of the base shape

of a product and cannot be provided by the base shape, and *intrinsic* messages are those within what the base shape of a product. Taking Rolex's mechanical watches as an example, their luxuriousness is well-known, which has to do with sensorial, emotional and meaningful aspects of them, such as delicate engraving, beautiful materials and surfacing, elegant forms, and the status built by society. Messages derive from those belong to extrinsic messages of watches, on contrary of which, watch faces, hands (plus essential properties of it, e.g. its position), band and etc. are intrinsic messages.

In the case of product metaphor, the target entity (i.e. the product, actually, the base shape of the product) in the metaphor provides intrinsic messages. In contrast, the source entity can provide extrinsic messages, or help with emphasizing intrinsic messages provided by the target entity, or even both at the same time. One thing needs clarification: when emphasizing, messages would be mutual across target and source, but they are defined as intrinsic messages not extrinsic. Here takes Kastor the pencil sharpener (Figure 2.15 A) as an example. The base shape of pencil sharpeners (Figure 2.15 B is closer to it) as target entity just implies how this product can be used, by preserving information like the hole to put pencil in, the container that holds wastes, the component doing the sharpening, and etc. The beaver, which is the source entity in this metaphor, implies messages like cuteness that the base shape of pencil sharpeners doesn't have.

Figure 2.15 A, Kastor the pencil sharpener. B, an ordinary pencil sharpener.

Taking hourglass brewer seen in Figure 2.16 as another example. "…users to 'flip' the machine after putting in coffee and wait for a while to have it ready" (Cila, 2013, p. 14) is what this metaphor tells. This hourglass figure emphasizes on how a cold brewer should be used, which is intrinsic messages: users need to wait for it to be ready. In addition, it also brings extrinsic messages, for example, flipping. One noteworthy thing is that this extrinsic message is a how-this-product-should-be-used message but hardly an added value, which will be discussed in the later case studies.

Figure 2.16 Hourglass Cold Brew Coffee Maker System by Hourglass Coffee Maker.

A design often spreads both extrinsic messages and intrinsic messages. There is a tension between the emphasis on extrinsic messages or on emphasis of intrinsic messages. If a design promotes a wealth of extrinsic messages, intrinsic messages could be disturbed or limited. In contrast, if a product preserves what it requires by functionality, the base shape will dominate the form, where there will be limited extrinsic messages. Because of this tension, design projects fall into a continuous range. And the extrinsic messages and the intrinsic messages are the two ends of the range. However, only talking about extrinsic messages and intrinsic messages is not enough to route designers to proper design approaches and tools regarding the metaphor, since design strategies other than the metaphor can promote these messages as well. Given that some messages are the reason to employ a metaphor and some are not, those being the reason are the key ones for organizing and suggesting different approaches to and tools for the development of metaphor in product design.

Figure 2.17 A range with extrinsic and intrinsic messages as two ends.

Two Different Priorities

A metaphor is employed because of some intended messages, but the metaphor can bring non-intended messages of both kinds (i.e. the extrinsic and the intrinsic). Besides, both extrinsic and intrinsic messages can be intended messages at the same time. As a result, extrinsic messages and intrinsic messages both need care in a single design and a single metaphor. Though this, one of them will be in priority over the other one. The difference of importance of the two kinds of messages determines the design project's position in the continuum. Among intended messages, if extrinsic ones are in priority over intrinsic ones, the position inclines towards the

end of extrinsic messages (in Figure 2.17, it's the left end) and some approaches are suggested, and vice versa.

Based on the five intentions (identification, use/operation, prose/poetry, ideology, and fun/wit), three types of designs are constructed: *artistic expressions*, *emotional acceptance/attractiveness*, *communication on functions*. If a design has use/operation to be the focus, it goes to communication on functions, where intrinsic messages are more decisive than extrinsic messages on the product form, and sometimes barely involve extrinsic messages. If a design has fun/wit to be the focus but still requires pragmatic intentions, it goes to emotional acceptance/attractiveness, where intrinsic messages or extrinsic messages are not necessarily over another. If a design has ideology to be the focus and require few in terms of other intentions, it probably belongs to artistic expressions, where extrinsic messages are more decisive than intrinsic messages on the product form, and extremely, intrinsic messages can be ignored widely. These fall in positions approximately shown in Figure 2.18. Later this thesis will provide product examples.

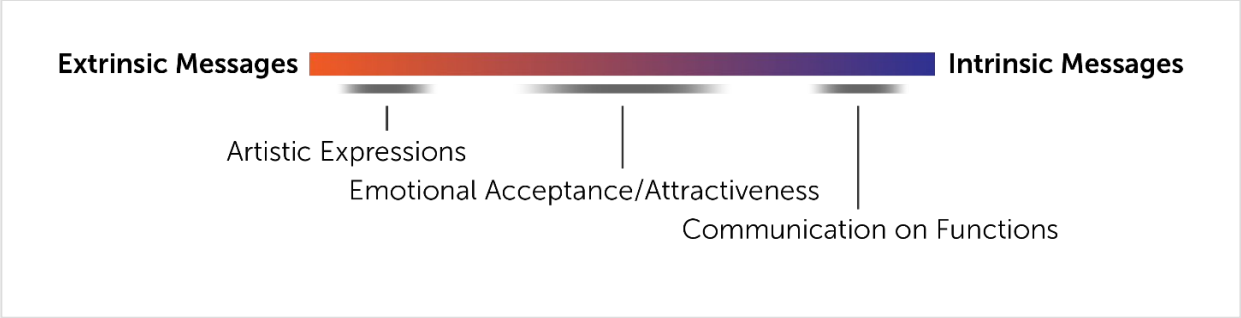


Figure 2.18 Some positions in the continuum.

These three types are not exhaustive categories. The primary purpose of them is to be a more practical angle for explaining/understanding the continuum. In practice, designers can

define their own type(s) of design, or, they can define the position of their design project in the continuum directly basing on the tension between intrinsic and extrinsic.

Designers' Entry Points

Different approaches to the development of product metaphor have different strengths because of their applicability to different kinds of information. Intrinsic messages likely are information that users need for using the product to complete a task. According to the reviews about the conceptual model, to understand how a product should be used is to build adequate conceptual models of the product. So, using a metaphor to communicate intrinsic messages likely means using the source entity of the metaphor for making the conceptual model of the target entity (i.e. the product) more concrete or more standing out. Since image schemas could be a way to depict conceptual models (see 2.5.3), approaches correlating to image schemas should work for the development of intrinsic-messages-prioritized product metaphor. Moreover, searching for source entities is a must-have at the early stage of the development, despite different approaches relying on different things. What (information) designers have for searching a source entity, or what (information) designers want to secure in the product, is the key to product metaphors, which points to the entrance of the process of the development. Since image schemas are the preserved (conceptual) structures between source and target entities (see 2.5.2), they can be the bridge to a wealth of source entities when intrinsic messages are in higher priority. Conversely, if designers intend to add values to a product, they probably already have the certain values as some form of defined meanings. As mentioned in 2.5.6, using image schemas to decompose meanings would become an extra step or could lose "information" when finding a source entity. So as for extrinsic messages being in priority, using approaches relying on defined meanings for searching source entities should be more natural.

Thus, approaches taking defining meanings or extracting image schemas as an early step for designing metaphors, are now plugged into the continuum, as shown in Figure 2.19. Defined meanings and image schemas should be designers' two entry points of the roadmap derived from the complex of continuum (the complex of continuum refers to the continuum as the frame with organized approaches plugged in to the continuum).

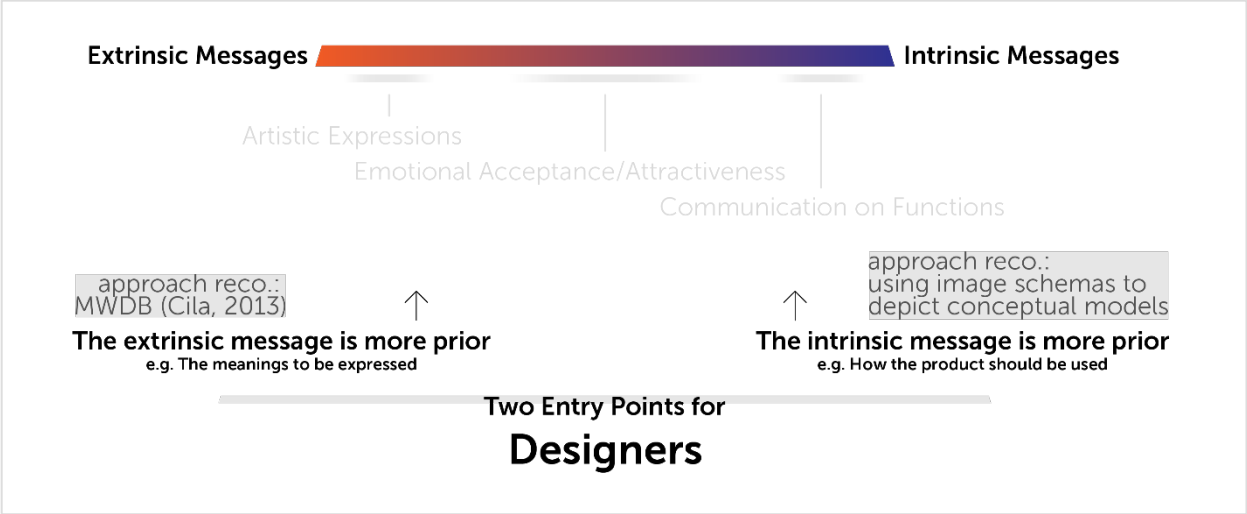


Figure 2.19 Designs' entry points.

Furthermore, one type of message being of a higher priority does not mean the other one can be ignored. For examples, if a source entity successfully conveys extrinsic messages but it conflicts with how the target entity works, the metaphor will not be a good one as long as the product use remains one of design goals. If a source entity successfully tells how the target entity works but it adds meanings conflicting with the product and the context of usage, the metaphor will not be a good one either.

Users' side

Just as the designers' side has been given attention, the users' side should also not be overlooked. Before the metaphor becomes effective, users should first be able to recognize the

source entity. So, as for the users' side, the focus turns to the recognition of the source entity in metaphor. Besides approaches relying on visual resemblances, one of the two capacities of image schemas, imagery-mapping (see 2.5.3) should be able to help this demand. By following the principle of imagery-mapping, the physical fusion of source and target should become reasonable and natural, since it is how people sensorially associate two entities. And because of the multi-modality of the image schema, the mapping should be able to extend beyond just visual properties. In addition, users do not typically distinguish if a message is extrinsic or intrinsic, which is one major reason for designers to consider both messages. An overall evaluation could be helpful to check if the final application has problems of undesired or even harmful messages.

Image schemas in the continuum

In the framework of the continuum, it marked two main roles of image schemas. One is for depicting conceptual models, which could be the language/vocabulary for intrinsic messages. This aligns with that image schemas can be the metalanguage for the designing user interface of intuitive use (Hurtienne, 2011). To establish the tool for the depicting, we can learn from or reuse Hurtienne's research. The other role is to instruct or evaluate the physical fusion between two entities, in order to provide convincing or satisfying design solutions. Cila (2013) suggests the methods for physical fusion is mostly an uncultivated area at the time of her research.

To Summarize

Designers need to look at three parts when designing the product metaphor, which are the intrinsic messages, extrinsic messages, and the surface (i.e. the physical properties of the product). And different approaches find their anticipated recommended positions in the continuum. See Figure 2.20 the continuum as a framework (with organized approaches plugged in to the continuum).

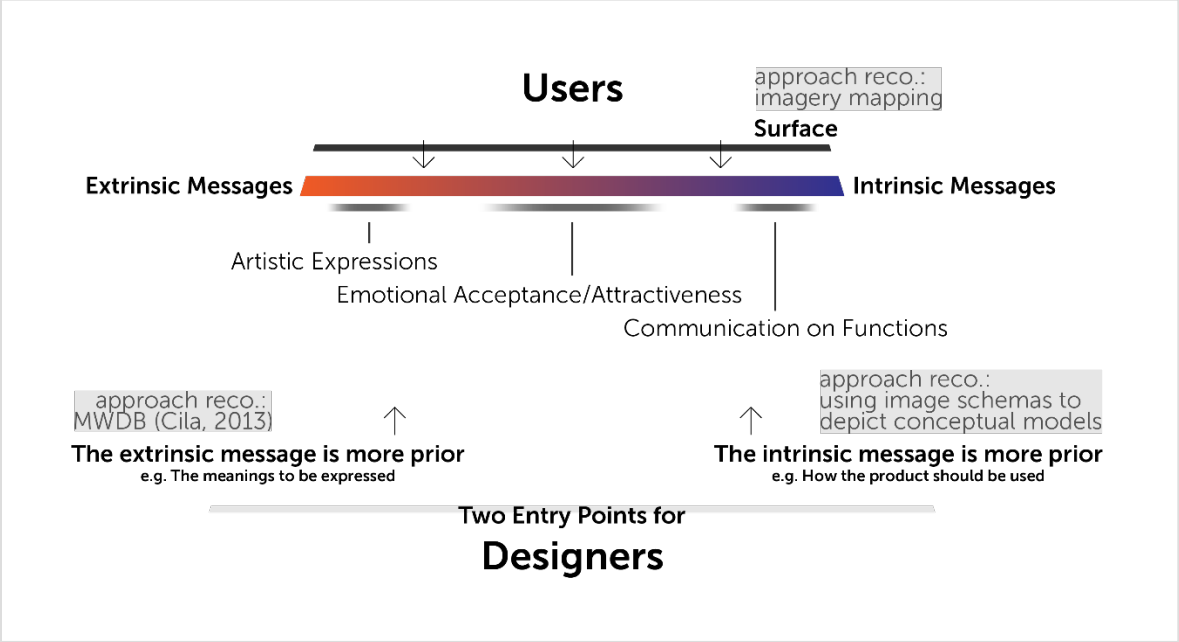


Figure 2.20 The continuum as a framework.

2.7.2 What to Do with It

Case Studies

Though the continuum takes existing theories and studies as the base, it is over theoretical and to some extent is hypothetical. Further studies are needed. What is presented so far is more a deductive development. Because "… case studies can test deductive theories and …" (George & Bennett, 2005, p. 111), case studies on existing product examples is a good method for trying to validate the continuum and it as a framework for organizing approaches (e.g. validating whether approaches are connected to the continuum aptly or not). This matches the thesis's purpose of organizing different approaches to employing metaphors in product design.

The continuum and the practical roadmap derived from the continuum could imply some vacancies or insufficiency. So far, some are noted in 2.7.1. So, besides the validation, case studies should indicate important vacancies and insufficiency, especially of image-schema-

related ones, and lead to explorations that could fulfill them. This matches the main purpose of this thesis, about using image schemas for supporting the development of the metaphors in product design. This is also a demonstration that the continuum provides implications about research directions.

Other Aspects Needing Consideration

Basing on some empirical impressions on product metaphor examples and much research, there could be aspects or dimensions other than added values, functionality and the physical fusion, which also need to be considered when designing product metaphors. Here are two possible ones. First, the usage or cultural context of users could affect the interpretation of a product metaphor. For example, the Desktop Metaphor, which is well adapted in the computer world, conformed to the environment of office. The second one is scene-level matching. In Figure 3.41 is a rug imaged as the moon. When users stand or walking on the rug, the metaphor completes: “I am on the moon”. The matching between the source entity and the target entity can go beyond the product but to a scene level. Along with case studies more about these could be found.

Chapter 3 Case Studies

3.1 Introduction

Practically the research question for the case studies is: can designers achieve a similar design by following the path suggested by the continuum and how can this be done? The case studies here likely belong to the type of plausibility probes (or theory testing case studies) mentioned by George & Bennett (2005)

Though how these products are actually designed and developed is very valuable, it is largely proprietary. Thus, the key of this study is not focused here, but on whether there is a method/approach that can reliably output design results similar to these products with metaphors of same or better quality (or allow designers to avoid low quality ones). This study can help testing possible methods and bring implications to advance current methods.

There are many cases required to cover the diversity and completeness of product metaphors. So, when reading, consider choosing one or two cases and go to the summary first, then revisit as needed.

3.1.1 Selection of Cases

Cases are selected by considering several dimensions. Some key ones are as:

- Covering products and design projects initially having different intentions.
- Covering from well-developed metaphors to metaphors with undesirable effects. A few looking-like metaphors or non-metaphors are also covered.
- Different product types are preferred.
- Enough of an amount.
- Different levels of product complexity.

3.1.2 What Aspects to Be Studied, or What Contents Are Expected

The contents will start with some basic descriptions and background of the product. Then some other basics will be answered, such as, how the product is (or not) a metaphor, what the source and target entities in the product are, and what the good or bad things of the metaphor are. Furthermore, the following aspects will be examined:

For testing the continuum

a) What messages are in this design? Are they intrinsic messages, extrinsic messages, or else?

b) In the continuum, is there a place for this design project?

c) How could intrinsic messages and extrinsic messages be used for searching for sources at the early stage? Can the searching activity follow the path of defined meaning or image schemas? (see Designs' Entry Points in 2.1.7 for the information about these two paths)

d) How good is this physical fusion? Does it well conform to the imagery-mapping via image schemas?

e) Are intrinsic messages, extrinsic messages and physical fusion enough to be the three main parts for the development of product metaphors? And if there are interplays between these parts, or between design tools working for different parts, what are the interplays?

f) What else is noteworthy?

For deriving the roadmap and developing the vacancy part in the roadmap

g) What the roadmap would be like for designers to achieve (or avoid) designs like this product example?

h) Is there significant inadequateness other than that noted in 2.7.2?

i) What does this case suggest for developing the vacant/inadequate design tool regarding image schemas?

There will be several case studies in such detail. However, there are many more product metaphors that can contribute, which makes it not practical to study and document all of them in such detail. To solve this, after several cases, more cases are discussed more freely. Since the contribution of many cases are diverse in a minor way but still important, the larger discussion is primarily about findings novel to previous detailed discussions. But issues that strongly strengthen or weaken findings in the earlier case studies are also mentioned.

3.2 Case Studies

3.2.1 Kastor Pencil Sharpener

Figure 3.21 Kastor Pencil Sharpener by Rodrigo Torres

This is a product that is relatively simple to understand and clearly has a metaphor in it. Kastor is a beaver-shaped pencil sharpener. It is a paperweight as well thanks to its solid construction (*Rodrigo Torres - "Kastor" / Alessi*, n.d.). In this metaphor, the target entity is a pencil sharpener, and the source entity is a beaver. Using this pencil sharpener can be fun and

playful. There is no strangeness that a beaver can sharpen a pencil. Overall, it is a good design of product metaphor, with no noticeable interruptions to the interpretation and appreciation of the metaphor. It does a good job on delivering experiential effects as well as hints of how the product should be used.

For testing the continuum

(a)

Interpretations differ among users. Here pick six salient messages:

1, the mouth to put in a wooden stick (/the hole to put pencil in);

2, the belly to hold what comes into mouth (/the container that holds waste);

3, a beaver nibbling to get the pencil processed (/the sharpening process);

4, the beaver standing up (/an electrical pencil sharpener is often able to be put on a table while being used);

5, a beaver being a friendly and cute animal. This is a relatively subjective message;

6, the abstract appearance of the beaver, plus the glossy metal surface, adds luxuriousness to the product. This is a relatively subjective message as well.

If using descriptions outside the brackets, they are related to a beaver, which seems to be extrinsic. However, if taken another way (i.e. descriptions in the brackets) to look at some of them, they are actually the different forms of what the base shape of a pencil sharpener has. Therefore, 1, 2, 3, and 4 are originally intrinsic messages, and are emphasized by the source entity. And 5 and 6 are extrinsic messages. Message 6 is not powered by the metaphor, which aligns with the definition of extrinsic messages, and the metaphor is not the only way to add value. Besides, 1, 2, 3, and 4 are function-related and are establishing the conceptual model of a pencil sharpener.

(b)

To find the position of this design in the continuum, information in the early stage of the design project is needed. So, the assumption needs to be made that the product successfully meets the designer's main expectations, so that it can be traced back according to what is seen. This assumption is applied to all case studies if no further specification is given. Given this, as for a design result like Kastor, making the pencil sharpener interesting or affectionate should be the most possible aim of the design project. It is evident that this design intends to provide some emotional experiences. Meanwhile, this is still intended to be a product for everyday use, so the functionality is still an aspect that cannot fail. This is a mixed pursuit. Therefore, messages relevant to both aspects (emotional experiences and functionality) need to be identified and taken into account for specifying the priority. Without going to a very definite answer to the priority, the project should lean towards the middle part of the continuum. This means both intrinsic messages and extrinsic messages could be higher priority than the other, and the importance of them do not differ a lot.

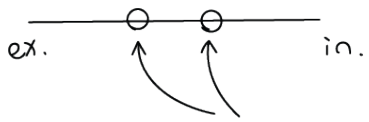


Figure 3.22 The position of this design in the continuum.

(c)

Hence, to get a design result like Kastor, designers could be in one of two different situations, generally. The two different situations are distinguished by which kind of message is higher priority. One situation is, designers want to make the product more acceptable or attractive, but they haven't decided the specific value to add in order to achieve so. Since, of this

product, the functionality is still an aspect that cannot fail, intrinsic messages are used for searching for the source entity. And because the playground for the metaphor will likely be the whole product, all major intrinsic messages are taken into account. Given that the continuum suggests a path using image schemas for depicting the conceptual model, here an extraction of image schemas from major intrinsic messages (not necessarily limited to message 1 to 4) is attempted. “The sharpening process is the ITERATION of ROTATION, whereas an electrical one is also the ITERATION, but without specified to be ROTATION. Or, it can be understood not so mechanism-oriented, but more straightforward, which is the ITERATION of material REMOVAL. The space for waste is a CONTAINER, on top of which there should be an entrance. Usually, the sharpening process is at the entrance so the waste can be perfectly collected, meaning the hole (where the pencil is put and also where the ITERATION happens) is the entrance of the container. There should be an exit as well. For a pencil sharpener it is much less frequently used, so it can be hidden in the final product. Conceptually any opening of the CONTAINER can be the entrance and the exit. What makes the entrance and the exit is the direction the follows IN-OUT. On the level of whole product, a salient element of source entity implicating (the keep of) BALANCE should enhance the aptness of source entity.” From this analysis a structure develops and can be used for searching entities. The results are candidates of the source entity, which should have their main structure effectively overlapped with the structure from the analysis. So far, the candidates should comply with a conceptual model of the target. Yet, they are not necessarily making a product more acceptable or attractive, so, an additional criterion or step should be performed, which filters candidates into those that can fulfill designers’ intensions of experiential aspects. Some of the searching criteria from MWDB (e.g. salience) should be good, for example, to filter the candidates by asking if acceptable or

attractive qualities, like cuteness, friendliness, softness, or etc., is salient to them. After the filtering, the beaver should be one of candidates left, and other candidates left should be good design variations.

The other situation is when designers know the specific values (e.g. the cuteness) that they want to add to a basic pencil sharpener at the beginning, or designers define them in a step just before the searching. To make the desired value an anchor while searching for the source entity, approaches relying on defined meanings (e.g. MWDB) should be apt and preferred. By following MWDB, the source entity is found through five criteria. The beaver complies to these criteria well: 1, saliently, a beaver is a cute and friendly figure; 2, working on a wooden stick makes the relatedness strong enough; 3, no huge deformity is needed for the beaver figure to contain parts of a pencil sharpener, which makes it mappable; 4, except metaphor, not many reasons exist for making a pencil sharpener beaver-like, so a beaver-like pencil sharpener should be uncommon; 5, the beaver figure is able to be in line with the functionality, so the completeness criterion is achieved. After searching, there should be candidates including the beaver and ranked by the criteria. Since the functionality is still an aspect that cannot fail, the matching of the user conceptual model should be a criterion as well, of which the 5th criterion has a tendency. The importance of the 5th criterion (i.e. completeness) elevates in this project, because of this additional and stricter requirement of matching the user conceptual model. It can be seen that, as a main force serving the part of extrinsic messages, MWDB has also taken the part of intrinsic messages into account, e.g. through this completeness criterion.

(d)

This is a very successful physical fusion, with no obvious interruption or confusion along the interpretation of both the source and target entities. And this physical fusion corresponds to

imagery-mapping following image schemas. Figure 3.23 shows how the source and target matched. Besides the imagery-mapping, the form design is possible to be complete with many common methods like finishes, styles of appearance, and etc., which is a great preservation enabled by image schemas. Another pencil sharpener design with a figure of beaver is shown in the picture, which uses a different design strategy.

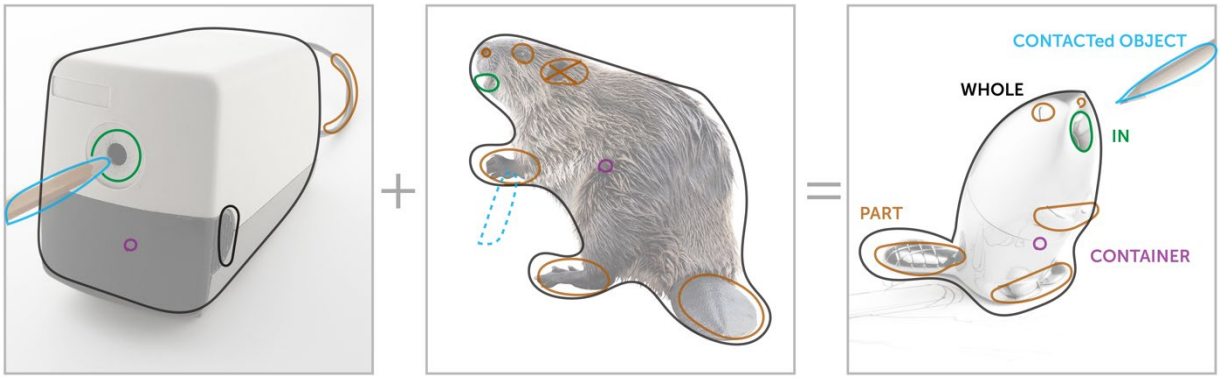


Figure 3.23 The imagery-mapping between a beaver and a pencil sharpener.

Figure 3.24 Another beaver pencil sharpener design.

(e)

So far, in regards of products like this, the three aspects, extrinsic messages, intrinsic messages, and physical fusion should be enough. According to above, there is an implication that

some interplays between design tools working for different aspects. 1, the image-schema structure used for imagery-mapping can overlap the image-schema structure depicting the conceptual model; 2, the imagery-mapping can inform the mappability criterion when searching by meaning; 3, the image-schema structure extracted from intrinsic messages can inform the completeness criterion when searching by meaning; 4, some of the criteria used in searching by meaning should be used for filtering candidates found by intrinsic messages (or, the image-schema structure depicting the conceptual model). These interplays suggest the order of steps and some linkages in the design process.

(f)

The beaver figured pencil sharpener is the artifact in focus, however, the metaphor could not be complete without the pencil or the wooden stick. So, the criteria and the matchings should be used in a scene-level. And, not only subjects in the scene, but also motions and actions work for the metaphor. The "scene-level" also implies specific action(s) could be hiding or non-existing without thinking in scene-level.

For deriving the roadmap and developing the vacancy part in the roadmap

There are some fragments of the roadmap appearing in the analysis above. By combining these fragments (majorly), reviewed approaches and the industry standard general design process, a very brief roadmap is drawn, as shown in Figure 3.25. This is not a general roadmap yet, but a relatively specific roadmap for getting to a design result of this product. A more general and instructive roadmap can be developed later basing on many product-specific roadmaps like this. As for developing the vacancy parts regarding image schemas, design tools are possible to be constructed from how image schemas are used in the analysis earlier in "for testing the continuum", such as, the extraction, depicting, marking-out matchings. Following

case studies could be the same that the embryos of design tools scatter in the “for testing the continuum”. As more cases are studied, a general roadmap and design tools could be constructed.

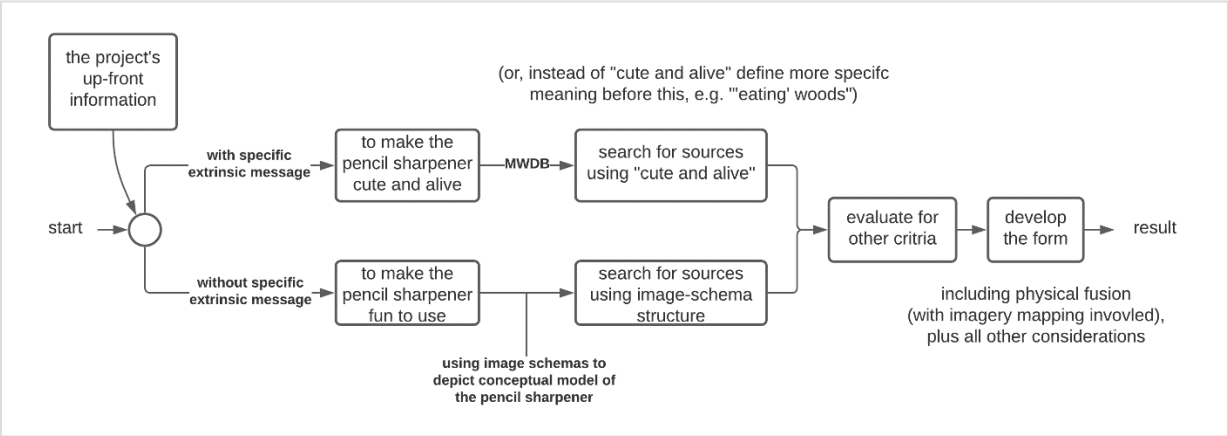


Figure 3.25 A brief roadmap regarding the beaver-shaped pencil sharpener.

3.2.2 The Desktop Metaphor

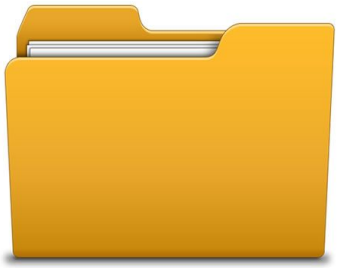


Figure 3.26 Folders and files in the desktop metaphor.

The Desktop metaphor on desktop computers is a well-known and broadly accepted metaphor. It consists of many concepts and the relations between concepts. The whole metaphor can be complex and repetitive in studying (e.g. notepad, trash can, cursor, selection and etc.), so, folders and files in this metaphor are picked to be investigated, and some related concepts are also mentioned (e.g. the desktop). In this metaphor, the target is data and algorithms lying in the abstract domain, which does not necessarily have concrete manifestations. And the source entity

is the folder, the file and etc., which often be seen or handled in an office environment, specifically on office desks. This metaphor gives the manifestation to abstract things, enabling people to manipulate them in a more understandable and tangible way. The broad acceptance implies this is a very effective metaphor in terms of computer functionality.

For testing the continuum

(a) (b)

In history, the creation of desktop metaphor hardly follows approaches based on the theories of conceptual metaphor, since even the term conceptual metaphor is not coined before then. However, using a successful metaphor to test newly proposed approaches has its own value. Specifically, the testing is to see if the desktop metaphor would be one of the end results, and starting with some salient messages this metaphor conveys:

1, a file is can be grabbed, moved and etc.;

2, a folder is a place to put one or more files, usually relevant ones are put into the same folder;

3, usually the desk is where files are processed, and there are other tools/accessories in this environment;

4, when handling the files, they can be arranged as wished, and there could be overlaps;

5, there could be multiple desks for different situations;

6, the yellow color of folder in the figure helps users think of a literal folder. (Besides, it could give a feeling of joy, or less boring. These are read from Figure 3.26, however, the initial implementation of the desktop or folder metaphor was not colored, so it's hard to say any effect of the yellow color was initially intended).

There are more implications people can infer from physical files, folders and desktops. Above are just some of simple and salient ones. Among them, message 1 to 5 should be intended messages and can be traced back to what we want to do to data and algorithms:

1, we should be able to manipulate data chunk by chunk, topic by topic;

2, there should be a way to mark data to be relevant, in order to find certain data easier;

3, data are manipulated in running programs, so people need a place to monitor and configure these active programs. Besides, there are various supportive programs supposed to be started easily;

4, it will be useful if we can bring up (or, jump to) certain active data and programs right away, without losing track;

5, data and programs can be about different tasks, and should there be a way to bring them up respectively all at once.

These are all intrinsic messages, because all five lead to bare functions of computers. The reason to have a metaphor in this product is to make the communication about these functions greatly effective across people having limited expertise of computers and programing. This design project should be located somewhere near the right end of the continuum, where the intrinsic messages are the priority.

(c)

In order to search the eligible source entity, first needed are functions like above but more accurate and complete ones, which emphasize on the key ones in terms of conceptual models. Then attempts should translate these functions and corresponding conceptual models using image-schema structures. This should be done using part of Hurtienne's approach, which is to learn from users' utterances. First, target users as interviewers are put into task context, and

questions are asked. Then, information is collected and analyzed, which should tell what functions are needed and how users understand specific concepts and actions appeared with functions. At the same stage, image schemas can be extracted. The target users and usage context are the key to what conceptual model designers could have. Researchers at Xerox PARC (Palo Alto Research Center) focused on applications on individually equipped computers for words, design and communications, while the mainstream then dealt with number and data manipulation (Carlson, 2017). It is not hard to get to a conjecture that conceptual models basing tasks on words, design and communications should be suitable and some concepts from the physical working space of them are borrowed. As a result, files, canvas, folders, and many other physical entities becomes representations of data and algorithms metaphorically. After being borrowed, files remain to be OBJECTs, folders remain to be CONTAINERs, desktops remain to be SURFACEs, and etc.

(d) (e)

The physical fusion in a virtual product is a difficult part to look into. Based on the analysis perspective in a book (Gentner, Holyoak, & Kokinov, 2001, p. 267), here is one example of where the source and target stitch together. When a file is selected, it is marked or highlighted. This corresponds to the physical actions like “hold”, “grasp”, or “in attention”. The source entity and the computer are essentially different things, meaning the interaction will be different. What we see on the screen is the form of file, which belongs to the source, and new emerging signifier, which belongs to the target. The folder and the signifier are in CONTACT, which is in line with the physical world that when a file is held, the hands or tools holding it are in CONTACT with the file.

(f)

The desktop metaphor is complicated and the analysis here is very limited, so it is hard to say that intrinsic messages, extrinsic messages, and the physical fusion are covering major design specifications for developing a product metaphor like desktop metaphor. The desktop metaphor is a result of years' development. It gets hard to address further findings. However, one thing is vaguely possible to be an additional consideration needs attention, which is the *user community*. Users in the same community could share similar knowledge and expertise, could share similar goals and missions, and could share similar habits and tendencies. The user community constrains considerably the scope of source entities, like this desktop metaphor. If designers use image-schema structures to search for sources without thinking of the user community, there are many candidates that could be strange, e.g. farm fields, solar system, and many more. Or, if not doing the conceptual model research with target users, the conceptual model would be different and lead to much different candidates. For a serious product, it would be crucial to constrain the source to be meaningful around the community, and applicable to the tasks and missions of the community.

Besides, the desktop metaphor as a metaphor with an abstract and virtual target has its uniqueness. One of the characteristics is that the target entity is easily arbitrary. This could be the reason that we need to assume no confidence on what the target is like and learn it from users. Another one is the source can be extremely abstract that only implies image schemas, but not a literal entity. For example, smartphones now are using rounded rectangles to represent CONTAINERs. There could be more, but this makes virtual interfaces beyond the scope and capability of this research.

3.2.3 Xerox Copiers

Figure 3.27 Left: Xerox 1075, middle: Xerox 1090, and right: Xerox 5060 (picture from Xeroxnostalgia.Com – Early Xerox Products and History).

Xerox copiers are mentioned in *The Semantic Turn* (Krippendorff, 2006, p. 98) as examples of product metaphor. The book considers them to be a metaphor with the source entity "desktop", but it doesn't mention the specific model of the copier. It mentions several attributes making the metaphor, and this thesis takes three of them as convincing. First, the overall shape and size of the machine is desk-like. Second, office workers handle things on the top of the machine, which aligns with a desk. Third, there are drawers for paper storage, which at the time are new to copiers but easily seen on desks or other furniture. According to the website (same website as the source of Figure 3.27), there is more information. Xerox 1075, which launched in September 1982, did not yet have a drawer-like paper storage. Later in February 1985 was announced Xerox 1075. And no later than 1988, Xerox 5060 appeared. Xerox 5060 has four drawers for paper storage, and different drawers are for different papers (XEROX, n.d.). The first two attributes don't emerge in-between models shown above, whereas the drawer emerges distinctively. In spite of this, all these attributes participate in the development of this desk metaphor. Xerox 5060 is taken as the expected quality of design result in terms of metaphor

(while Xerox 1075 is taken as the conventional design result of the same product). This is a good metaphor since it makes the introduction to new functions smooth without introducing any confusion and inconvenience. It makes good use of previous and everyday knowledge, and newly applies them to a product innovation.

For testing the continuum

(a) (b)

This use of metaphor is clear. Here are some messages:

1, overall it can be treated as a furniture in the environment of office;

2, the top of it is where interactive parts and operations concentrate;

3, drawers are storage places with high accessibility, and they serve different types of contents;

4, blue color makes some parts more noticeable than other parts.

All four messages assist functionality of the copier and are rephrased into possible design specifications used in early design stages, as such: 1, the machine is not the focus in the workflow and requires no heavy expertise, and it stays out of sight when not needed; 2, it is more comfortable to operate at the height about the chest and belly; 3, paper as consumptions should be stored in highly accessible places, and paper types are different; 4, some frequently used and interactable features are distinct by colors, in order to easily draw attentions of ordinary users. The latter three messages exist in the base shape of a copier, meaning these are intrinsic, while the first can be interpreted as a quality of being “hidden”. As the reason to employ a metaphor, this implies the metaphor helps the functionality the most, so, if wanting to conduct a similar design project, the project should be located somewhere near the right end of the continuum, where the intrinsic messages are the priority. In the original design project of these copiers

should have other specifications easily, but being the most outside level of semantic layer, these four should be the key ones.

(c)

These four desired specifications are concrete, simple, and already user-centered. So, if simulating a design process, the extraction of image schema from these specifications can take over from this point, but not necessarily an extraction directly from users' utterances. (This is to say, if specifications or similar information are user-centered enough thanks to well-adapted design processes, image-schema structures can be constructed from things other than users' utterances.) Here is the attempt of extraction: "The WHOLE product has common shape of what target users (i.e. office workers) often see. The top PART of it is a SURFACE facing UP where many operation-related components are contained. Here the height of SURFACE is not constrained since changing the size of source entity does not easily break the recognition of the source. Then, in the product, there are CONTAINERs for papers, which is another type of PART. The openings of these CONTAINERs are explicit on the appearances, and they are arranged as a COLLECTION. In addition, these openings have the force of ATTRACTION, which can be enabled by several means, e.g. they look BIG comparing to other elements on the appearance, whereas the specification already brings an option of attractive colors." The extraction result is shown as an image in Figure 3.28.

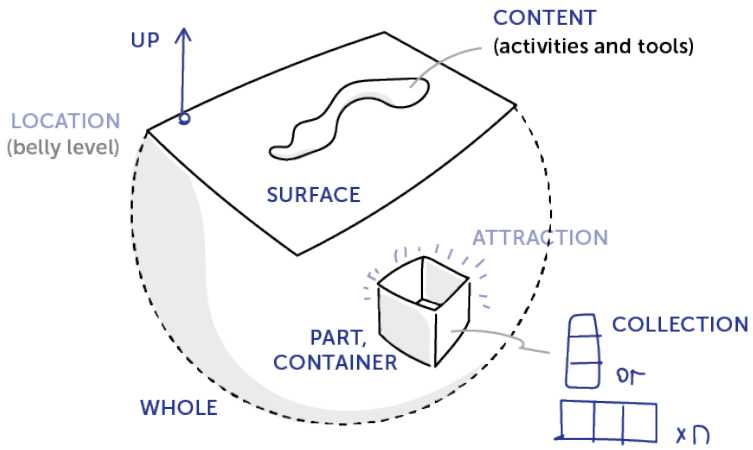


Figure 3.28 An image showing the extraction result.

Next, a search begins for source entities through this structure of image schemas, bearing mind what target users often see, and what harmful messages (or inferences) the source entity can bring. As mentioned in *The Semantic Turn*, in search of a good metaphor, target users' workflow and environment are looked at. Without minding what target users often see, the source entity can be strange to target users, just like the solar system mentioned previously in the desktop metaphor. This leads to the criteria in MWDB, specifically the relatedness. In MWDB the relatedness is mainly about how acceptable the source is when it appears in the certain environment and the interestingness of the metaphor. Here, the relatedness is mainly responsible for the former. As for the harmful messages, other criteria in MWDB can help, for example, the salient quality of the source candidates is evaluated to prevent harmful candidates. So, just like Kastor (a beaver-shaped pencil sharpener), the approach of MWDB is supplemental to use image-schema structures for searching source entities. Besides the source bringing harmful extrinsic messages, it can also harm the product functionality, so major intrinsic messages of the target entity except those used for searching the source also need to be taken into account in the

evaluation, where the image schema could come into play again as one of tools. As the result of all, the desk (with drawers) metaphor is found. Objects like desks, dressers, and etc. all work the same.

(d)

Now it comes to the form-giving stage – the physical fusion. Overall the fusion is good, since no obvious interruption or confusion along the interpretation of both the source and target entities. And how the physical fusion corresponds to imagery-mapping of image schemas is summed in the Figure 3.29. The same as the Kastor pencil sharpener, the imagery-mapping enabled by image schemas gives significant room for other features. Many components are plunged into the desk figure without interrupting it, as long as the mapping structure remains.

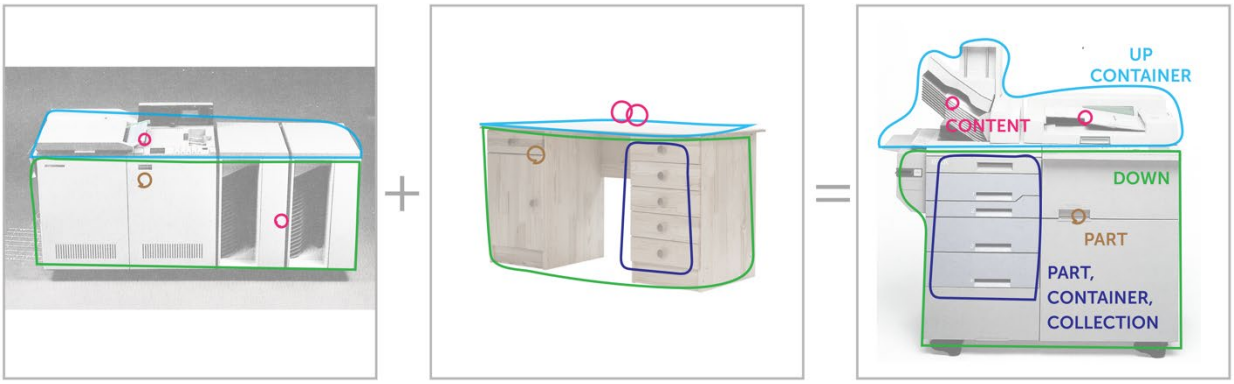


Figure 3.29 The imagery-mapping between a Xerox copier and a desk.

(e) (f)

Despite the extrinsic messages being not much involved in this case, this case remains in the frame of the three aspects. It mostly follows a path which is from some intrinsic messages as design objectives to the physical form-giving. After Figure 3.28 and Figure 3.29 are compared, this case makes one of four interplays (addressed in the Kastor case) more evident: the image-schema structure used for imagery-mapping can overlap the image-schema structure depicting

the conceptual model. Besides, there are some clues strengthening the finding that approaches relying on meaning and approaches relying on image schemas can be supplemental to each other. It means the source entity cannot bring effects of the intrinsic message and the extrinsic message separately, so, designers should not overlook any one of them when the design objectives focus on the other one. One possible reason is users won't automatically pick one type of messages to receive but interpret the product in all angles they are familiar with. Finally, as for the question "What else is noteworthy?" The answer is the user community, which is discussed earlier in the attempt of extraction as well as in the case of the desktop metaphor.

For deriving the roadmap

In the same way as the Kastor pencil sharpener, some fragments of the roadmap appear along the analysis. But this case is a bit simpler, without the branch in the case of Kastor. The brief roadmap specific to this case is pulled together and shown in Figure 3.30.

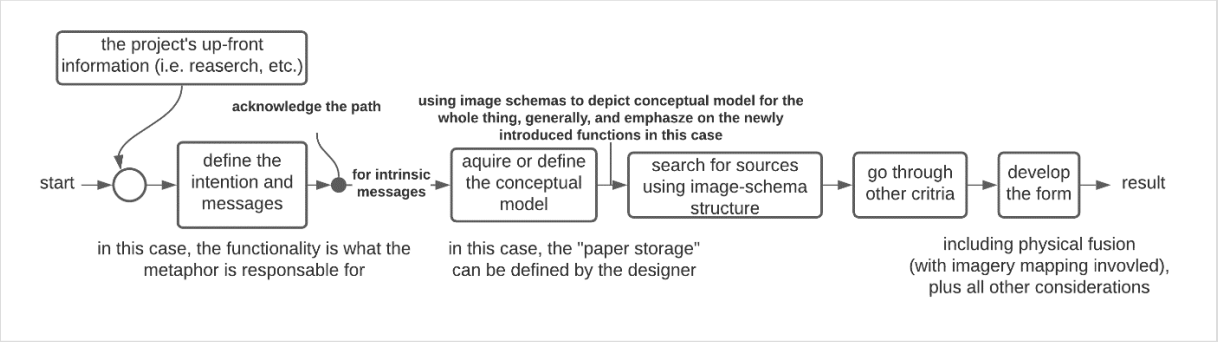


Figure 3.30 A brief roadmap regarding the desk metaphor in copiers.

3.2.4 Meeting Owl Pro from Owl Labs

Figure 3.31 Meeting Owl Pro from Owl Labs

The Meeting Owl Pro is a device for remote meetings, which is a combination of a 360-degree camera, mic and speaker. In this product, the combination is the target, and the Owl is the source. To design the combination, as one of options, the form can be basic geometries that fit the technologies and aesthetics. Owl Labs decided another option, which is to give the combination a well-known figure from a domain remote from electronic, office, and technology. The Owl is their figure. An owl can be soft, peaceful and attractive through furriness and cuteness. And an owl is good with eyesight, which implies a good performance of the product. These all benefit a remote meeting scenario, both emotionally and technically.

For testing the continuum

(a)

This product presents many messages and here are some most useful ones (most frequently used, effective and important ones):

1, the whole thing looks simple, and the roundness makes it soft and friendly, plus, with the owl figure it feels peaceful;

2, the shining “eyes” can mean sharpness of the spirit, and the impression that owls have intelligence and good eyesight implies the performance of camera is smart and good (plus, owls stay at the silent nights and watch);

3, (as an indicator of camera being on/off,) the “eyes” align with the fact that owls see when eyes open and owls don’t see when eyes closed;

4, owls make sounds when awake just as many other animals do (/speakers make sound);

5, owls listen (/mics listen);

6, owls fly;

7, the “head” part is delicate.

8, there are buttons appearing and performing just as industry conventions, e.g. the mute.

It is not hard to develop a device like this into forms without message-1 and still having the same functions, so message 1 should be extrinsic. As for the rest, some are communicating functionality explicitly, which are intrinsic messages, including messages 3, 4, 5, and 8. Messages 3, 4, and 5 can be translated into functional form of messages shown in the brackets. Message 8 is conveyed through design conventions. Since these conventions are minor in the product, they are not interrupting the metaphor. Messages 2, 6, and 7 can be related to the functionality as well, but implicitly: 2, the sharpness and the smartness, and the good image quality of the camera; 6, remoteness, distance; 7, technically the camera can be delicate, especially the lens. Among these, 6 and 7 are not major properties that urgently need exploration, and even the association between these qualities of the owl and the related properties of the device seems farfetched, meaning 6 and 7 could be more of the user’s interpretation but not what

designers initially intended, and they can be considered as side-effects of using the metaphor. However, message 2 is an important message that brings delight of the product. And this is interesting because it is not so clear whether this is intrinsic or extrinsic. The smartness and good image quality do not sound like descriptions for functions, but the interpretation of functional descriptions from the perspective of humanity. They are not concrete and neutral enough to be functional descriptions or intrinsic messages, but they are emphasizing intrinsic messages with honesty. Back to the development of metaphor, they are in the same form/modality as added values, which are very useful information for source-searching. So, this thesis would promote them as *value-modal intrinsic messages* (or *valued intrinsic messages*). As the result, they should be able to be used in meaning related design approaches and methods, as they can also lead back to or be analyzed into image-schema structures which are reflecting the functions.

(b)

The next is to answer the position of a design project like this in the continuum. Since this product is supposed to be capable of some commercial-level usages, the functionality is more important than emotional aspects. Otherwise, the employment of conventions will not be as apparent. Nevertheless, it is evident that the designers are not pursuing high level seriousness but to provide some level of emotional care or inspiration. In sum, it is a loose balance of functionality and emotional aspects under a clear awareness of functionality being a bit more important. In between extrinsic and intrinsic messages the metaphor is responsible for, it shares the same kind of balance. A design project like this should fall in the middle-right part.

(c)

Assume a design project has message 1, 2, 3 and 8 as the primary specifications, and 4, 5 as the secondary, among which 8 is a bit more flexible than 1, 2 and 3. Here is a sorted-out

version: 1, the device overall feels simple, friendly and peaceful; 2, the device's main functions are smart and reliably performed, where the camera is smart and good in image quality; 3, there is the indicator of the camera on/off status; 4 and 5, there are speakers and mics in this device; 8, there are other detailed but important functions like mute, power switch, and etc. As mentioned in 2.7.1, what type of information we have for searching a source entity tells us what path to apply. For this reason, source entity is searched for according to 1 and 2, through the approach from MWDB, with some possible domains of source entity in mind as inspirations. Message 3 is not used here because the reason to employ a metaphor in the product is more to concentrate on 1 and 2. Some possible domains are mentioned in 2.6.4, e.g. animals. Starting with salience, friendly, peaceful, smart and "clairvoyance" can be salient qualities of some creatures, some professions or etc., and from a group of designers or by taking more time, there should be more possible choices thought of. Then, relatedness requires the source entity to show up in the design result to be acceptable for target users, for example, a buddha is not as good as an owl because a buddha is not common and simple as an owl, which makes buddha pickier on a suitable target and the remote meeting device is not it in this case. Then, novelty-vs.-understandability actually can be balanced along with relatedness. The next is completeness, where possible source entities can be evaluated with the help of image schemas converted from messages 3, 4, and 5 and other major intrinsic messages. "Light rays, which convey visual information, can be accepted by opening(s) on a CONTAINER. Opening(s) is/are the PART(s) of the CONTAINER, and its/their status can switch between ENABLED and DISABLED. The opening(s) provides a conceptual force of BLOCKAGE if DISABLED. In addition, the indicator, i.e. the opening, should be ATTRACTIVE when ENABLED. As for the sound going IN-OUT, it is similar to light rays, but with less importance." Before the help of this structure, the contribution to functionality required

by the completeness criterion is already made (though limitedly), because the valued intrinsic messages are derived from intrinsic messages. This structure allows the contribution to functionality to be stronger or unharmful. At this point, the owl should be one of candidates with high satisfaction. The final criterion is mappability, to which a good mapping tool can bring some insights. So, let us move on to the physical fusion.

(d)

The physical fusion of the source and the target in this metaphor is strong. Features from the source and the target are not obviously fighting with each other or make the product split into two things. In Figure 3.32, how this physical fusion corresponds to imagery-mapping of image schemas is revealed. Besides visual properties, the sound made by owls is also fused into the product, which is an example showing that the fusion can happen in many modes. In addition, this is an example of the multi-modality of image schemas, where the sound can be understanding as SUBSTANCE going IN and OUT the owl as an OBJECT. The same as the Kastor pencil sharpener, image-schema structure leaves a plenty of room for applying different design strategies. In this product, the simplicity, the rounded visual elements, the white color, the mesh texture and more are those strategies, which have no interruption on the interpretation of source. And the same as the Xerox copiers, components are plunged into the structure without obvious damage to the owl figure, for example, the logo and the mute button. It should be noted that, this design does not make the mute function metaphorically represented by, for example, providing a switchable and beak-like physical element, which can enhance the metaphor but likely costs more and could mar the simplicity or usability. In sum, by preserving the image-schema structure, the selected source entity can be employed into the product effectively.

Figure 3.32 The imagery-mapping between devices for remote meeting and an owl.

(e)

Then the design solution is developed. The three aspects, i.e. intrinsic messages, extrinsic messages and the physical fusion is enough to contain major aspects when developing metaphors in product design, since the process from design specifications to the valid design solutions is smooth, which is based on these three aspects. No obvious roughness means no big missing parts outside these three. In this design case, some interplays between these three and their corresponding design methods are found. One of the interplays is about the valued intrinsic message. The valued intrinsic message is relatively special and stands in-between definite extrinsic messages and definite intrinsic messages. It can be used in meaning related approaches. And strictly it should be derived from functions. If not, they are not valued intrinsic messages but extrinsic messages. Another interplay is, the image-schema structure helps possible source entities in making sense of functionality by participating in the criteria for source-searching. This again means approaches relying on image schemas (to the physical fusion as well as to the source-searching with intrinsic messages) can be supplemental to approaches relying on meaning. And the third interplay, also again, is that the image-schema structure used in source-searching stage overlaps a lot with it used in the physical fusion stage.

For deriving the roadmap

A roadmap of the anticipated design process is organized and presented in the Figure 3.33. New to what is proposed in 2.7.1, the implication about valued intrinsic messages suggests that approaches relying on defined meaning can also be used in some cases when intrinsic messages are in priority over extrinsic messages.

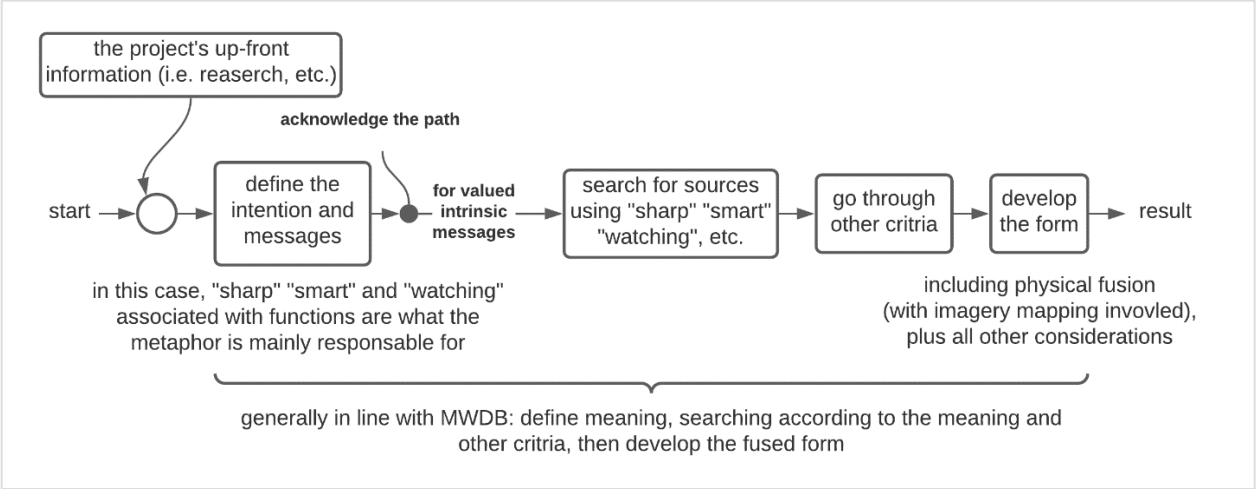


Figure 3.33 A brief roadmap regarding the owl-like remote meeting device.

3.2.5 Surveillance Chandelier

Figure 3.34 Surveillance Chandelier by Humans Since 1982

The Surveillance Chandelier by Humans Since 1982 mainly is an artwork. In a practical sense it is also a functional chandelier consisting of six spotlights. A chandelier is the target entity in its metaphor. And the surveillance camera is the source entity. Ideologically, it is supposed to remind us there can be Big Brother watching us everywhere, by introducing the figure of surveillance cameras into our private area (Hekkert & Cila, 2015). The expression is clear and strong, and the metaphor is successful. Though it is functional, it is not practical enough for common users since the meaning it expresses is too aggressive and artistical to fit in the common environments for a chandelier.

For testing the continuum

(a) (b)

The intended message in this design is clear and straightforward: there can Big Brother watching us everywhere (or over-surveillance), which is an extrinsic message to a chandelier or spotlights. It is possible to read other messages. For example, the disordered cables mean being careless when it comes to peripheral elements. There could be other messages a typical chandelier can bring us but are missing in this design. For example, while a typical chandelier tries to offer the wide and unified light, this design implicates differently, which is more focused light, or even opposite, which is collecting light but not offering it. The missing is acceptable because in an art-oriented design the extrinsic messages are largely prior to intrinsic messages. The messages being the reason to employ this metaphor share the same priority. This priority in terms of messages means, when designers first create the design project like this case, its position highly likely belongs to somewhere near the left end of the continuum (i.e. near the end of extrinsic).

(c)

In order to get a product metaphor with similar or better quality, here anticipates a process mainly following MWDB. To design a chandelier conveying the message of over-surveillance, the message is used for searching source entities. Things or people like uninvited camera, mics, or special agents appearing in our private areas bring a feeling of over-surveillance as a salient quality. There could also be more possibilities. Regarding relatedness, devices should be better than people, but by making use of synecdoche it is possible to get some source candidates in the sweet spot of relatedness. For example, the relatedness can be enhanced by using a special accessory an agent wears (e.g. armband). The completeness can be evaluated by the conceptual model depicted by the image schemas. The main image-schema structure is shown in Figure 3.35. The novelty is less important and balanced along with relatedness. And the mappability can evaluated by a rapid examination of pre-imagery-mapping for each of source candidates. The surveillance camera should survive all criteria.

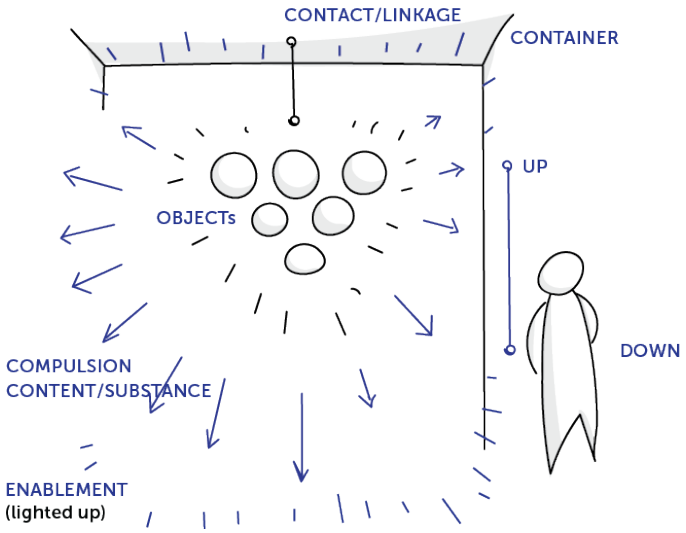


Figure 3.35 An image showing the main image-schema structure.

Interestingly, tracing back to possible design process of this specific artwork, there is a second but more possible path, where the chandelier is not initially decided but determined

according to the surveillance camera. In this process the source entity is defined according to the intended message before the target entity. Then, designers look at products common in private areas for the target entity, in order to find one that perfectly carries the figure of surveillance camera. It seems this process deviates a lot from target-first processes. However, the MWDB and the image schema are still widely effective in similar ways. The basis is still from messages to searching entities, and finally to the physical fusion. The surveillance camera has surveillance as the salient quality, so, in order to accomplish the message of over-surveillance, "being in private areas" is defined, which is decided to be supposed salient quality of the unknown target entity. Then, the image schema contributes to the evaluation about reasonableness in terms of functionality and the mappability, and to the actual physical fusion.

According to Hekkert and Cila (2015), the intention behind the message of over-surveillance in this design is to provide "food for thought" (p. 201). This is another path to a design result like the surveillance chandelier, where the extrinsic messages are open and not necessary to be as strong as artistic expression. Actually, if a design project has "food for thought" as intention, it fits more in emotional acceptance or attractiveness, which is in the middle part of the continuum. And the same as the Kastor pencil sharpener, two situations are possible. In one situation, the extrinsic messages come first, where the intended meaning is defined according to the "food for thought" intention and then the image-schema structures help with the evaluation and selection of source candidates. This situation will lead to a process the same as the first process anticipated earlier, if over-surveillance is defined to be the intended meaning. Or, there could be other meaning fulfilling the "food for thought" intention but likely making not much difference to the process. In the other situation the intrinsic messages come first, where image-schema structures are used for representing the conceptual model of a

chandelier. Then the source entity with similar structures are searched, along with which the candidates are filtered according to the extrinsic messages the source can bring to the product. There is a problem for this situation. The conceptual model of a chandelier likely would not suggest the surveillance camera to be the source entity, since, as some main intrinsic messages, the focused lights and the wide and unified lights, or, collecting and offering, are conflicting with each other. Here Liu's research (2016) is able to resolve the problem. In her research, some prudent violations of image-schema structures of the target entity is one of the means to bring novel experiences, intended expressions and more.

(d)

Then it comes the phase of physical fusion, regardless of how the source is found. This Surveillance Chandelier by Humans Since 1982 is a good result of fusion. Figure 3.36 shows how effective the imagery-mapping can support the fusion result of this design.

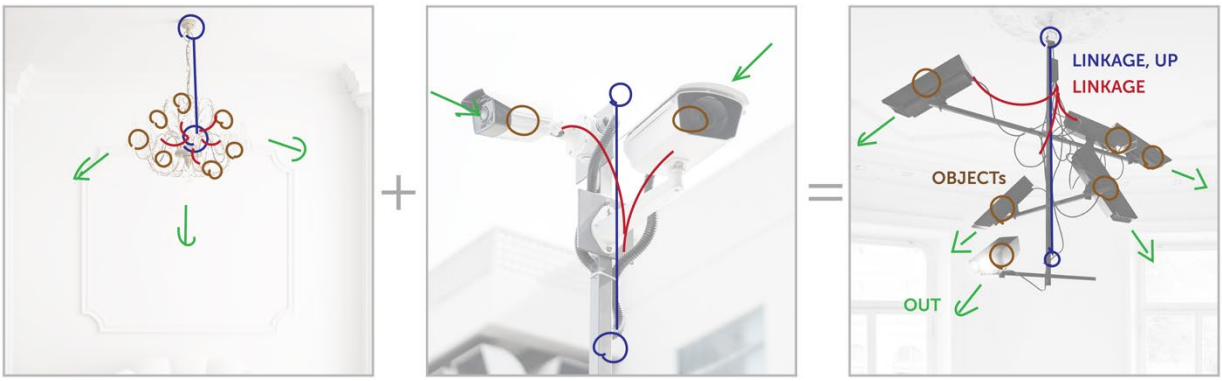


Figure 3.36 The imagery-mapping between a chandelier and surveillance cameras.

(e) (f)

The adequateness of intrinsic messages, extrinsic messages and the physical fusion becomes clearer and clearer from case to case. Especially in this case, even though there are multiple possible paths, the three parts still hold for each of them. The same as previous cases,

this case implies approaches relying on meaning and approaches relying on image schemas are supporting each other so that a good product metaphor can be provided. Also, the finding continues that the imagery-mapping is supporting the MWDB and overlapping with the image-schema-depicted conceptual model of the product. However, there is one layer to add to the three aspects when constructing the general roadmap, which is the intention. The intention should be in front of meaning or the image-schema-depicted conceptual model in the process. It is already promoted in MWDB, but not yet clear enough in terms of how it can affect the process and more.

For deriving the roadmap

This design suggests multiple potential roadmaps, which are shown in Figure 3.37. In order to cover as large range of the intentions to employ metaphors as possible, the roadmap regarding artistic expressions will be considered for generating the general roadmap.

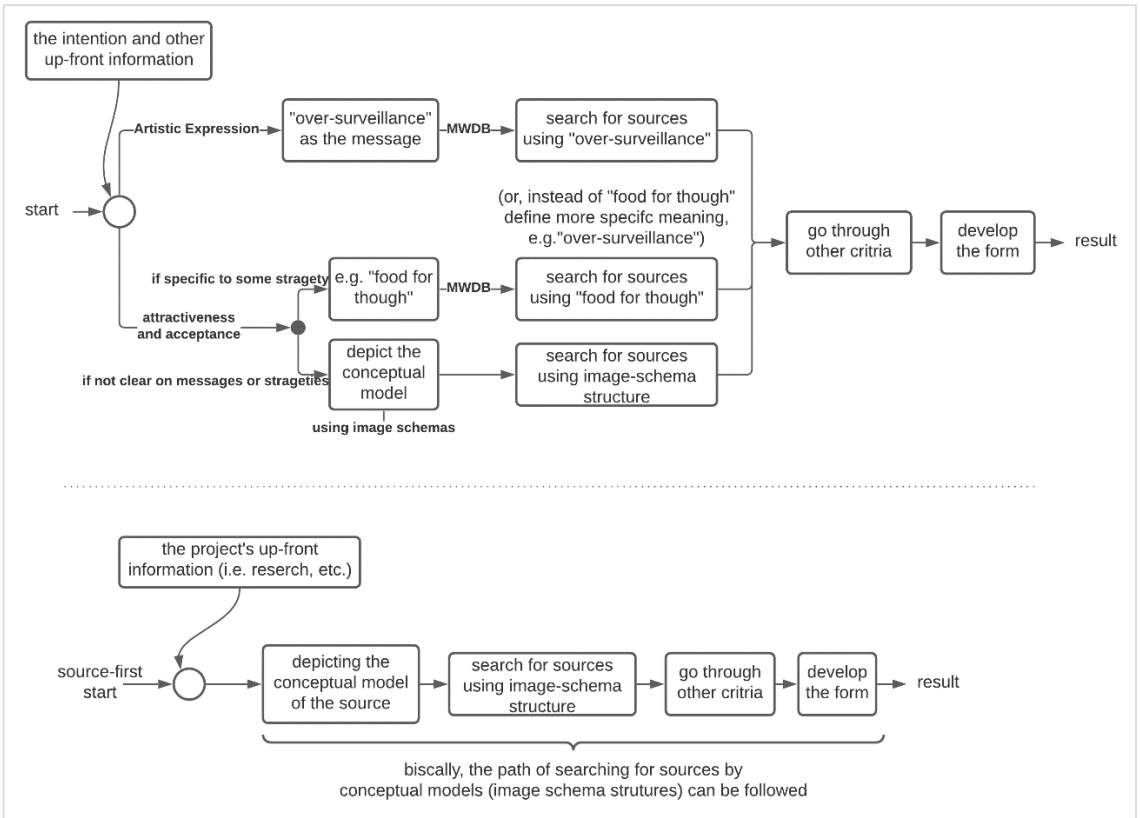


Figure 3.37 Several brief roadmaps regarding the Surveillance Chandelier.

3.2.6 Rosaria Rosary

Figure 3.38 Rosaria rosary by Joe Velluto

While products similar to surveillance Chandelier by Humans Since 1982 shifts its intended messages, Rosaria rosary by Joe Velluto is more definite regarding artistic expressions. So, the Rosaria rosary is studied. The target in the metaphor is the rosary, and the source is bubble wrap. According to the designer's online webpage (*RosAria | JoeVelluto Design*, 2018), the meaning ascribed to the product is that the rosary is not the key, but the churchgoer herself/himself, human, and the activity of praying itself are. The webpage says the designer wants to release the attention and spirituality occupied by the rosary and give it to the churchgoer and praying, by making the rosary an apparently industrial and easily disposable product. This is an effective solution since it can reduce the perceived value of the rosary. The disrespectfulness is a potential misreading. However, this misreading is partially rooted in the intended message, so it is hardly avoidable for many if the expression is strong. The protection is another potential

misreading since it is a salient quality of bubble wrap. In order to eliminate these misreadings, the acknowledgement of the reasoning behind the product is needed, e.g. to read descriptions on the webpage. Once the designer's idea is acknowledged, the interpretation of Rosaria rosary is restrained, and Rosaria rosary becomes great and strong in expressing the idea that the key is not the rosary but the human and the praying are.

For testing the continuum

(a) (b)

Being expressive, this design focuses on a clear message: the key is not the rosary but the human and the activity of praying. This is an extrinsic message. To be the only message as being the motivation to employ a metaphor, it makes the position of design product near the left end.

(c)

This message is a bit too general, so, in this design it is enabled by more practical messages, i.e. the rosary itself should not be precious or occupying, which is an insightful conversion. The design tools for reproducing such conversion is hard to be constructed and beyond the capacity of this thesis. Therefore, the anticipation of possible design process will take the more practical messages as the aim directly. Then, since the messages is in a modal of meaning (or added value), the process is anticipated by basing on the approach from MWDB. Hance, the five criteria are used for searching and selecting the source entity. Along with the bubble wrap, cardboard, Google's search page, tin cans and many others are noticed as their salient or second salient quality is being economic, industrial and less occupying. To be secondly salient is allowed here because, as for a design aiming at artistic expressions, users can be forgiving on the implicitness of the message if the message is highly meaningful, and additional information helping with the understanding is more welcomed. Novelty means a lot about how

strong and distinctive the expression can be. As the result, novelty is more enforced than the salience. Though the relatedness is still in designers' awareness, it is not so enforced in this case because of artistic expressions also. Coming to completeness, the source to make a functional contribution is beneficial to the significance of the design because it enhances meaningfulness from idea to the extent of usage and functionality. Besides, the design is still a product meant to be used. Image-schema structures should help. The use of rosary is about COMPULSION on chained (COLLECTED and LINKED) OBJECTS one by one. By conforming with the structure accordingly, it will make the source entity less of a decoration but more reasonable and deeper. Till now, plastic bead chains for rolling shade or other candidates are still competing with the bubble wrap, where the mappability challenges next and tools for physical fusion should be able to give some implications.

(d)

The physical fusion of the source entity and the target entity is good enough. As shown in Figure 3.39, the fusion highly likely conforms with the image-schema structure preservation. Attributes form the source like materials, colors and manufacturing technics are brought to the target, without twisting the target into unrecognizable. Actually, the target is highly recognizable.

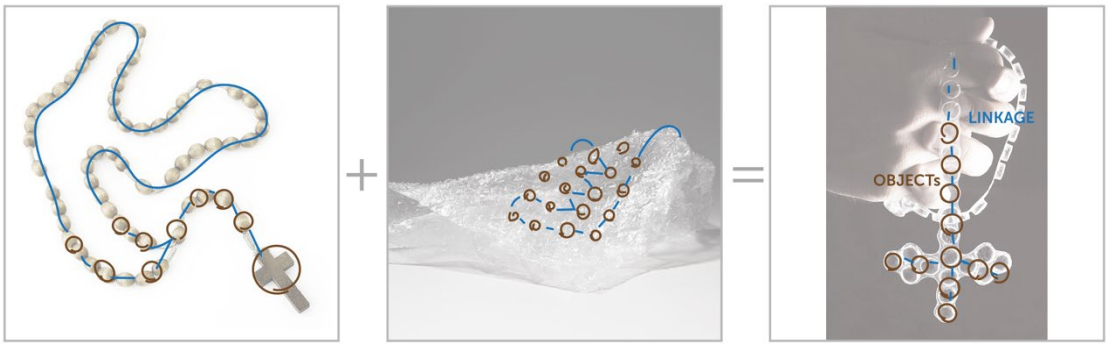


Figure 3.39 The preserved image-schema structure of a rosary and how the bubble wrap be imagery-mapped.

(e) (f)

Two kinds of messages and the physical fusion cover major considerations in the development of this metaphor. The interplay suggested in this case are not new to those addressed in previous case studies, so they are not repeatedly talked about. However, there are specific things needing notice. Patterned design processes are hard to follow for artistic expressions. As can be seen, there are some impactful modifications for the approach from MWDB to satisfy a design process of this product, e.g. the modification about salience criterion. So, effectively covering artistic expression is beyond capability of this thesis. But the process in general is following the structure consisting of meaning, source searching, and physical fusion. And some details, e.g. some of the criteria, are still useful as loose considerations. Plus, in terms of intrinsic messages and the physical fusion, the image schema is still helpful. Besides the general structure still being valid in this case, what makes this difficulty less damaging is that the intention of artistic expression is not as significant in product design compared to other intensions, and it lives in a narrower range next to the left end of the continuum because of the extreme priority of the extrinsic messages.

For deriving the roadmap

The potential roadmap suggested by this design is shown in the Figure 3.40. Same as noted in the last case study, in order to cover as large range of the intentions to employ metaphors as possible, the roadmap regarding artistic expressions will be considered for generating the general roadmap. Given the characteristic of artistic expression projects, the contribution this roadmap makes is not as weighty as other roadmaps.

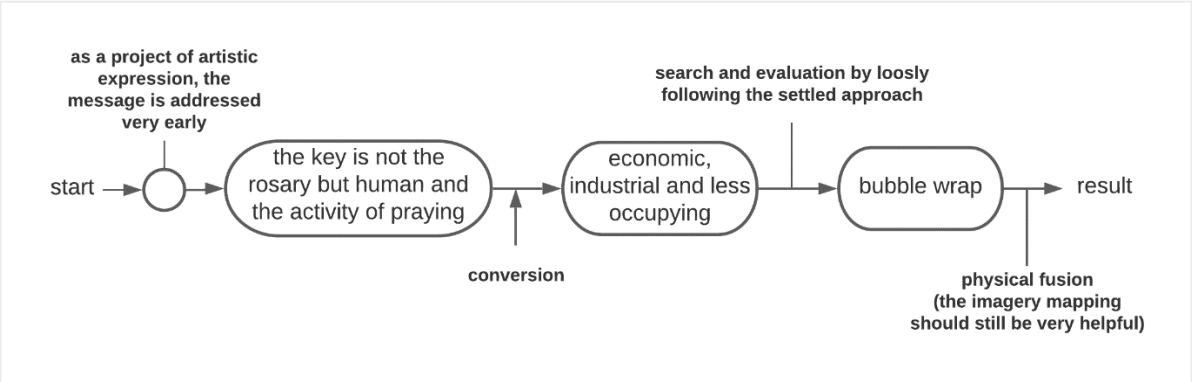


Figure 3.40 A brief roadmap regarding Rosaria rosary.

On upcoming cases

So far, the cases distribute evenly in different intentions, of experiential and of practical, as well as around the vague border of these two. Upcoming cases will be discussed more freely and will try to provide noteworthy novel findings. Some aspects and information patterned in earlier studies are included but not repeatedly detailed, for example, the Figures about imagery-mappings will be provided accordingly for the development of design tools regarding image schemas.

3.2.7 Luna Rug

Figure 3.41 Luna Rug by Nanimarquina

Luna is a rug featuring the picture of moon. This rug is the re-edition of La Luna rugs from the ’80s, which is originally a design by Oscar Tusquets. In the metaphor, the moon and the rug are the source and target entity respectively. Scene-level matching is critical to this design, since the experience completes when we stand or walk on the rug, which guides us to an imagination of being on the moon with feet touching the soil of the moon. Or the experience completes when the rug is hung on the wall, where the rug together with the wall become the sky. Every major element/object involved in the task needs attention. Without the scene-level effects, the rug itself could just be a soft picture be placed somewhere. To come up with a similar design result, two paths are possible, which is the same as the study of the Kastor pencil sharpener. But there is a minor difference. If taking the path using defined meaning for source searching, the moon could come into play directly if the defined meaning is open. Or messages like walking on somewhere romantic or fantastic could work. If taking the path using image-schema structure of the rug, there could be many candidates, where the moon could be lost in the sea of candidates. Here Liu’s research helps, by reminding designers that the image-schema structure can be edited or enriched (not recommended for products near the intrinsic message end of the continuum). For example, the SURFACE containing users can be scaled up to a magnified contrast between the SURFACE and the users (an OBJECT), in other words, a magnified contrast of BIG-SMALL, where the contrast between planets and human is more possible to be introduced to the project. Interestingly, the BIG-SMALL was too implicit, if not absent, in a typical rug. If a moon doesn’t become final, other entities are possible to provide interesting experiences, especially with the help of Liu’s research. As for the development of practical tools regarding image-schemas, two figures are provided. These two again overlap with each other.

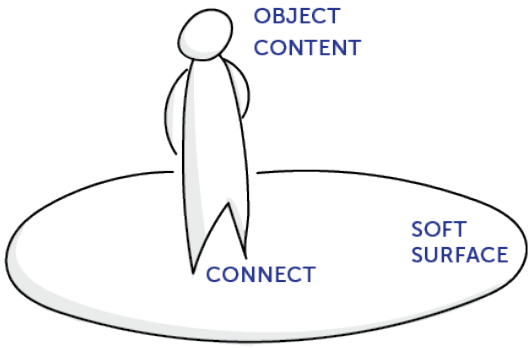


Figure 3.42 A possible conceptual model of a typical rug depicted by image schemas.

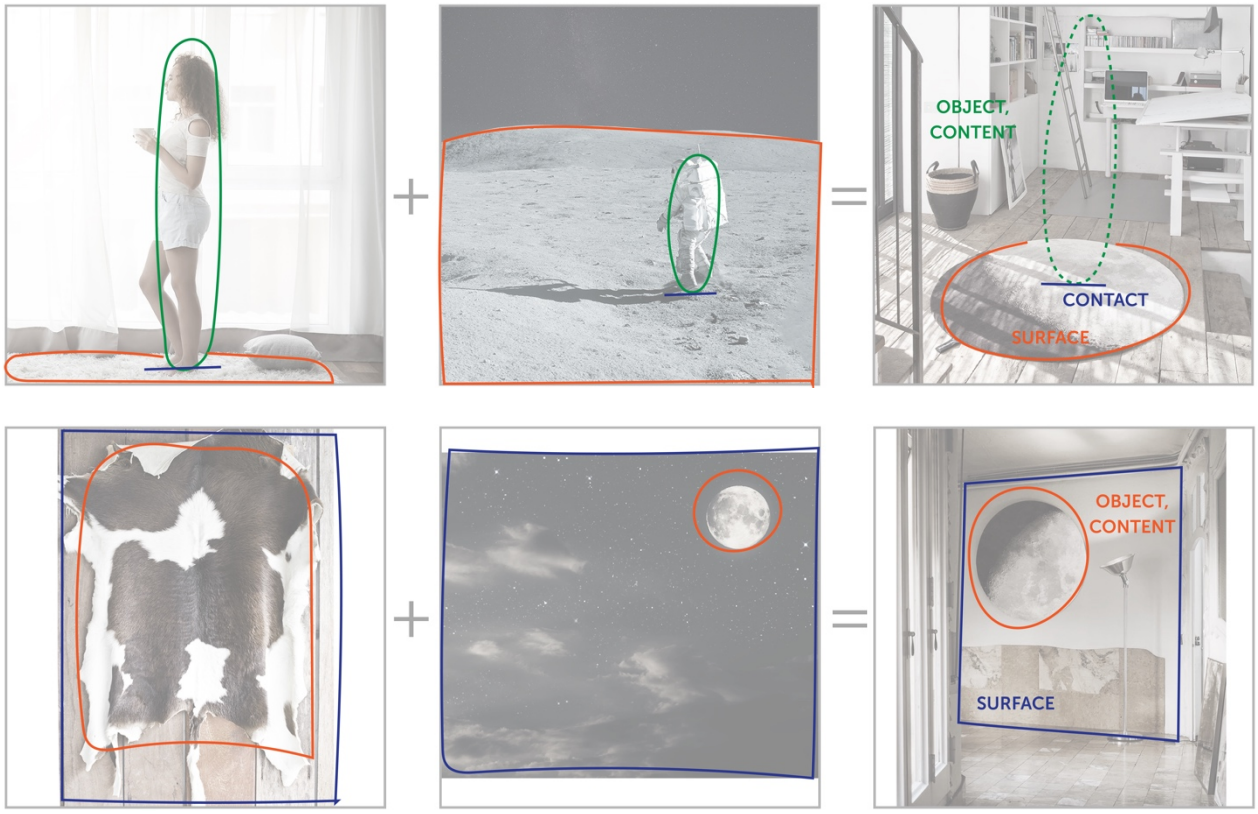


Figure 3.43 Imagery-mapping between the Luna rug and the moon on a scene-level (two, for the floor and the wall respectively).

3.2.8 Pianobell Doorbell

Figure 3.44 Pianobell Doorbell by Li Jianye

The Pianobell Doorbell is a product concept with a (playing) piano metaphor. Scene-level is also a necessary consideration in the approach to developing metaphors for a product. Without playing/ring the piano/bell, the product is just a piano-like (or keyboard-like) artifact. It is the action enabled by the scene-level mapping to be the real fruit of the metaphor. Besides, the image-schema structures are relatively clear in this product and metaphor, so this is a good case to contribute to the design tools. Some analyses are in following figures.

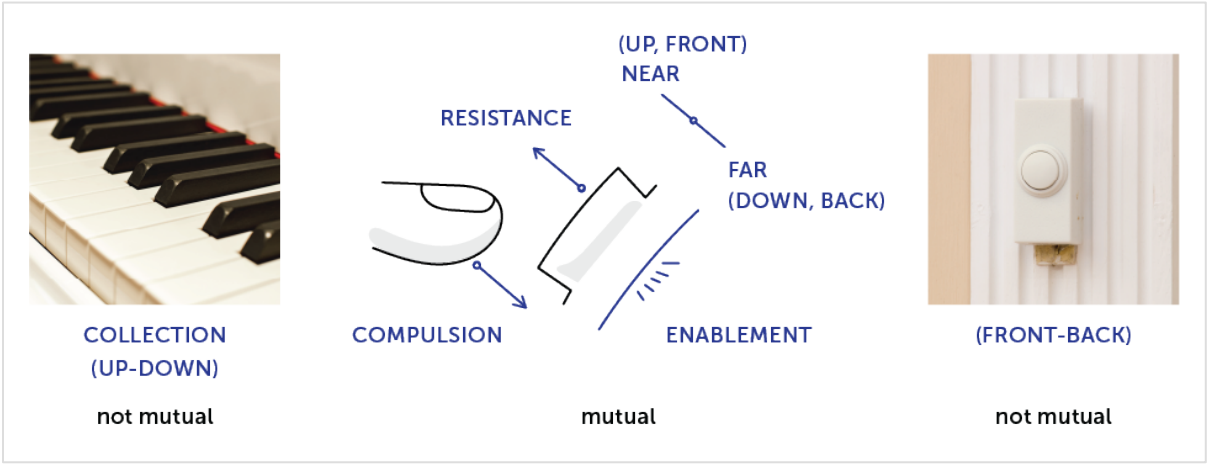


Figure 3.45 Possible conceptual models of the doorbell and the keyboard of piano depicted by image schemas.

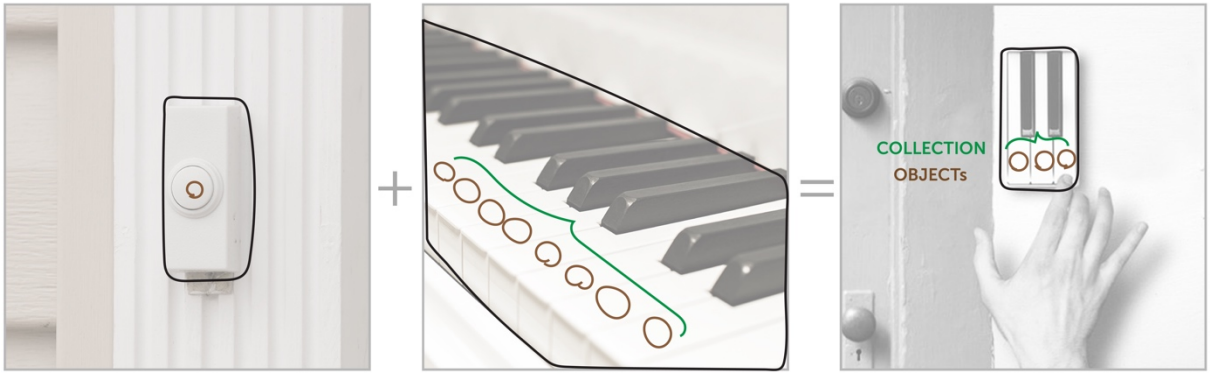


Figure 3.46 Imagery-mapping between the Pianobell doorbell and the keyboard of piano.

3.2.9 Cord UIs by Tangible Media Group

Figure 3.47 One example of Cord UIs (one frame from an introduction video (Cord UIs, 2015))

This case is a simple idea for functionality. In Figure 3.47 is one of the implementations about tangible user interfaces documented in an article (Schoessler, Leigh, Jagannath, van Hoof, & Ishii, 2015). The target in this case is not the whole product, but the electric current. And the source is one kind of flowing SUBSTANCE, which often is water or air. Electric current is not literal current but already a metaphorical understanding. By understanding the electric current as the current, it is implied that the electric current can be controlled by the CONTAINER of it. Luckily the cable is soft and can be understand as a tube, which is the CONTAINER and the SUBSTANCE in it moves from FAR to NEAR. As the result, it is reasonable and even intuitive

of this Cord UI that the electric current is supposed to be controlled by applying force to the cable. And the narrower (higher BLOCKAGE) the cable is, the less the current is. This case shows how the conceptual model is able to be depicted by image schemas, and how the metaphorical understandings can be established upon image-schema structures and be applied to product design.

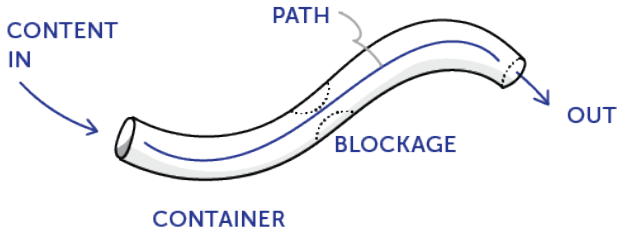


Figure 3.48 The possible conceptual model of cable depicted by image schemas.

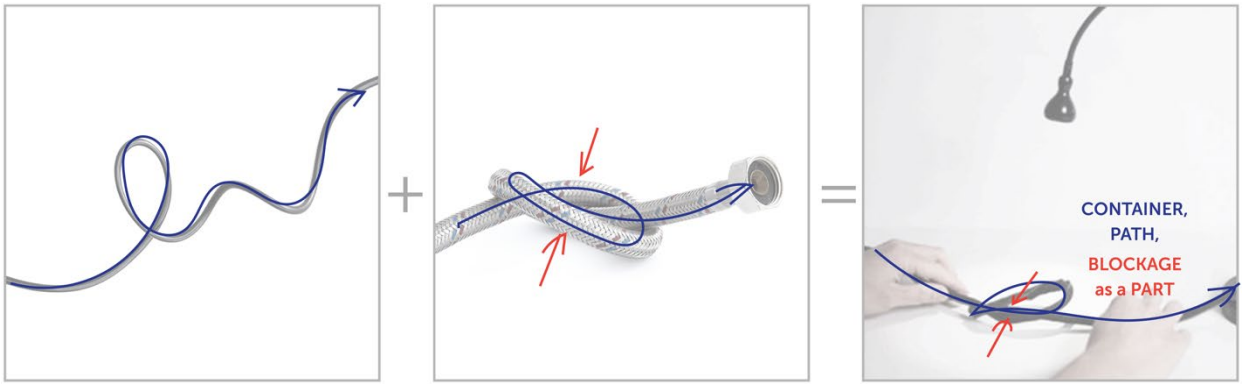


Figure 3.49 Imagery-mapping between the cable and the knotted tube.

3.2.10 Mickey Mouse Clubhouse Cell Phone Toy

Figure 3.50 Mickey Mouse Clubhouse Cell Phone Toy

This toy imitates a real cellphone that specially allows a user to call Disney Junior's Mickey Mouse. Besides the cellphone, Mickey Mouse is another figure in this toy. However, this is not a very good result of employing a metaphor in a cellphone. There are obvious unmatching elements between two entities, which makes the interpretation of their association less smooth. And the missing features on the head of Mickey Mouse results in limited manifestation of the conceptual model, meaning the effect that it has to be a metaphor is limited, especially as the intended extrinsic messages are weak and vague. The figure of Mickey Mouse in this product is more of a decoration, but hardly makes an effective metaphor for it. If trying to avoid a design solution when developing a metaphor, image schemas should help a lot. Imagery mapping suggests several changes, for example, the screen could be made into a sunglasses-shape, and the number pad could be some special make-up around the nose or the mouth. However, imitating a real cellphone is the purpose of this product, and these changes can conflict with the imitation. So, a metaphor-wise strong association is not always the solution.

This product reminds of a product category, souvenirs. Metaphors are welcomed in this area since the enhancement of the association between the product functions and the figure integrated into the product makes the product more favorable and long-lasting. In terms of the metaphor, there is a special angle but one that is normal for designing souvenirs, which is to use source entities to define specific products as target entities. This angle gets touched in a previous case, Surveillance Chandelier by Humans Since 1982, and will not be talked about repeatedly.

Figure 3.51 The unsmooth imagery-mapping between a cellphone and Mickey Mouse.

3.2.11 Hourglass Cold Brew Coffee Maker

Figure 3.52 Hourglass Cold Brew Coffee Maker System by Hourglass Coffee Maker

Hourglass Cold Brew Coffee Maker System by Hourglass Coffee Maker is an example used by Hekkert and Cila (2015). In the article, this product is categorized into use and operation intentions. By following their reasoning, it is not hard to notice the “flipping” operation brought to the product by hourglasses (i.e. the source entity). So, source entities can bring how-this-product-should-be-used messages that a base shape of cold brewer does not have. However, this is not a counterexample defying how-this-product-should-be-used messages equals intrinsic messages when searching a source. The classification of extrinsic and intrinsic messages is effective when giving form to products, because different prior messages suggest different processes. The meaningfulness of the classification fades when the form-giving or the fusion is done, since it makes the least sense to tell what are extrinsic and what are intrinsic after all blended into one artifact.

To specify, for searching a source, there would be two paths. First, the flipping is one of messages that designs already addressed before a source, where the flipping is considered as a part of functioning prototype by designers, which is an intrinsic message. Then, source is searched according to this and other messages designers have. Intrinsic messages like “SUBSTANCE transferred from one CONTAINER to another” does not restrain the source to be hourglass, unless “upside down” or etc. is already an intrinsic message. The second path would be the hourglass comes before the “flipping”. The hourglass is found by messages like “waiting for it to be ready”. The “flipping” is introduced to the functionality after the source (i.e. hourglasses) is found. During the second path, “flipping” should be one of messages be evaluated as it could be harmful, which on contrary is majorly good for this product. This path is in line with the earlier mentioning in 2.7.1, where the “flipping” is taken as an extrinsic message. In sum, “flipping” either is one of designated messages or what the source brought to harm

intrinsic messages or coexist with intrinsic messages, and none of these options relates to extrinsic messages before or at the source searching stage. Besides all above, a graph in Figure 3.53 shows how image schemas bridge the source and target while imagery mapping.

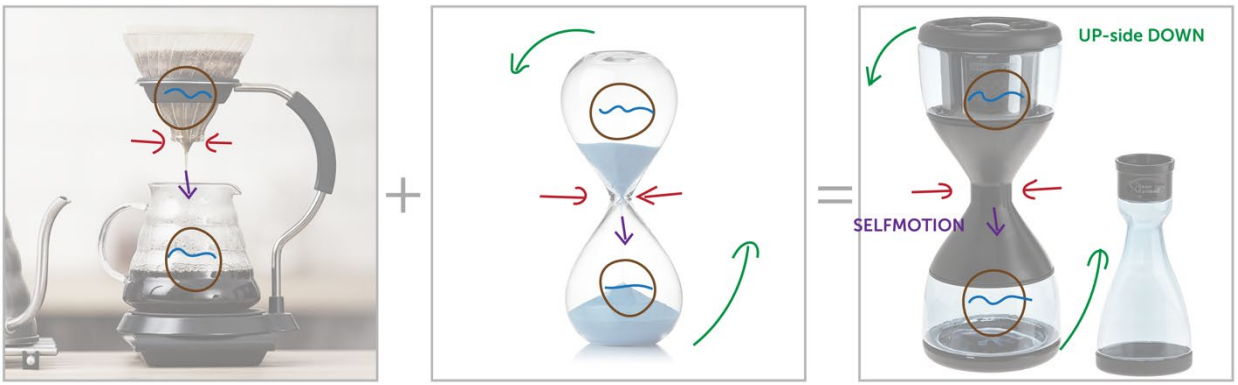


Figure 3.53 Image schemas bridging the source and target while imagery mapping.

3.2.12 Power Seat Controls

Figure 3.54 Left: Seat controls on Mercedes-Benz C63 2019, picture from (Mercedes-Benz C63 S AMG Sedan (2019), n.d.), right: instructions of it from user's manual (Mercedes-Benz, 2019).

The seat controls use a metaphor leading to a real seat, which itself is not the whole product but one component of the vehicle. This is a good example showing how powerful of the metaphor is for a smooth association between the controls and the seat, if the matching of the

image schema structures is accomplished. Here are the image schema structures of both the conceptual model and the form of a real seat is preserved in the seat controls.

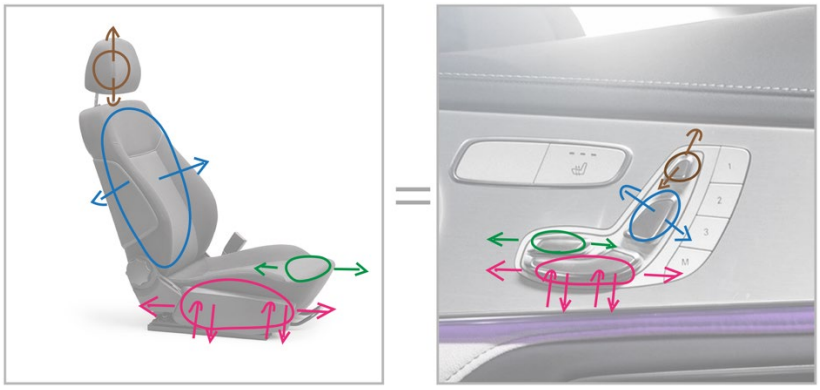


Figure 3.55 How the image schema structures of a seat are preserved in the seat controls.

This case brings up the distinction of two imagery-mapping processes. One is the users' process, which they rely on for making sensorial association of two things, in this case the controls and the seat. Another is what designers are doing, for fusing plain controls and the figure of a real seat together into one artifact. The former is the reason of the later. In addition, there are differences between this case and some other cases. In this case, the source entity is part of the usage, different from how many product metaphors reach to users' imaginary ones. However, if we break the usage of seat controls into three stages, those product metaphors are not so different. The first stage is users to infer how the controls can be manipulated by thinking of a seat (i.e. the source). Then the second stage is to operate the controls (i.e. the target or the fused product) according to inferences. The reactions of the seat are the third. As for those metaphors going for imaginary ones, the first two are the same, and the last differs only because the purpose of the task does not go back to what users think of at the first stage.

3.2.13 Pepelkus Outdoor Cigarette Receptacle

Figure 3.56 Pepelkus Outdoor Cigarette Receptacle by Art Lebedev studio

Pepelkus is an outdoor cigarette receptacle themed as the appearance of a cigarette. This appearance helps people with telling the receptacle from a regular garbage container (*Pepelkus Outdoor Cigarette Receptacle*, n.d.). This use of another entity on the product is hardly a deep metaphor, because the effects stay at tagging the product but not implying messages including values or functions, where mere novelty or unbalanced relatedness could also be part of the reason. There is no noticeable association of conceptual model or meaning, though which the imagery mapping roughly works by following STRAIGHT and two PARTs on the appearance. And along with the structure some identifying properties are mapped.

3.2.14 Wall mounted CD Player

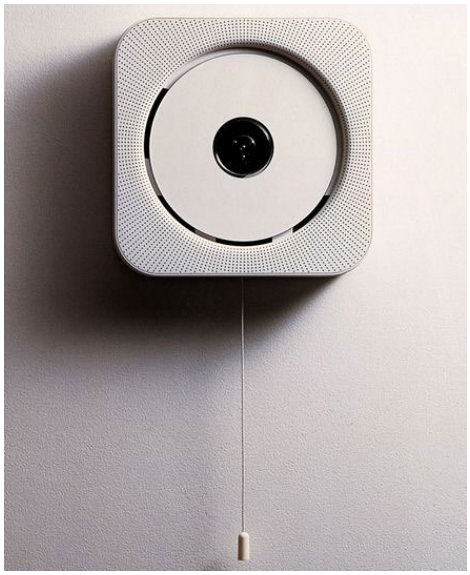


Figure 3.57 Wall mounted CD Player by Naoto Fukasawa

This Wall mounted CD Player is an icon of MUJI and the designer Naoto Fukasawa. The emotions it might evoke are fuzzy and uncontrolled from individual to individual. It can be about nostalgia, habitability, novelty, coziness, hominess and more. The thinking process of this design behind the scene is documented in the book *Naoto Fukasawa* (Fukasawa, 2007). According to the book, Fukasawa was first inspired by the rotation of a playing CD and thought of a ventilation fan in the kitchen. Then he became aware of more overlaps and resemblances of interaction and forms between two, e.g. to push the button vs. to pull the string but both for enabling the rotation, music flowing out vs. air flowing out, and the shape of main face can be rounded square. Along with the overlaps and resemblances he also thought about the feelings the imagined wall mounted CD player could provide. And finally, the design was decided and came out. One of processes anticipated for previous cases explains well and fits well for Fukasawa's thinking process. Fukasawa first noticed a source entity (i.e. a ventilation fan) by the conceptual model as the stimuli: users' one action ENABLEs the ROTATION of a slice-formed OBJECT,

then SUBSTANCE comes OUT from the artifact because of the ROTATION. Then the source entity is evaluated by criteria about the salient meaning it can provide, and the possibility of fusing them into one product. Finally, the ventilation fan is decided, and the properties of it are widely transferred to a CD player in order to make a strong statement about the source. And the transfer is done without major violation of the imagery mapping. For example, the ROTATION PART in the CENTER of the CD player is transferred to the ventilation fan's elements with same image schemas. This is a good case not only because of the success of the product itself, but also the clearly documented thinking and conceiving process behind. This process is briefly represented as a roadmap in the Figure 2.58.

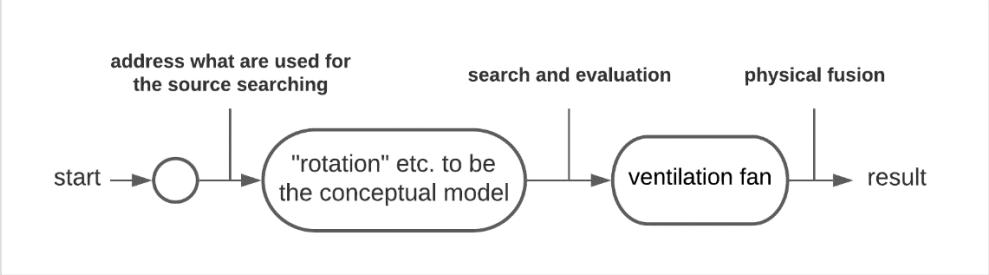


Figure 3.58 A roadmap regarding ventilation-fan-like CD player.

3.2.15 Hair driers

Figure 3.59 Left: a more regular hair drier, right: a Dyson branded hair drier.

This is an example about how users would read messages not intended by designers. Through the source searching and selecting, potential messages brought by the source should be taken into account for the evaluation of the source candidates. The form of a regular hair dryer is picked for the sake of functionality (the similarity of the physical mechanism could be the reason that pistols and hair dryer come into similar form). However, the pistol-like design solution should be avoided since for many users the form brings a feeling of offending and threatening. Understandably the pistol-like form is not designated to be a metaphor, but as designers have no means of limiting users to not making the association if users do. When it comes to metaphors as the designer intended, the reason is even stronger for not overlooking a user's interpretation. Arguably users are familiar with the form and feel less threatened, which could relate to a "dead metaphor". But instead of turning the responsibility over to time, designers need to take the responsibility. The hair drier from Dyson is a better design solution on avoiding the image of pistol. Here in the Figure 3.60 shows how Dyson's hair dryer breaks some major image schemas used in imagery mapping, compared to a regular hair dryer.

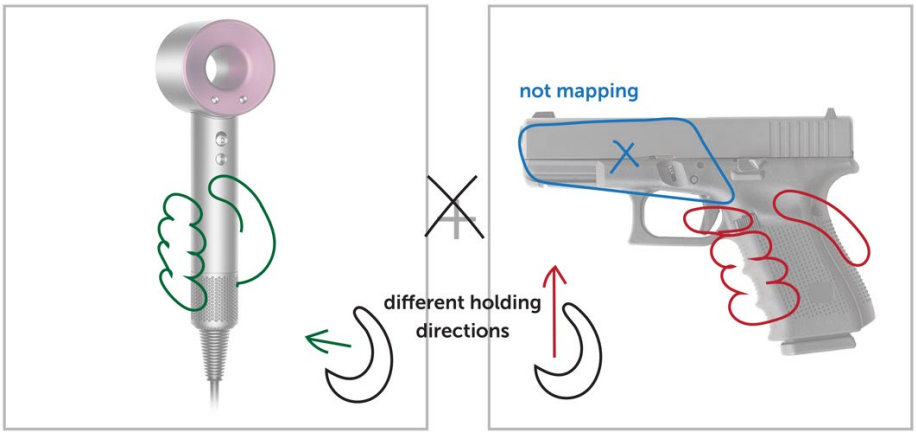


Figure 3.60 The unobvious imagery mapping between Dyson hair drier and a pistol.

3.2.16 The Powerfulness of Electric Vehicles

Imagining an aggressive-looking and “muscled” electric vehicle (or, EV), its powerfulness can come from the look as well as the commonly accepted quality that the an EV has great performance interpreted to be powerful. If we get rid of the effects of look, an EV still means powerful, so by definition it is closer to intrinsic messages not extrinsic messages. However, the powerfulness is not messages like fast acceleration. Powerfulness is more a value but less a plain description. The same as the smartness in the case of Meeting Owl Pro, valued intrinsic messages should be an apt name for powerfulness in this case.

3.2.17 Garlic Press

Figure 3.61 Garlic press (with storage for garlic cloves) by Eva Solo

The garlic press together with the storage for garlic cloves makes the product a figure of garlic bulb. Though the metaphor mainly is for tagging like the Pepelkus outdoor cigarette receptacle, the whole appearance of this product can provide more interestingness than that. Reasons could be two. One is the combination of the press and the storage is clever as it raises the possibility of a good imagery mapping, which makes the use of the real garlic bulb novel and supersizing. Another is in the regular form design strategies are well and more freely executed, so the product is visually appealing even without the effects of the garlic bulb figure.

Among two kinds of messages and the physical fusion, this metaphor mainly conforms with the imagery mapping and has very limited connection with the two message aspects. This implies that the added values and functions can be left to other design decisions outside of the metaphor, and simply imagery mapping can evoke some very general experiences or users' compulsion of appreciation like novelty and interestingness. This design does not reach the core power of metaphor, which makes this use type of metaphor marginal. But this type is still on the topic of metaphor since this type needs guidance from imagery mapping or other physical fusion methods. As for the process, the imagery mapping contributes a lot, and searching source through meaning and conceptual models barely play a part because the garlic is already decided as the source entity. The imagery mapping is more powerful than it is revealed in previous case studies. For example, the imagery mapping can guide the searching of missing parts in the fusion. There is a possible sequence of decisions like such: first, the aimed product to be the garlic press, and the tag to be the figure of garlic bulb; then, the garlic sprout to be where the press maps; at last, in order to fulfill the rest of the garlic bulb figure, the storage for garlic cloves is found, which also contributes well to functionality.

3.2.18 Night Birds

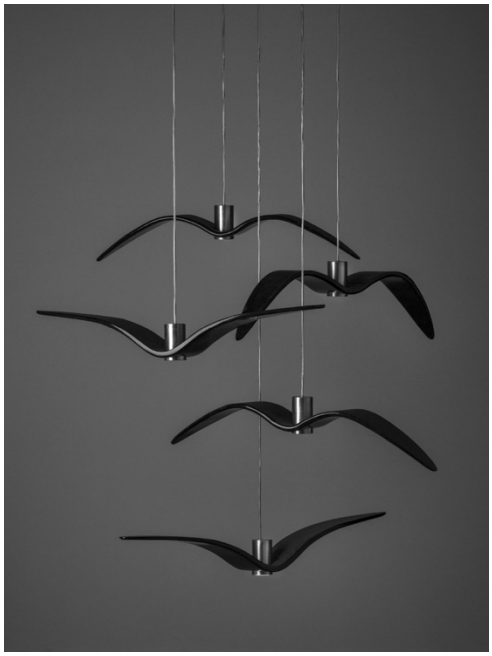


Figure 3.62 Night Birds by Boris Klimek

Night Birds is a set of suspension lights. According to the official descriptions, the inspiration of this design is “the abandon and freedom of bird flight” (*Night Birds – Brokis.Cz*, n.d.), which is the meaning ascribed to the lights and belongs to extrinsic messages or valued intrinsic messages. The designer intends to impart lights’ poetic enchantment and unparalleled dynamism. The meaning and MWDB should play the main part of the process for developing a metaphor solution like this design. As for the imagery mapping, this design is adequate. There are some obstructions when decoding the form into birds. For example, people could tend to recognize the cylinders as the torso of birds, but the cylinders’ style (e.g. hard edges) make the recognition less fit. For another example, the wire is hard to be understood as a part of birds. However, the high quality of this design proves in some projects (e.g. design that has many highlights other than good imagery mapping) the source entity does not need to be perfectly conforming.

3.2.19 Ashtanur Pencil Holder

Figure 3.63 Ashtanur Pencil Holder by Ido mohar

The description of this design is “Ashtanur is a local pita bread of Jerusalem. made to an appetizing pencil holder” (mohar, n.d.). The appetizing as meaning is used for searching a source, and the ashtanur as one source with a CONTAINER structure is picked for this design. There could be other candidates (e.g. taco, dumpling, etc.) which are good design variations. Rolling is what the source brings to the product, which enhances the interestingness or novelty of the product. If using the conceptual model to search source entities, many candidates can be thought of except the ashtanur or even food-related ones. Then designers will pick the satisfying one, which actually is an equivalence of the salience criterion in MWDB and meaning is involved. No matter what is used for the source searching, the imagery mapping is followed by this design, as the container to container, content to content, with some other identifying properties are transferred.

3.2.20 Hoodie Lamp and 5 more

So far, many aspects and different-type products and metaphors are covered. For better constructing the tools regarding image schemas, here are few more analyses. According to some studied case, the graph showing how could image schemas depicting conceptual models and how

the physical fusion conforms with imagery mapping would be much potential in developing the tools. From this point, for developing the inadequate tools, these figures are provided for few more products.

THEA (Hoodie Lamp) by Joe Fentress

Figure 3.64 The fusion of a lamp and hoodie.

Get ready for the Launch by "Homo Ludens" Arnout Meijer

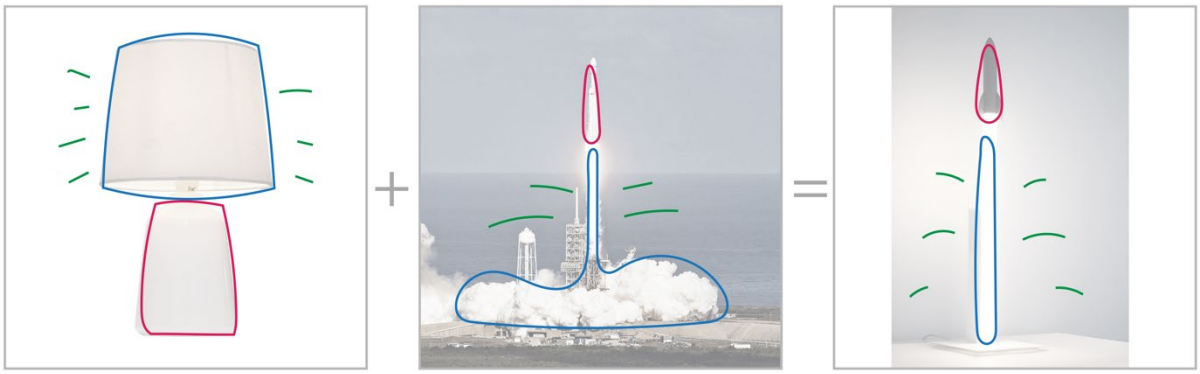


Figure 3.65 The fusion of a lamp and the rocket launch.

Firephant

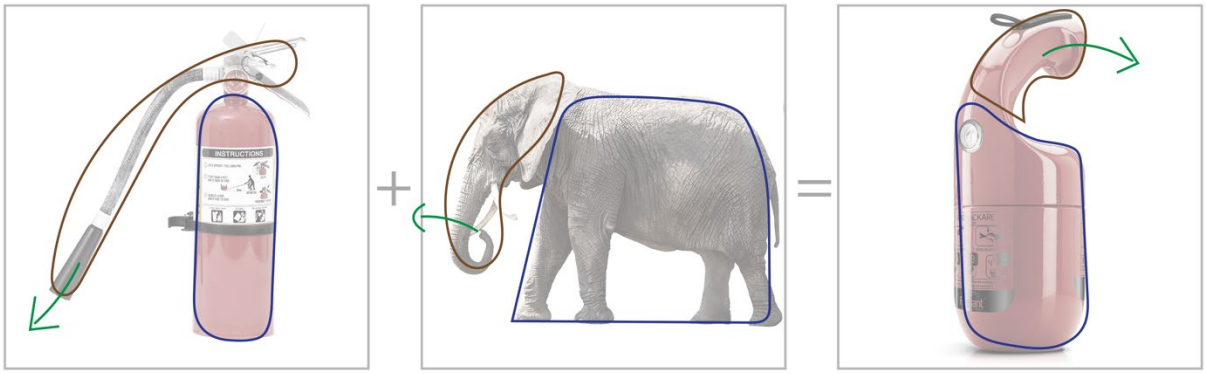


Figure 3.66 The fusion of a fire extinguisher and an elephant.

SHEEP STORAGE ORGANISER branded MesmerizeD

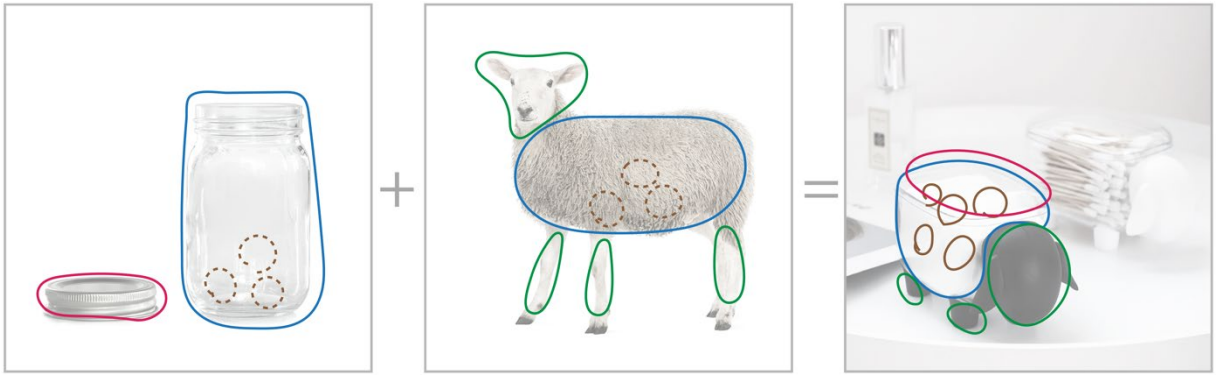


Figure 3.67 The fusion of a storage container and a sheep.

Tropical Bird Pencil Holder by BKID

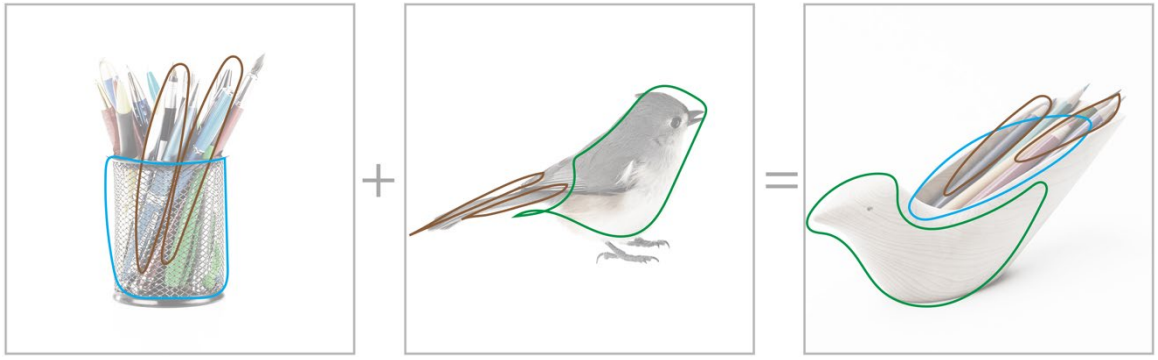


Figure 3.68 The fusion of a pen holder and a bird.

Cloud Sofa

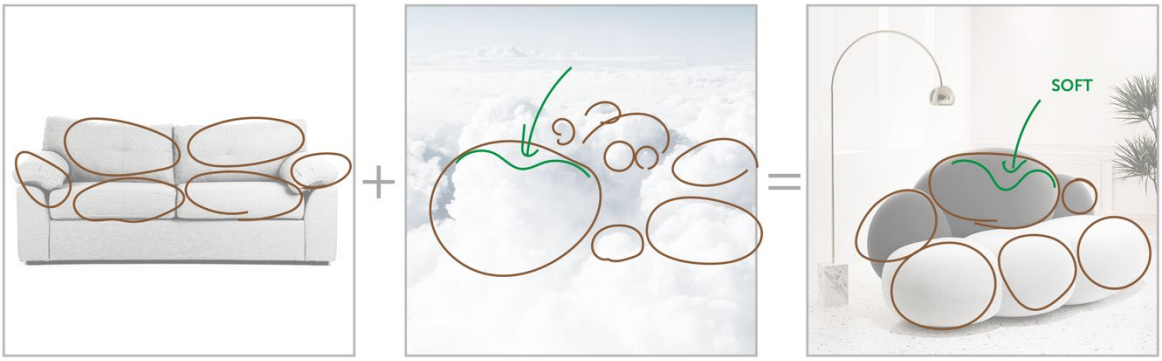


Figure 3.69 The fusion of the sofa and cloud.

3.3 Summary and Discussion

On the next page is a table (Figure 3.70) organizing the analysis in all studies, marking key elements about the continuum as the framework, process and design tools regarding image schemas. Among these cases, some are not as obvious in terms of metaphors, so when the contents in these case studies contribute to patterns, they could be less weighted than those that are more evident with metaphors. Their more valuable purpose is for documenting special situations. The graph showing most positions of designs is in Figure 3.71, which is brought out from the main table. Some of the designs are not compatible with the position diagram, since they don't have enough messages (or have none) asking for the metaphor. For some of these, tagging effects is the main purpose of the discrete entity, and the imagery mapping is still in sight as a good guidance for them. Besides, some products appear multiple times, meaning no matter which path the project takes, it can come to similar source entity. This wide range in the continuum is allowed by its project's intention of employing the metaphor, which is to say the intention (and messages) and the design result is still aligning with each other, though different paths are taken. In addition, in the middle there is a black block indicating the position of valued intrinsic messages. The heights of images do not indicate anything.

			basic		(a)	(b)	(g) (c) (d)				(e)				(h) (i)			
			metaphor intentions	how metaphor	message types	position	which path it could take				all that got involved				tools of image schemas used			
							value	c.m.	ph.f	else	value	c.m.	ph.f.	else	depict c.m.	i.m.	overlaps	
in detail	1	A Beaver-Shaped Pencil Sharpener	attr./accept.	●	●	see another figure	●	●			●	●	●		●	●	(to-do)	1
	2	The Desktop Metaphor	functionality	●	●			●				●	special	user community	●			2
	3	Xerox Copiers	functionality	●	●			●			●	●	●	user community	●	●		3
	4	Meeting Owl Pro from Owl Labs	attr./accept.	●	●		●				●	●	●	valued intrinsic messages	●	●		4
	5	Surveillance Chandelier	expression, attr./accept.	●	●		●	●		source first	●	●	●		●	●		5
	6	Rosaria Rosary	expression	●	●		●				●	●	●		●	●		6
freely	7	Luna Rug	attr./accept.	●	NA		●	●			●	●	●		●	●		7
	8	Pianobell Doorbell	attr./accept.	●			●	●			●	●	●		●	●		8
	9	Cord UIs by Tangible Media Group	functionality	●				●				●	●		●	●		9
	10	Mickey Mouse Clubhouse Cell Phone Toy	attr./accept.	●					then	source first		●	●		●	●		10
	11	Hourglass Cold Brew Coffee Maker	attr./accept.	●			●	●			●	●	●		●	●		11
	12	Power Seat Controls	functionality	●					then	source first		●	●	the source in context	●	●		12
	13	Pepelkus Outdoor Cigarette Receptacle	tagging	●					then	source first			●			●		13
	14	Wall mounted CD Player	attr./accept.	●			●	●			●	●	●		●	●		14
	15	Hair driers	NA	●					NA		●		●			●		15
	16	The Powerfulness of Electric Vehicles	attr./accept.	●			●			Van Rompay's			●	valued intrinsic messages		●		16
	17	Garlic Press	attr./accept., tagging	●					then	source first			●			●		17
	18	Night Birds	attr./accept., expression	●			●				●		●			●		18
	19	Ashtanur Pencil Holder	attr./accept.	●			●	●			●	●	●		●	●		19
graphs	20	Hoodie Lamp and 5 more	NA	●			NA				●	●	●		●	●		20

c.m. conceptual model
ph.f physical fusion
i.m. imagery mapping
attr./accept. attractiveness/acceptance
NA not available

green: strong
yellow: not strong
red: harmful

black: mentioned in the case study
grey: not mentioned in the case study

Figure 3.70 The table showing partial summery of case studies.

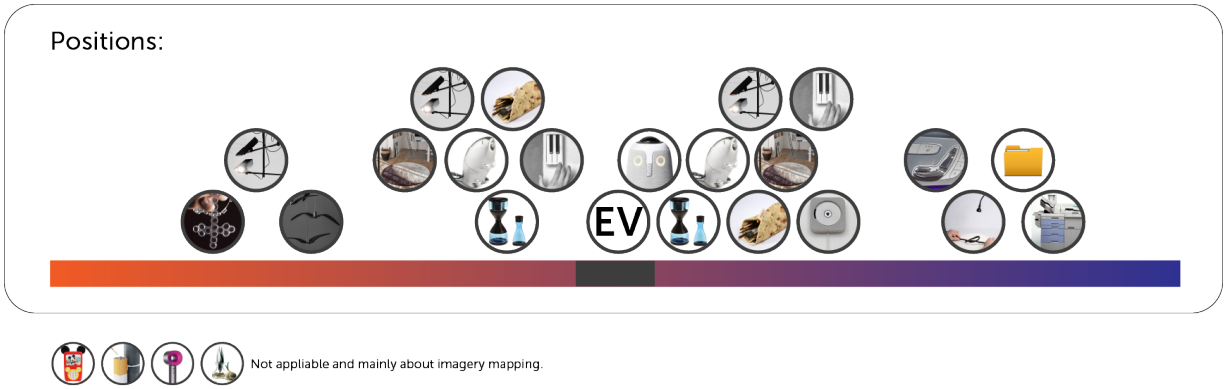


Figure 3.71 All positions of designs in case studies.

The continuum is valid enough.

In case studies, aspects (a) to (e) (see 3.1.2) can be answered without much deviation from anticipated patterns. From the columns “basic” “(a)” “(b)”, especially “(e)” we can see the continuum covers major elements the metaphor examples in cases are suggesting. Among these “(a)” shows the message categorization is capable, though valued intrinsic messages were overlooked in 2.7.1; “(b)” shows the priority is a valid concept for metaphors employed in products; and “(g) (c) (d)” together with “intentions” and “(b)” show the concept of message priority does validly suggest apt paths for developing the metaphor.

The approach/process and tools can be constructed.

Case studies imply a general process is possible, for two reasons. Firstly, major cases fall into anticipated apt paths, and anticipated apt paths follow the pattern of the continuum framework; secondly, brief roadmaps are drawn or described in many case studies, which have no unacceptable collateral branch or deviations. Besides, it is also possible to construct the general tool of image schemas, because there are patterns across the figures showing how conceptual models are depicted by image schemas and patterns across the figures showing how physical fusion conforms to imagery mapping. And, metaphors that suggest conceptual models

by suggesting image schema structures imply that if designers deliberately embody apt image schema structures and make them noticeable, users would likely acquire good conceptual models.

Interplays between different approaches for different paths imply that different approaches are not actually distinctive or excluded from each other. Instead of leaving them separated to different paths after organizing them, a combination of approaches is possible and preferred. And future approaches are welcomed to join in the combination, possibly with the guidance of the continuum.

Approach as evaluation tools, and on imagery mapping.

For some cases, the combined approach and related tools could be a flexible or informal design tool in terms of searching sources, because often much effort is needed for conducting it compared to situations that designers can come up with a source very fast using intuition. The intuition should not be abandoned because metaphor is at the core of our mind, which officially makes the intuition a powerful means. Nevertheless, the combined approach and related tools are still reliable design tools for evaluating the search result by intuition, and a way to inform the form-giving. Imagery mapping conforming with image schemas can be used separately, or as an individual tool, no matter what's your own way of defining the source entity. If an excellent source and the excellent association are discovered within a momentary instant, the imagery mapping is still helpful.

Specifically, using image schema structure to search for the source is not that practical for some cases. But it can easily enhance the meaningfulness as it can be a measure to boost functional associations. So, it would be more effective to use it as an evaluation tool for source selection in those cases. Besides, the image schema structure is really a useful tool for form-

giving decisions, which makes the principles of effective physical fusion concrete and simple; meanwhile it allows great room for other design actions, features and strategies.

For most cases the inspirations for the searching are salient qualities or image-schema structures depicting conceptual models, where other criteria are actually playing a role as evaluation tools.

On depicting conceptual models.

Only using image schemas probably is not sufficient to depict a detailed conceptual model: image schemas can be the structure of the conceptual model, but probably cannot define a product from only the image-schema structure. Properties plugged into the structure nodes are needed if wanting to draw the complete conceptual model. The image-schema structure loses those details. This loss could be why metaphorical understanding is possible. If all details are still there, the object is literal, and there is no room for other objects to play. So, if searching sources for metaphor, completely plugging detailed properties will not be necessary.

In case studies, most image schema structures are writer generated from the perspective of a designer. Though they succeed, it is not the reason to abandon the method using users' utterances and etc., which should be more reliable. The reason to use the perspective of a designer is because for most cases this kind of information is not so ambiguous. If specifications are already user-centered enough under industry standard design process, image-schema structures can be constructed from information other than users' utterance.

As for two image-schema structures (for conceptual model and imagery mapping respectively), in many case studies they overlap a lot, but they are still two different things. One evident conclusion is the conceptual model does not necessarily to be manifested, but the

structure in imagery mapping is all manifested. Besides, some difficulties are preventing the unification of them.

Other noticeable findings or notes.

Along case studies, many interesting and special implications are found. Here is a table showing which case study is linked to what findings.

		(f) keywords of (additionally) noticeable findings								
		valued intrinsic messages	scene-level	user community	the virtual as targets	source decided	modified structure	unintended messages	loose criteria	notes
1	A Beaver-Shaped Pencil Sharpener		•							
2	The Desktop Metaphor			•	•					
3	Xerox Copiers			•						
4	Meeting Owl Pro from Owl Labs	•								
5	Surveillance Chandelier					•	•			
6	Rosaria Rosary								•	since more information are welcomed
7	Luna Rug		•				•			
8	Pianobell Doorbell		•							
9	Cord UIs by Tangible Media Group				•					part of target
10	Mickey Mouse Clubhouse Cell Phone Toy					•				souvenirs
11	Hourglass Cold Brew Coffee Maker							•		
12	Power Seat Controls					•				source in context
13	Pepelkus Outdoor Cigarette Receptacle					•				
14	Wall mounted CD Player									detailed actual process
15	Hair driers							•		to avoid it
16	The Powerfulness of Electric Vehicles	•								
17	Garlic Press					•				imagery mapping delivers good result
18	Night Birds								•	
19	Ashtanur Pencil Holder							•		
20	Hoodie Lamp and 5 more	NA								

Figure 3.72 A table showing which case study is inked to what findings.

Valued intrinsic messages. Except intrinsic messages and extrinsic messages, there is one kind sitting in-between. *Value-modal intrinsic messages* (or *valued intrinsic messages*) are not descriptions for functions like the intrinsic messages, but the interpretation of functional descriptions from the perspective of humanity; like extrinsic messages they could be values. They are not concrete and neutral enough to be functional descriptions or intrinsic messages, but they are emphasizing intrinsic messages with honesty.

Scene-level. The product is the artifact in focus. However, the metaphor could be complete with artifacts or even actions extended from the product. The designer is recommended

to think at a scene-level and the product is one of the subjects and motions or actions in the scene. In addition, the scene-level thinking could inform scalability mentioned by Saffer (2005).

User community. Users in the same community could share similar knowledge and expertise, could share similar goals and missions, and could share similar habits, tendencies and even culture. A source entity being used in the product should be orientated to this factor, so that the metaphor can be less strange but more acceptable. And, this factor is also a library of sources or an inspiration helping the source searching.

The virtual. The target is or partially is virtual in these cases. This is a field where metaphors are one of main players. People use metaphors to understand functions like configurations, data streaming, etc., which are the target entities in the metaphors. However, the detail of this is not in the focus of this thesis. Hurtienne (2011) and others provide focused research on it.

When the source is decided first. The source could be decided before the target (i.e. the product), for example, designing souvenirs, or at the same time of the target. Using a discrete entity to tag a product often falls in this situation also. In this source-decided-first case, using image-schema structures for the source searching should be appliable. Or, designers could go straight to the physical fusion stage.

Modified structure. After depicting it, the image-schema structure can be applied with some modifications, in order to do a smoother source searching or reach some effects. The reaching effects part is discussed a lot be Liu (2016).

Unintended messages. There could be messages brought by the source that are not initially expected, like the pistol-like and the “flipping” mentioned earlier. Some are harmful and

need to be avoided, and some are good and enhancing interestingness, novelty or such. An interpretation test on the overall product after the employment of the metaphor could be helpful.

Loose criteria. This has been touched on earlier. For some purposes that use a metaphor in the product, criteria for searching and selecting the source can be loosely used, which are more like references but less like the requirements. The designer should have the freedom to assess and pick what criteria they weight more.

Chapter 4 Design Approach

4.1 Overview of the Process

Based on the case studies, the reviewed approaches and the continuum, the roadmap and some tools for the development of metaphors for product design are constructed, in which the image schema plays an important role. The basis of the roadmap is in line with the three phases addressed by MWDB. Firstly, acquiring the dependent information for searching; secondly, searching and selecting source candidates; and thirdly, the physical fusion. As the continuum implies, there is a branching point in the roadmap leading to different paths for source searching and filtering (i.e. selecting), the merging of which happens before the form-giving. In the next page, Figure 4.73 shows the overview of the process. For every label introducing a task, the upper line with the colored background is the task and the lower line with the white background is the expected outcome of the task. Image-schema-related tasks are marked out by green spots.

The process also needs contributions from regular methods and techniques of product design, e.g. brainstorming, strategies regarding aesthetics, gestalt principle, etc. The process can be taken as a specific implementation of a general process called Double Diamond (*What Is the Framework for Innovation?*, 2015) (see Figure 4.74 Upper, for the representing diagram). The "define" part in this process can be considered as an extension of the "define" stage in the process of Double Diamond. Then the "search and select" and the "form-giving" fall in the "develop" stage of Double Diamond. Figure 4.74 (Lower) shows how this process aligns with the Double Diamond.

In the following sections are details of the process, along with which some templates are provided for designers' convenience, though it is not necessary for these templates to be strictly followed.

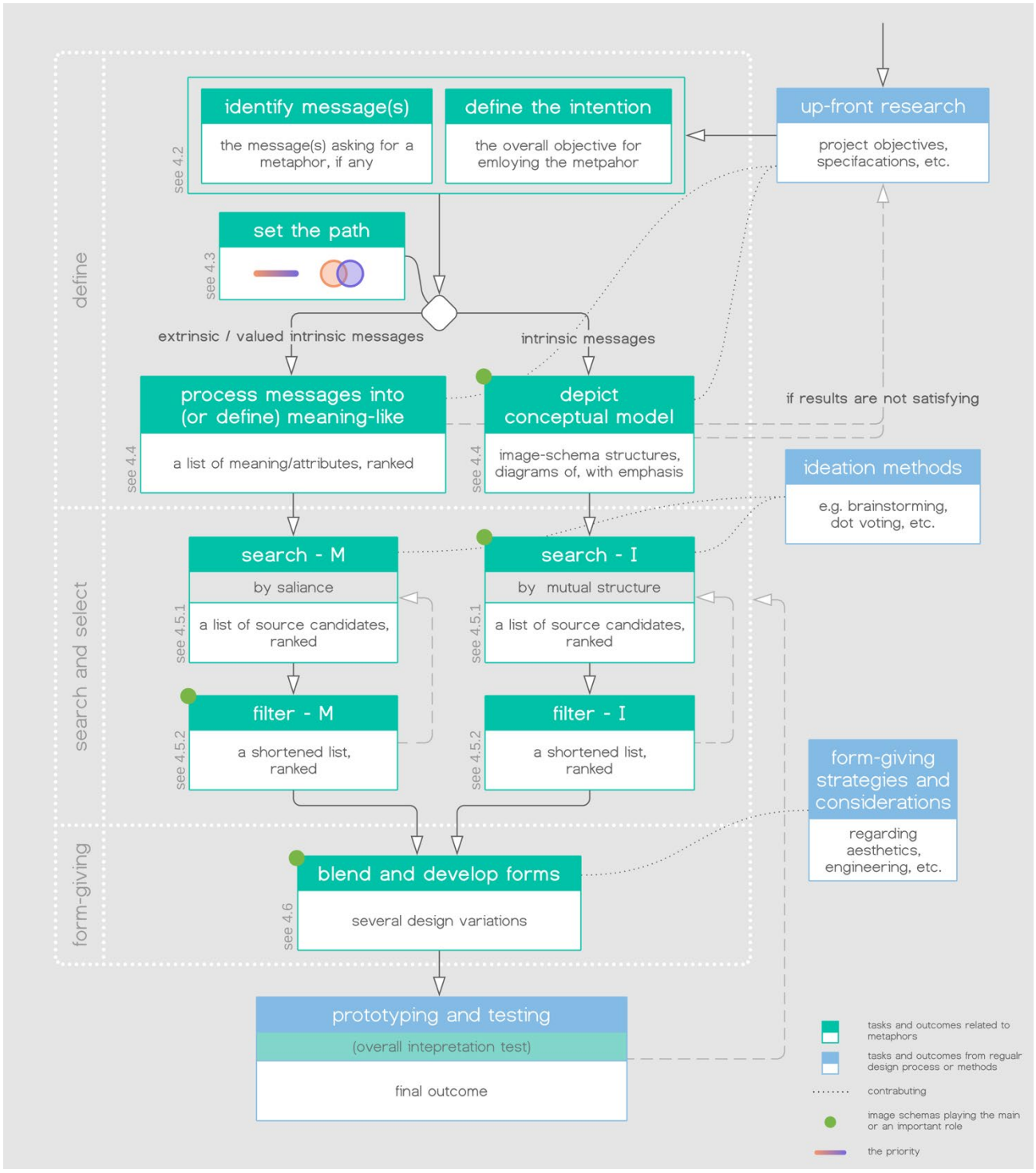


Figure 4.73 The development of metaphors for product design with the supports from image schemas, a process of.

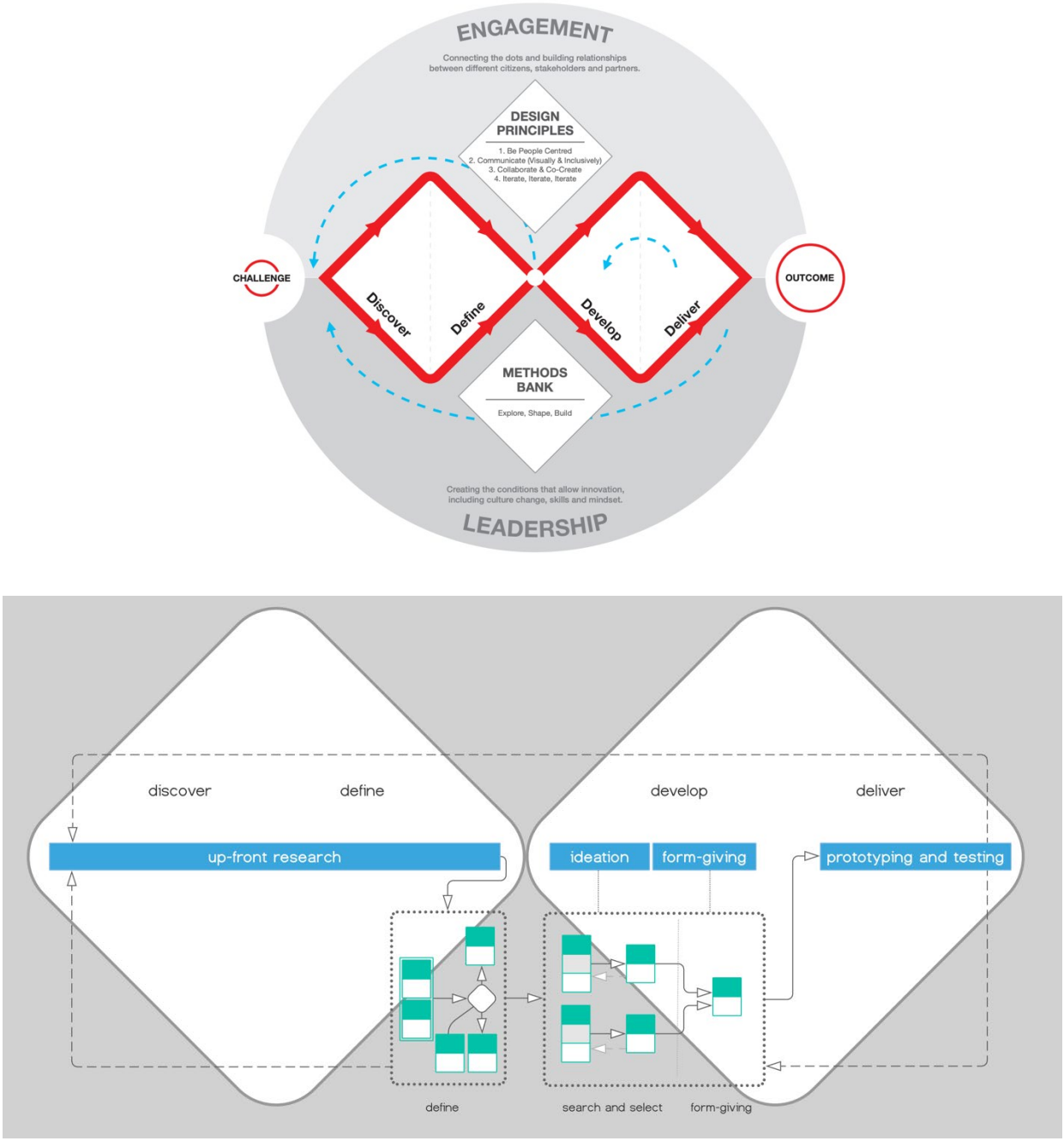


Figure 4.74 Upper: The Double Diamond Model.

Lower: The alignment between the process and Double Diamond.

4.2 Identify Messages and Define the Intention

Regular design projects typically use much up-front research regarding, for example, users, tasks, market, environment of use, technology and manufacturing, etc. This research should be organized into documents or other material for designers to follow and reference. Some are conclusions and some are raw material. In order to continue the process as the development of metaphors, at this point the designer is going to take advantage of some of them, specifically the objectives of the project and the information describing or implying what users need to perceive from the product for utilizing or experiencing it. According to these kinds of information, the designer defines the intention for employing the metaphor, and identifies the message(s) he/she wants to ascribe to the product through the metaphor, if there already are any.

Identify messages.

Messages are what designers intend for users to perceive from the product for utilizing or experiencing it. In terms of product metaphors, some commonly seen messages are qualities, values, suggested functions or interactions, supposed experiences, etc. As for some examples of messages, see case studies. Among information from the up-front research, there might by one or more particular message(s) encouraging designers to employ a metaphor, which are going to be identified and noted down during this sub-task. And it is also possible to have no clear messages at this point.

Define the intention.

The intention is what overall effect designers want/need the metaphor to achieve. In sum, the intention is defined by following what the project desires, as well as what a metaphor is capable of.

The intention can be derived from the objectives of the project. Objectives usually are mixed, and for some objectives, metaphors might not be suitable. But several (not all) intentions that the metaphor is capable of are mentioned in the literature review (see Figure 2.18, section 2.2.4) and case studies. For instance, metaphor can let users understand how the product can be used without much requirement of mental loads; it can make use of users' previous knowledge for a newly emerged product or function; it can bring extra values to a product; etc. In some cases, the intension can be more specific than "communicating (new) functions" or "introducing rich experiences", as long as it is linking to effects of metaphors. For example, the intention of providing a "food for thought" experience mentioned in case 3.2.5 is more specific but still in a good level, which is asking for the extra value. When a metaphor is employed in the product, it could become a noticeable feature which impacts the whole product, including the overall orientation (e.g. useful, experiential, etc.). Thus, the intention should not depart far from the overall orientation of the project's objectives, and it likely will not as it is derived from them.

If any message is identified in the other sub-task, the message(s) should be taken into account when defining the intention. And, after the intention is defined, it can help designers with identifying the message in a more informed way. So, moving back and forth between these two sub-tasks several times is something worth considering.

The Template for the Parts 4.2, and 4.3.

Firstly, Figure 4.75 shows the coverage of templates provided by this thesis. There are five blocks of them. And in total seven different sheets of templates are provided. Figure 4.76 is the template for noting down information from tasks in 4.2 and some more for the next step, including the identified messages, defined intentions and more. Templates are shown in a larger scale in Appendix.

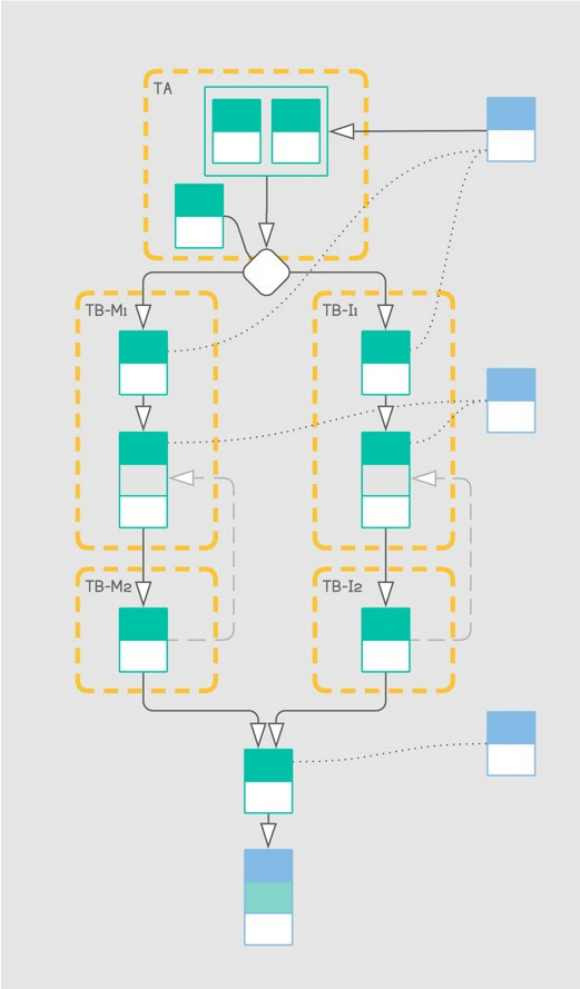


Figure 4.75 The coverage of templates provided by this thesis.

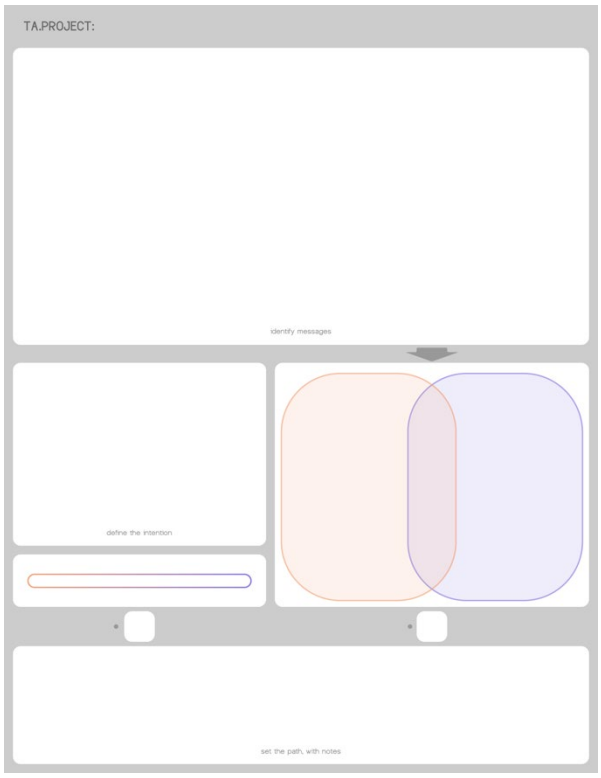


Figure 4.76 The template for messages, the intention, and the priority.

(also see Figure A1 for the larger scale)

4.3 Set the Path for the Rest of Process

The metaphor can serve very different purposes in the product design, from functionality to artistic expressions. It is not practical or effective enough for all the purposes to just have one kind/mode of information that designers use for searching source candidates. And very different information means the process bifurcates into different paths and one of them will be followed by the designer accordingly. Given the discussion and the validation about the continuum and in the case studies, the path can be set according to the priority of different kinds of messages. So, at this stage, the priority is going to be answered and noted. And then the rest of process can be acknowledged.

The priority.

Messages can be categorized into intrinsic messages, valued intrinsic messages and extrinsic messages (see 2.7.1 and 3.2.4 (a) for explanations). The process is routed according to which type of messages should be the higher priority for the metaphor. Basically, whichever has a higher priority is going to be what is used for searching the source entity. So, the priority will be answered according to the identified messages by types and the intention.

Categorize identified messages.

The messages identified in the previous tasks are going to be categorized into the three types. The most important or desired ones are marked out with different ink or as the designer prefers. The priority can be indicated by the category with more highly weighted messages. If there is no specified message from previous tasks, then leave it blank.

Infer from the intention.

The priority directly based on identified messages is one factor, as the priority implied from the intention is another. So, before setting the path, the priority is going to be inferred according to the intention and noted as a position in a continuum representing the tension between extrinsic messages and intrinsic messages. Here are some examples for what intentions may imply. If the intention is more about functionality (e.g. to communicate some functions), the intrinsic messages are highly likely more important than extrinsic ones. If experiential aspects are involved in the intention, the position tends to the direction of extrinsic messages.

Set the path.

In the template, there are two places for filling numbers in, which would work like the coefficient. The designer fills in two numbers that represents the reliability or preferability of two sources for the priority respectively. Because these two source-information pieces might be

coordinated to each other a lot during the task in 4.2, sometimes the numbers do not mean much. Then, a final priority comes out and the path can be set according to it. The reason for that the priority can tell the path is that the most prior messages (or, information, clues, etc.) should be what the design wants to secure in the design the most, where using the prior messages for the initial source searching enhances it.

Basically, there are two paths. One makes use of intrinsic messages and image schemas for the initial source searching, which in this thesis is tagged with the letter "I" (standing for image schemas), as showed in the Figure 4.73, while the other one makes use of meaning-like (or value-like) messages, which is tagged with the letter "M" (standing for meaning from MWDB). If intrinsic messages have priority over other messages, the path-I is going to be taken. If extrinsic messages or valued intrinsic messages have priority, the path-M is going to be taken. These two paths share the same general structure of preparing-searching-filtering, though the detail is different. And for one project, the designer needs only to go through one path.

4.4 Prepare the Information for the Search

Messages could need processing, so the designer can get more proper information for the search. Different messages are going to be dealt with differently. This task could need relevant raw material or specifications from up-front research. If the outcome is inadequate, the designer might conduct additional up-front research in order to get more input.

Path-M

Process or define messages, if needed.

As for extrinsic messages or valued intrinsic messages, descriptive words or such that capture qualities, values, experiences, imaginations, etc. could be suitable in order to get the designer inspired and to be related to a concrete entity. It would be helpful if they are sensorial,

experiential, distinctive, directive, or any that could evoke a concrete experience, judgement, etc. Making them simple, common or understandable could be other good considerations. However, it is not necessary for these certain terms to be followed, as long as the designer feels comfortable associating discrete entities to the messages effectively. And possibly many identified messages are already ready without being processed. Besides, if no message was identified previously, they are going to be defined according to the intention. After all, the output of this task would be a list of descriptive language, items in which are the equivalence or the actual of the meaning mentioned in MWDB. Additionally, the items in the list are ranked by the importance and desirableness.

Methods like mind-mapping could get involved if the designer decides to. For example, if joyfulness is one of identified messages, the designer could go from it to many different experiences or emotions that could contribute to it. Some might be similar and parallel, and some might be more specific. Or, the designer could use these methods for defining messages, by starting with the intention. These explorations are included in a template of a nearly blank sheet, as the left sheet shown in Figure 4.77. Considering the physical size, this sheet could be more suitable for records and documentation, and this sheet is optional since it is basically blank. This template can also be used for exploring the sources, e.g. mind mapping starting with some initial stimuli or scopes. The right one in Figure 4.77 is where to note down the list of descriptive language (the top part). The middle part of it is for keywords like animals, office, etc., which are implied by the up-front research and act as the very basic stimuli or scope. And, the lower part is for recording source candidates, which is for the next task.

Figure 4.77 The template for message preparation and the source candidates on path-M.

Path-I

Depict Conceptual Models.

When intrinsic messages are prior to other kinds, the conceptual models of the product are going to be depicted by using image schemas, which become structures consisting of image schemas. Usually the identified messages (if any) are not enough, since they are too focused, so the specifications or raw material from the up-front research will be utilized, e.g. users' utterances, current technical solutions, etc. For how the image-schema structure could depict the conceptual models, see the keyboard example in 2.5.3 and some of the case studies. Basically, image schemas are going to be extracted from users' understandings of the product functionality, the understandings users are designated to have, or how the product actually works from the technical or engineering point of view.

The depicting is not necessarily thorough. However, it could be helpful to cover the main components of the product, especially those on the shallow levels of semantic layers. If a part of the structures relates to identified messages, it will be marked out as emphasis (same, with different ink or other ways as the designer prefers).

One noticeable thing is that, before or even during the searching, modifications on the image-schema structures are allowed in some scenarios. For example, if the designer takes the emotional attractiveness as the intention and at the same time pursues no hard focus for particular meaning, some twists of the image-schema structures could enable some source candidates suggesting unexpected interactions/functions, which could be a way to achieve the attractiveness. Another noticeable thing is about souvenirs. If the project is of souvenir design, the designer might want to make use of this approach and start from this task, i.e. depicting the conceptual models of entities in the theme/topic of souvenirs.

Figure 4.78 shows two sheets of templates. On the left is for analyzing the messages, relevant specifications and raw material. The upper part is a place for the designer to pull them (or the leads to them) together, and while analyzing some structure fragments can be put into the lower part as drafts. On the right is a sheet for filling in a relatively matured image schema structure. The middle and the lower part are the same as the template in Figure 4.78 (right). And lastly, the number of both sheets in use in a design project are not necessarily limited to be one.

Figure 4.78 The template for message preparation and the source candidates on path-I.

4.5 Searching for the Source Candidates and Filtering Them

Then it comes to the searching and filtering tasks. They follow the structure of the criteria provided by MWDB, originally including salience, relatedness, novelty (and understandability), mappability and completeness. Contents of the path-M are mostly derived from MWDB, as some but not many revisions are made for it. As for the path-I, it also borrows quite a bit from MWDB, but with the image schema to play a really big role.

4.5.1 Searching

The searching stage does not have many details. This is an ideation activity, so regular ideation methods, e.g. inspiration canvas or mood board, brainstorming (with or without visual inspirations), dot voting, methods like wall walking, etc., are fruitful and could be used heavily.

Path-M

For path-M, the source searching goes by the *salience* criterion from MWDB. The designer (or "you" in the quote) is suggested to "use a source that has the meaning you intend to convey as a salient property" Cila (2013, p. 137). This would help with avoiding ambiguousness, confusion or misunderstanding about the metaphor (Cila, 2013). The searched entities as candidates are written/documented down in the supposed area in the template (Figure 3.77 right), with quick notes of which meaning they are pointing at and how salient in them the meaning is. Besides, one entity can satisfy multiple qualities/attributes as meaning; it also can satisfy one meaning but be harmful to others, to the intention or to the whole product. As a result of these, the candidates can be ranked. The number of the candidates allowed to go to the next task depends on the potentials of the candidates and on the design resources and the capacity the project is given.

Path-I

Rather than using values, qualities, etc., the path-I takes advantage of conceptual models and images schemas. Entities with similar or overlapping structures are going to be recognized as the source candidates. Especially the emphasized image schemas or fragments are going to be in overlap, which actually is the clue and stimuli leading the designer to those sources. In addition, these emphasized need to be noticeable or salient in the respective candidate. Then, similar to the path-M, the candidates are written/documented down in the supposed area in the template (Figure 4.78 right). And they can be ranked by the effectiveness.

Some explorations (e.g. sketches) for the image-schema structures of source candidates could be used by the designer, which can be conducted in the top-left area of the template in Figure 4.80. Or if the designer wants to keep it a bit cleaner, the satisfied result of the exploration is going to be documented in that area.

4.5.2 Filtering

Of templates for this task, each sheet is like a case of one candidate in one file page. The template consists of several areas corresponding to the (rest of) criteria. Top ranked candidates would be further analyzed and evaluated, and these templates utilized.

Path-M

For path-M, the salience is already applied thanks to the source searching task. Then the other four criteria become the evaluation tool which filters the source candidates into a shortened list. The template (Figure 4.79) is created based on the four criteria. For each of them, a box is provided for the designer to drop down a rating respectively. A place for the overall rating is also provided, at the top right corner.

Relatedness.

The relatedness describes the conceptual distance between two domains of the source and the target. Too far a distance could make the source and target hard to associate together, and too close could mean less interesting (Cila, 2013). If the extrinsic messages occupy some of the priority, a balanced relatedness is preferred. If a project heavily promotes the intrinsic messages and doesn't deliberately pursue the interestingness or such, the designer won't need to be harsh on a close source. In short, the preferred relatedness is recommended to be aligned with the priority of messages.

Novelty vs. Understandability.

This pair describes the association between the source and the target. It implies how conceptually challenging it is for users to get the association. In some cases, e.g. the Rosaria rosary, the challenge is desirable, and the understandability can be fulfilled by other means of

communication. In some cases, the usability still plays a part, where the understandability should be reasonably taken care of.

Completeness.

A source being more complete refers to the source suggests design concepts that are more compatible with the functionality of the target. In the template area for completeness, one image of the source and one of the target are put aside each other so that the designer can compare and mark out the functionality contributions the source can make. The image could be either photos or abstract sketches, and either the figure of the entities or conceptualized representations. What is marked out can be functions, interactions, or they can be image schemas, just like how image schemas are used for depicting the conceptual models. This is a place that image schemas can help, where the new blood comes into the structure of MWDB. They are one of the ways to analyze how the source contributes to the functionality.

When using valued intrinsic messages for searching, the conceptual models of source need attention, since, though MWDB is being used, the project still cares the functionality and the extrinsic messages are not surely prior. In order to have a source not offending functionality, a heavier analysis of key conceptual models is desired. Both conceptual models of the source and the target are going to be analyzed in a way like it is done in depicting the conceptual metaphor explained in section 4.4 path-I. Then, when using extrinsic messages, the conceptual model still needs to be considered, in a way mentioned in the previous paragraph, but not as heavy as on the path-I or about the valued intrinsic messages.

Mappability.

Mappability refers to how feasible it is to physically fuse two entities and reach a good form for the final solution. This is a quick analysis as the preliminary to the form-giving stage.

This is where image schemas can help a lot, being another place where the new blood comes into the structure of MWDB. Based on one capacity of the image schema, the mappability can be analyzed with the imagery-mapping effect (see 2.5.3). In the template (Figure 4.79), there is an area for a quick mapping test between the source and the target. Components (or elements) in the base shape of the product (i.e. the target, and see 1.4, 2.3 and 2.7.1 for the base shape) are mapped with components (or elements) in the source in order to examine how possibly the two are able to resemble to each other regarding the image-schema structures of the forms and of the conceptual models. To explain:

The usability requires the target to maintain in some form, where the source also needs to stay in some form and waits to be recognized by users. The room for the modifications on the form of the target is restrained much by the engineering, ergonomics and other relevant considerations, while the room for the source can be analyzed and delimited using image-schema structures. Assuming it to be static, if the final form maintains the basic image-schema structure of the source form, the final form can be easily associated with the source form. And with a few iconic properties of the source on the final form, or if the image-schema structure of the source form is preserved at a very detailed level, the final form would be recognized as the source. So, except for the structure and the iconic properties, the rest are the room for the source form to transform. And, if the designer doesn't want the final product to be too unrecognizable or strange, in addition to the considerations about engineering, etc., the designer needs to use some conventional forms of the target and treat them the same, if not more loosely. However, products often mean functions and interactions. So, the basic source's image-schema structure maintained in the final solution is not just of form, but also of conceptual models. If a design is not doing so, users could feel off when they actually use the product. To give an example of the form aspect: if

a component is an UP PART of the WHOLE source, it is suggested to be preserved as an UP PART of the final product. And to give an example of the function and interaction: the component of the target acts as a CONTAINER in the conceptual model are going to be transferred to the position of a CONTAINER component in the source, meaning the CONTAINER as the source's image schema is preserver in the final solution. Nevertheless, the preservation is recommended unless the design intends to, for instance, use the violation to create surprises and such, which is what Liu (2016) studies (the part relating to the modification of the image-schema structure). Above are actually the guidance for the form-giving stage. And coming back to this task, the quick mapping tells how similar the source and the target are in terms of image-schema structures; the higher the similarity is, the fewer the modifications are required by the guidance, and the higher the mappability is.

Ratings.

Boxes are provided in the template for ratings on every individual criterion, in order to let the designer rate the satisfaction. An overall rating is going to be written on the top right corner. This could help the design to compare these source candidates and pick some top satisfying ones for the next task. In the overall rating, the average score of the completeness and the mappability is counted because the two overlap much, where adding them separately means the image schema are over weighted. Moreover, if there is one crucially unsatisfying, it will prevent the candidate from going further in the development, which works like one-vote veto.

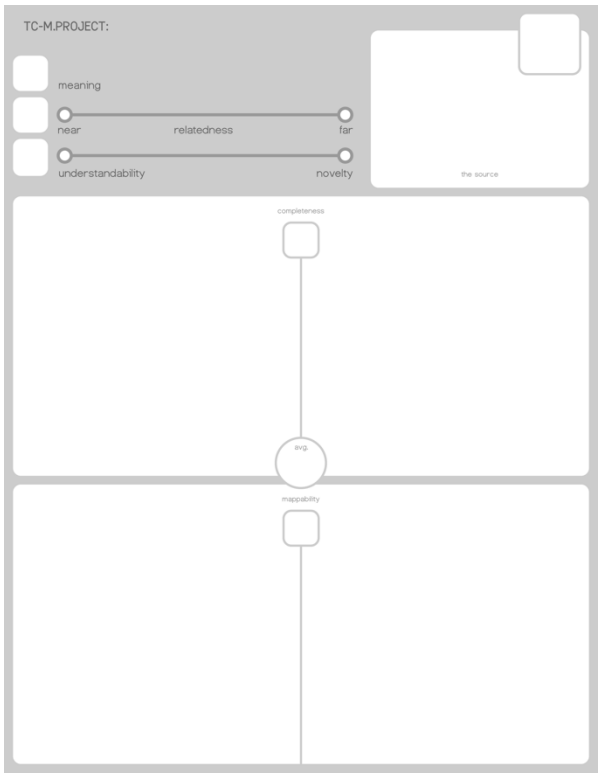


Figure 4.79 The template for source filtering on path-M.

Path-I

Regarding the path-I, the completeness can be left to conceptual models and image-schema structures covered by the searching task. However, on contrary of the path-M, the meaning has not been touched on at this point, so the salient meaning of every source candidates are going to be identified and evaluated. Then, the rest of the three criteria would be used in the same way as path-M. The template is created to cover all these, which is shown in the Figure 4.80. The area for *Relatedness, Novelty vs. Understandability, Mappability, Ratings* would work the same as explained in path-M.

Intention and meaning check.

All possible and salient messages the source produce should be noted in the area on the template. Then, the designer goes through each of them so that the messages can be checked if it

is good and desired or harmful according to the intention and other information from the up-front research.

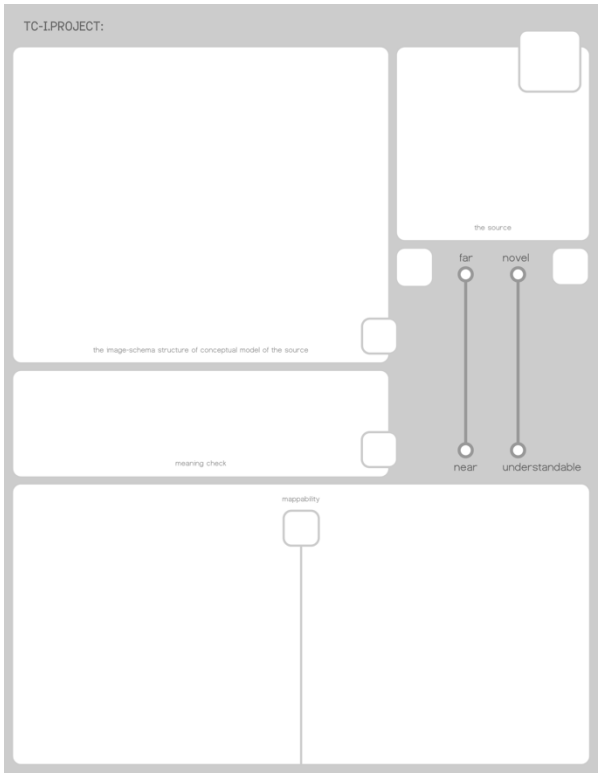


Figure 4.80 The template for source filtering on path-I.

Some notes about the searching and filtering in general.

After the filtering, there could be no satisfied candidates left. If the resources are allowed or the designer decide another try is worth it, the designer might go for another round of searching and filtering. Different inspirations and stimuli could help.

Besides, the searching and filtering could be loose for some intentions. For example, as the Rosaria rosary implies, if the designer has a strong expression, some criteria are acceptable to be ignored or loosened. So, the designer can pick his/her own criteria for the searching and filtering. Sometimes designers can come up with a source very fast and accurately using intuition, so then the criteria used in the searching and filtering could become just a supplemental

evaluation tool or references, or, even more loosely, the designer can skip all the tasks of preparation, searching and filtering, and go to the form-giving stage directly with a source in mind.

4.6 Form-Giving and After

Compared to verbal metaphor, the thorough physical fusion of the source and the target is a unique focus of product design. Belonging to the form-giving stage, it is absent in verbal metaphor but is very important to the employment of the metaphor in products. And the guidance to how the fusion could be done effectively is expected. Again, the "form" in the approach does not refer to just the visual elements, but visual elements and many other types of clues, e.g. sound.

The role of the image schema and its effect (imagery-mapping) in the physical fusion are explained in Mappability in 4.5.2. In the previous task, with the quick mapping it stops at a foresight level and it is actually applied to the practice in the form-giving stage as a guidance derived from the imagery-mapping effect. The guidance is actually for the form-giving. In short, during the form-giving stage, the aim is to develop the design that meets of the target and the source within their room of allowed transformation, by utilizing the imagery-mapping effect to delimit the room of the transformation (in the way discussed in Mappability in 4.5.2).

When the source is transformed, some image schemas and properties are more important, which will be considered in a high priority of the preservation, e.g. those necessary for the recognition of source, those essential elements or components for preserving and expressing the intended qualities and attributes, etc. On the contrary, components as the carrier of harmful meaning or conceptual models are recommended to be eliminated.

The metaphor employed in the product is not just about the source as a concept, but also the thorough design solution. Many other design considerations, techniques and strategies should be applied. One reason for involving others is as there are other strategies that also work for communicating messages, for examples, the elegance in some luxury watches are provided without a clear metaphor. Another reason is there are many aspects involved in a project, many requirements and considerations should be kept in mind and fulfilled throughout the development of form, e.g. regarding engineering, aesthetics generally, etc. Additionally, some strategies can inform the use of image schemas, like one example mentioned by Liu (2016), in which the gestalt principle could be a tool for analyzing how the clues in the form implies image schemas, e.g. how the outline can be established by the visual clues and suggesting a PART-WHOLE or IN-OUT relation. Many can be applied in parallel to the imagery mapping thanks to characteristics of the image schema, specifically the high design freedom enabled by the image schema compared to some other design approaches to the metaphor (for the “freedom”, see Hurtienne (2011, 2015) and some case studies).

In this task, activities like sketching will be executed for ideation. It is an activity involving many considerations and strategies, and the designer would like to follow his/her own way. So, no template is provided.

After the development and some design concepts proposed, an overall interpretation test could be helpful, in order to check if there are obvious defects of the metaphor, like the harmful meaning, communicative conflicts with the functionality, etc. The interpretation could be done in context, by both designers and users. Then, it follows some small adjustments or heavy countermeasures.

Again, if the designer decides the source quickly by intuition or any other ways, the imagery mapping is still worth considering for the physical fusion. The imagery mapping can be a good tool to be individually used and for the designer to jump into the point of this task.

4.7 Some Additional Considerations throughout the Development

- Scene-level thinking is preferable. Throughout the development, the metaphor is recommended to be thought at a scene-level. In 3.3 and some case studies, some detail has been discussed.
- The relatedness is actually a lead to enforcing user-community orientation. This has also been discussed in 3.3 and some case studies.
- The designer can access the process at different points. For example, if the source is detected very quickly, it is an option for the designer to go directly to the form-giving stage, and the interpretation test on the overall product could help with harmfulness or such; if the source is decided naturally by the project but the product needs to be found, e.g. souvenirs, the designer can go directly from the start of depicting the conceptual models of the source.
- Informal use of the process and criteria. This is mentioned in 3.3.
- Generally, templates are just optional. Sections and areas in the template can be broken down into pieces as the designers want. Or if the space feels limited, use multiple copies, scale them, or just not use them. Some areas can be ignored if the designer decide they are not applicable.

Chapter 5 Design Application

5.1 Introduction

In this chapter, the redesign of a product is conducted for demonstrating the process proposed in the last chapter, which is a hand soap dispenser. The background of the project is set that the product is for the public places like some museums, shopping malls, etc., so the reasonable scale of interestingness is welcomed. The dispenser developed by Georgia-Pacific Consumer Product is borrowed and will become the baseline of the redesign, since it can save on some unnecessary engineering efforts; nevertheless, the sense of real-world products could add to the credibility of the demonstration. Figure 5.81 shows one of the hand soap dispensers developed by Georgia-Pacific Consumer Product. In addition, the redesign is not complete product development but emphasizing on the development of the metaphors in product design, particularly the use of image schemas. In sum, the demo project is about redesigning the hand soap dispenser developed by Georgia-Pacific Consumer Products in order to attach an interest to the product using the approach of metaphor and specifically the process proposed.

Besides, Figure 5.82 shows the road this project is following.

Figure 5.81 A hand soap dispenser developed by Georgia-Pacific Consumer Products.

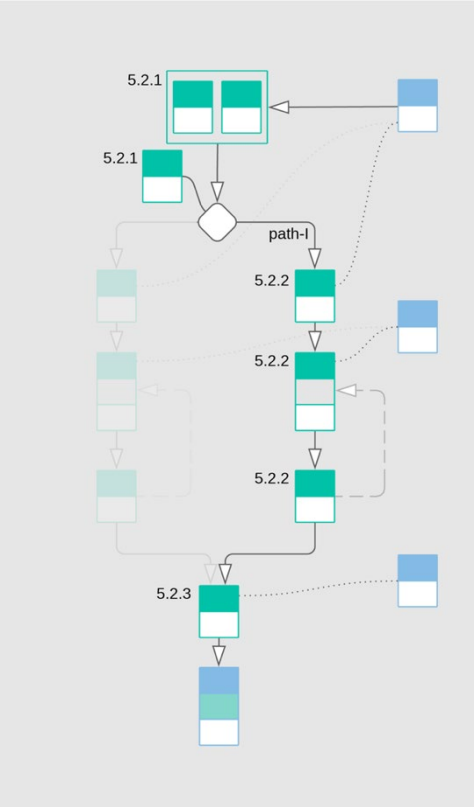


Figure 5.82 The Roadmap of the Demo Project in Section 5.2.

5.2 The Hand Soap Dispenser

5.2.1 Messages, the Intention, the Priority and the Path

The result is documented in the template shown in Figure 5.83. In the first step, some information is collected, which is the messages encouraging the designer to use a metaphor, and the intentions to use a metaphor is defined. The messages are shown in Figure 5.83. The intention is very general, which is derived from the setting of this demonstration (i.e. redesign for shopping malls, museums, etc.). Then the messages are categorized, and the intention lead to a priority. In this project specifically, the messages are not really encouraging a metaphor, so the coefficient for messages is not as high as it for the intention. Being very general, the intention means there is no specific value to attach and the functionality/usability is still in focus, so the

priority concluded form the intention is as shown in the Figure. Then, it is decided the path that uses image-schema structures for the source searching is going to be taken. (Note: there is a supplement demo project for the path-M; path-I is demonstrated before path-M because the image schema is the focus of this research.)

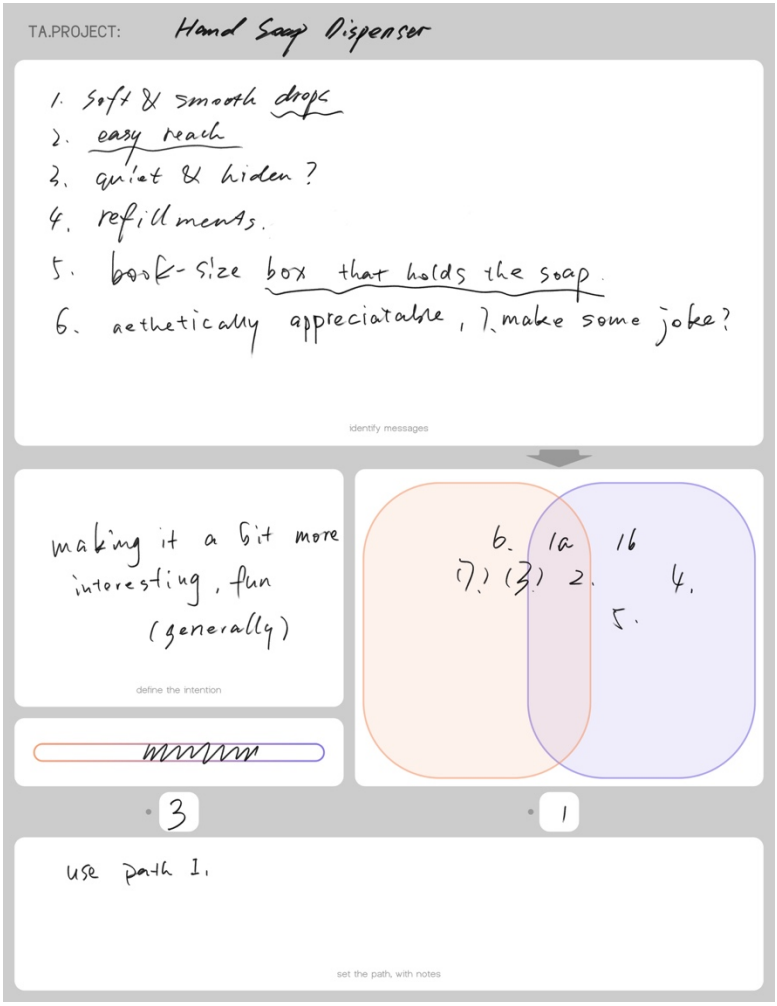


Figure 5.83 The result of using the template TA.

5.2.2 Searching and Filtering

Preparation

Before the searching, the messages need to be processed, or be identified or defined from information outside those mentioned in the previous task. Basically, major intrinsic messages in

the shallow semantic layers are pulled together and converted into fragments of images-schema structures and then combined into a single structure, which will be used for the searching. Some keywords are also detected as the loose directions of the source searching. The result is as shown in Figure 5.84.

Searching

The source searching is one of the heavy ideation tasks. During the searching, the source candidates are noted down in the template shown in Figure 5.84. Many commonly used methods would be helpful for the searching, as mentioned in 4.5.1. Limited by the scale and resources of this demonstration, the main method used in this project is the canvas collecting the visual stimuli.

Filtering

Then, several higher potential candidates are evaluated, and some less feasible ones are filtered off. In Figure 5.85, two candidates (chicken and cloud) are taken as the examples to show the use of the templates. For each candidate to be evaluated, one sheet of the template is used. Five items in the template are examined. Respectively, the source's image-schema structures are extracted and compared to the target; the meaning the source is suggesting; the conceptual distance between the source and the target domains, which suggests the strangeness of the use of this specific source; how novel the association is between the source and the target; and the feasibility of the physical fusion of the two. Each of them gets a score. Among the five, the relatedness (i.e. the conceptual distance) and the novelty are relatively forgiving so their scores do not fluctuate much across candidates. The scores of every item are collected to indicate how good the source candidate could be. After the filtering, chicken (laying eggs), cloud (raining),

etc. should ones with the most potential among the result of source searching, which will be put into further development.

Figure 5.84 The preparation for the searching and the result of it. (rotated 90° counterclockwise)

Figure 5.85 Examples of the filtering. (rotated 90° counterclockwise)

Figure 5.86 A thumbnail of some of the visual stimuli used for source searching.

5.2.3 Developing the Solution

This stage significantly is in line with the mainstream strategy of product design process but with the help of image schemas. While common methods and considerations are used in the form development, the image-schema structures function as a guidance to the better fusion result of the source and target. Sketching is conducted for exploration. The means of computer-aided design (i.e. CAD) is also applied. Mock-ups and many other methods for the exploration and the development are also recommended but this demonstration has limited resources, so here sketching is the main means in use.

Sketches

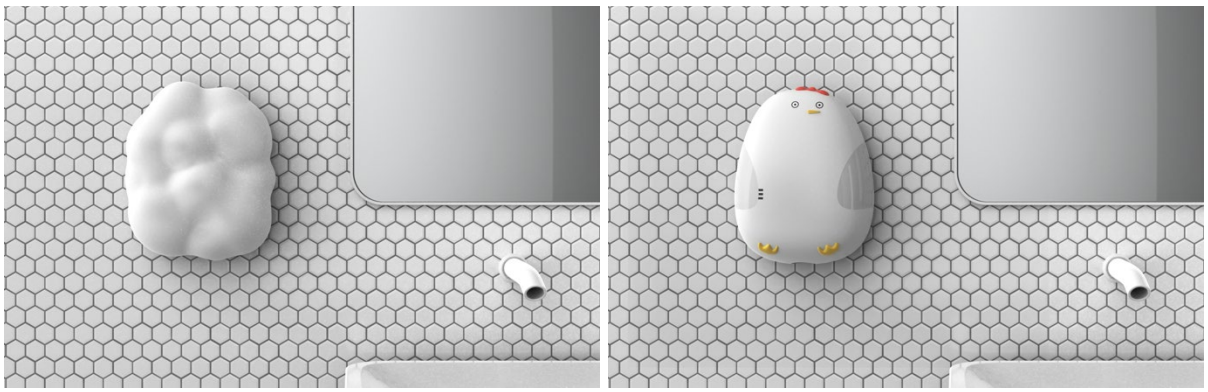
The solutions are explored while considering not only the metaphor (especially the physical fusion) but also other requirements. Like this project, fire safety, theft, cleaning, etc. are some examples needing concern. The hard surface is likely to be preferred; the appearance should be simple and with less parts or features so that cleaning would be easier; the material and mechanical structure should obey standards and at least achieve the desired functions; the styling should fit the context; and more. As for the preference of the fusion, the final one uses an abstract

form in order to make it more acceptable in a wider range of regular shopping malls and museums. Some sketches are shown below.

Figure 5.87 Some of sketches for the redesign of the hand soap dispenser.

Renderings

After the explorations and development, one or several developed solutions could come into being. In this demonstration, renderings are generated to present one developed solution. After going through all the steps, it should be a potential solution for the final delivery.



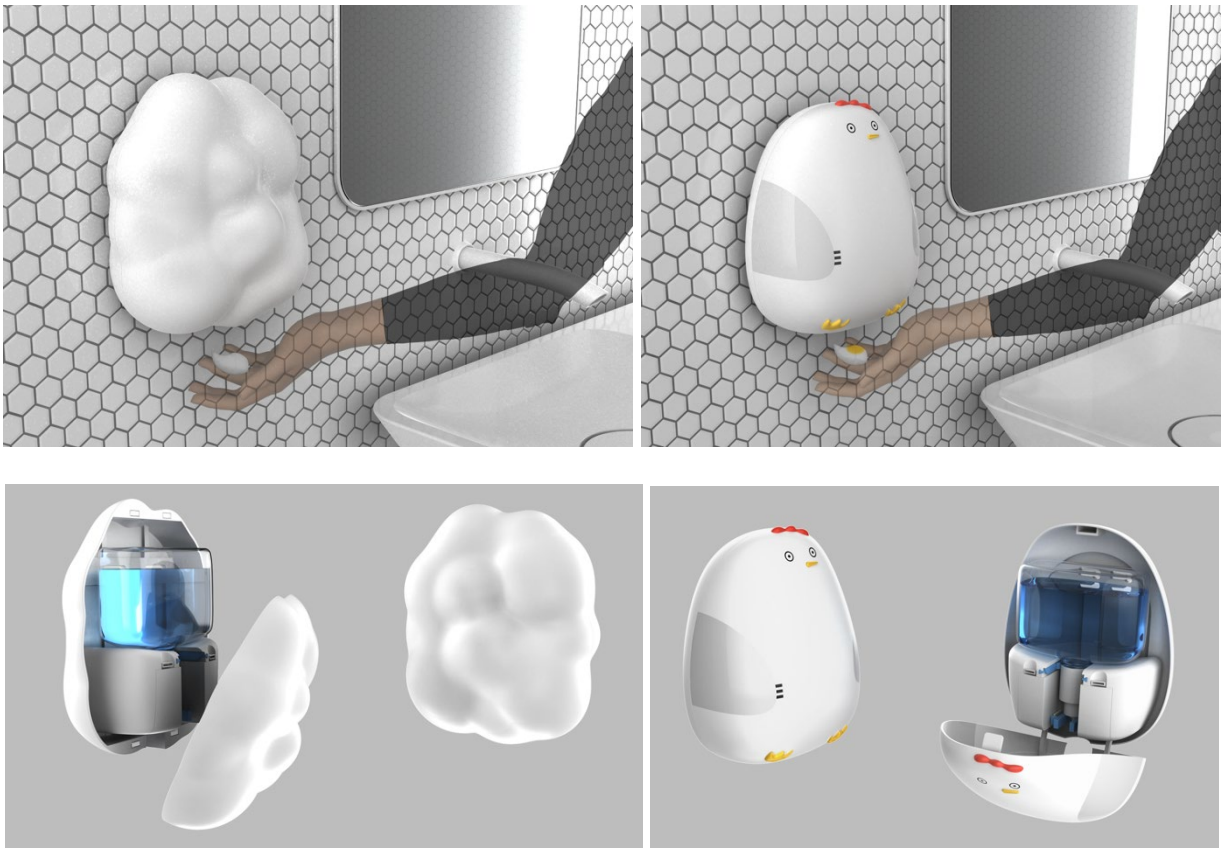


Figure 5.88 Renderings of the hand soap dispenser redesigns.

As for how the imagery mapping guides the fusion, the chicken concept is a bit more evident than the cloud, which makes the chicken concept an example for the explanation. Though this project is not so strong to demonstrate the imagery-mapping effect since the original dispenser does not have too many components on the surface but is basically a box, the traces still imply its appropriateness. For example, the main body of chicken is preserved as a dominating PART and as a CONTAINER of organs or such, which in the developed solution becomes the major form, and to contain components or consumables. Actually, the dispenser being a box (basically just being WHOLE without obvious PARTS) is asking for making the "head and neck" PART and the "body" PART of the chicken becoming one WHOLE piece. And thanks to what can be seen in real life, i.e. sometimes the head and body of a chicken looks

merged together, it is not strange to do so. Or, other way around could be separating the dispenser into parts, which is not as feasible.

5.2.4 Conclusion on This Project

Admittedly, compared with the beaver-like pencil sharpener (Kastor), these two design variations are not as effective, interesting or natural as the beaver metaphor whose quality is very high. That said, the cloud metaphor for the dispenser is close to the quality of the beaver metaphor. This difference could be due to the limited resources and time given to the project. If there were more designers participating, or more time and iterations were given to the search and filtering stage, there could be sources that excel beyond that of the cloud and chicken. However, even if resources are limited, at least the process would meet the lower limit of quality to an acceptable level.

Overall, the demo project successfully generated some developed solutions (though concepts), and the potentials of them to achieve the intention should be high. After experiencing this process, it is clear the process is successfully in making an elusive symbol, the metaphor, more concrete and developable.

5.2.5 More on This Project

Actually, designers can take the path-M in this demo project, according to the range defined in the continuum. It would be interesting to investigate what the result could be when using different path for one project. However, limited by the resources and time put into this thesis, here is a brief hypothesis:

- The analysis in the Figure 5.83 remains the same, but with the set path to be path-M.
- Then, meaning is newly defined to fulfill the interestingness. The meaning is likely to involve extrinsic messages. E.g. lively, amusing, etc.

- Then, the defined meaning is used for the source searching, and after the searching there would be some source candidates, which will be filtered by using additional criteria.
- After the filtering, some concepts are shifted to form development, and some final solution are expected. The chicken and the cloud could still be some acceptable candidates, but it is also possible to find more interesting and nature sources.

The logic is unobstructed so far. However, it is a very brief anticipation. A supplimental project is documented in the next section (5.3), which was conducted in order to demonstrate the path-M approach.

5.3 A Supplimental Project

5.3.1 Introduction

This second project is conducted to demonstrate the other path (path-M). The path-M is derived much from MWDB and already validated by that research. However, it is still valuable to use a demo project for the path because:

1, more demonstrations create more tests on the approach;

2, there are new contents added to the approach originally proposed in MWDB, e.g. the image schema is suggested to be helpful for practicing one of the criteria. Using this demo project would be the first to demonstrate them, which should be recommended when new contents are proposed.

This supplemental project still takes hand soap dispenser as the subject. Given the path-M to be the aim, strong or specific qualities/meaning, or intentions leading to these, can be used for setting the background of this supplemental project. Many extrinsic messages are eligible, e.g. warm, royal, active, strong, light, valuable, trust-worthy and much more, depending on the

objective of the project. Besides, valued intrinsic messages are also within consideration. After all, “clean” and “bringing cleanliness” are set as the project background. To specify, a key objective of this design project is to emphasize on the “clean” in order to hint to users that the device can be trusted for the improvement of cleanliness.

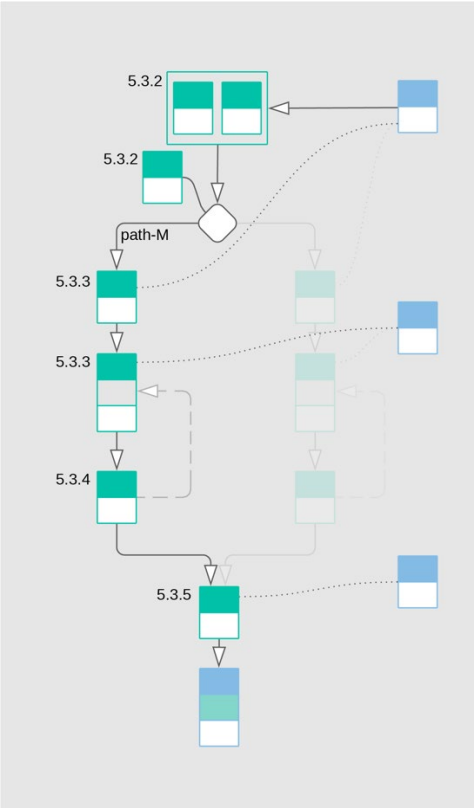


Figure 5.89 The Roadmap of Demo Project in Section 5.3.

5.3.2 Messages, the Intention, the Priority and the Path

At this stage, the messages, the intention, and the priority are analyzed. The result is as shown in Figure 5.90. The path is set to use path-M for developing the metaphor.

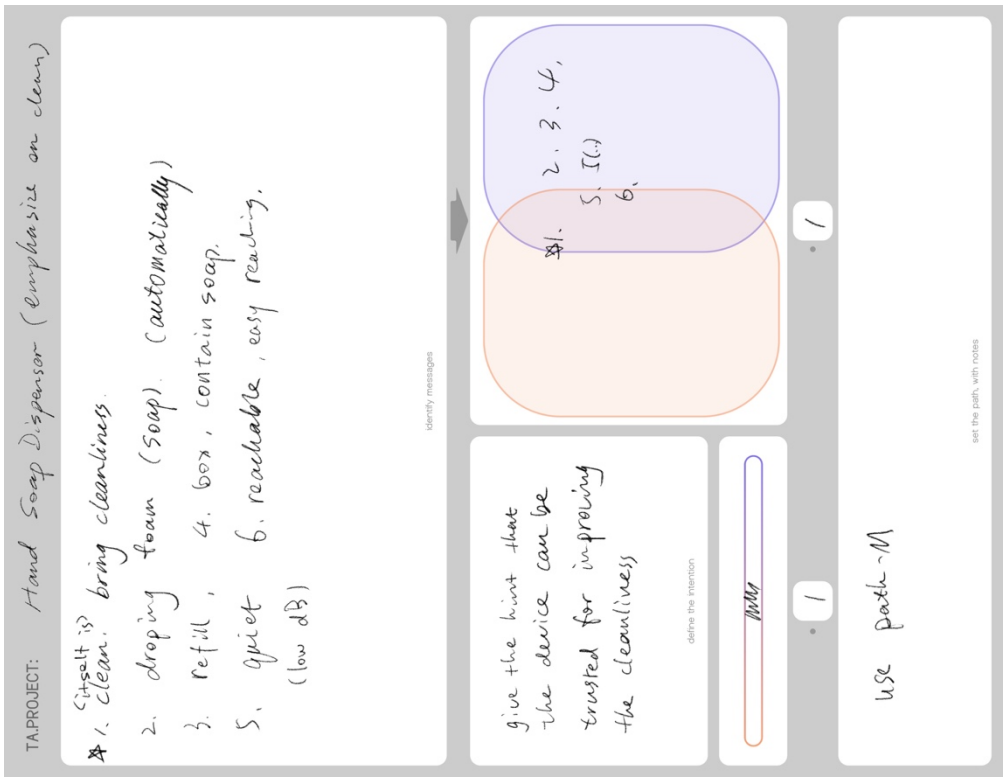


Figure 5.90 The result of using the template TA. (rotated 90° counterclockwise)

5.3.3 Preparation and Searching

At this stage, many sub-tasks are conducted:

- Expanding the meaning “cleaning/cleanliness” to other related meanings. (Figure 5.91)
- The meaning is written into TB-M2, with some general scopes and stimuli. (Figure 5.92)
- Exploration is executed for enhancing the range of searching. (Figure 5.93)

  Then identified sources along the exploration are written into TB-M2. (Figure 5.92)

Some sources marked as higher potential are going to be evaluated by other criteria at the next stage.

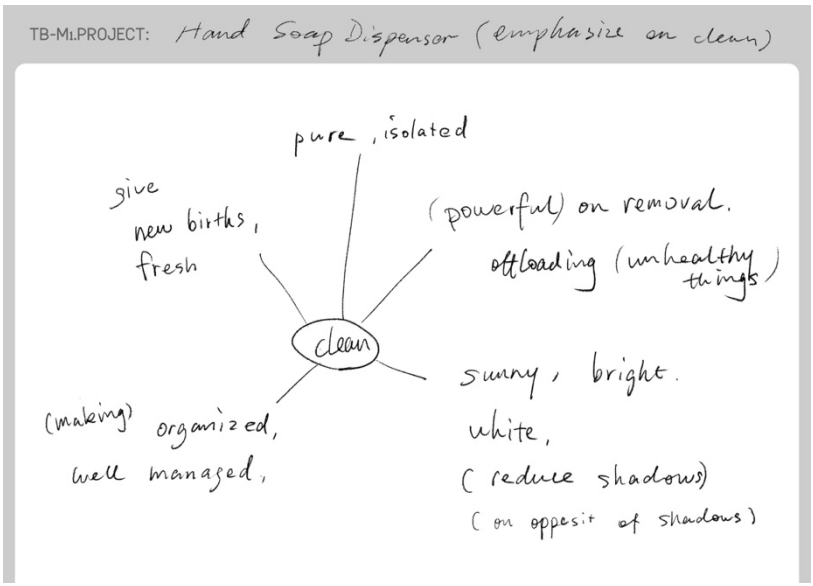


Figure 5.91 The result of expanding the meaning. (cropped)

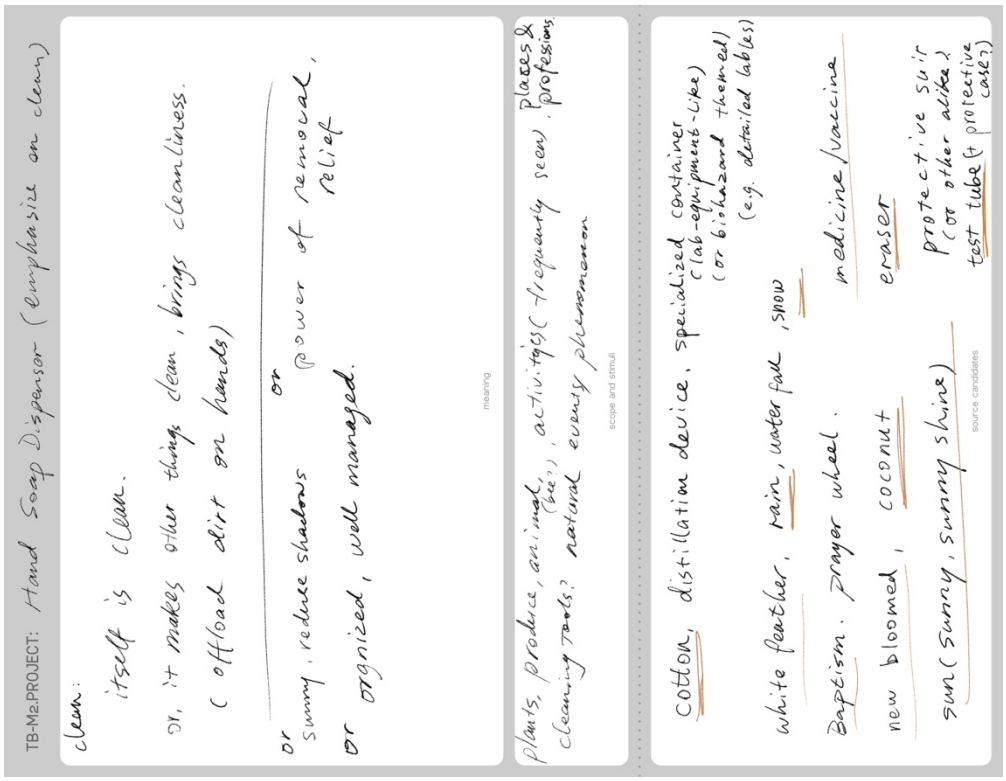


Figure 5.92 The result of expanding meaning. (rotated 90° counterclockwise)

Figure 5.93 Exploring for sources. (rotated 90° counterclockwise)

5.3.4 Filtering

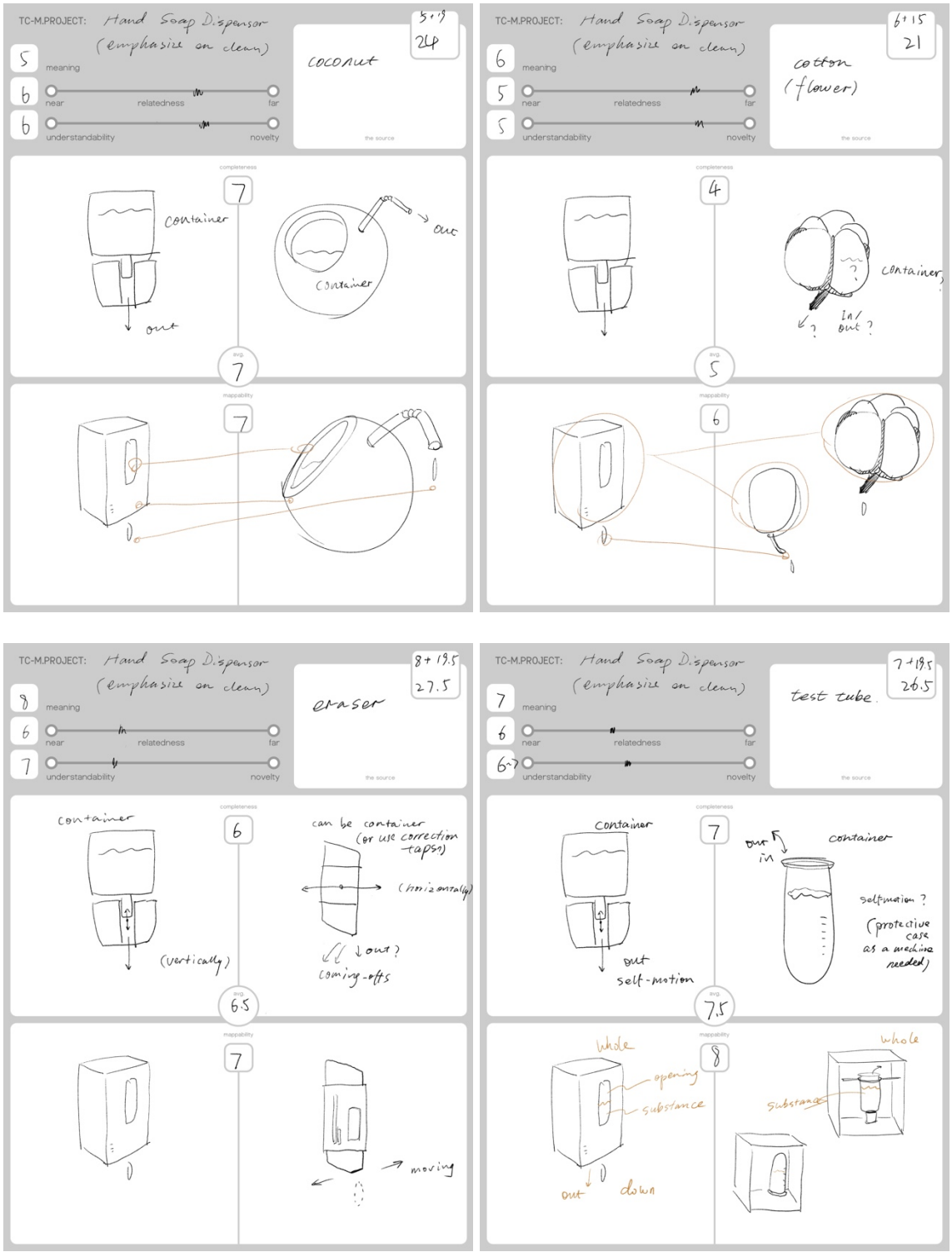


Figure 5.94 Examples of the filtering.

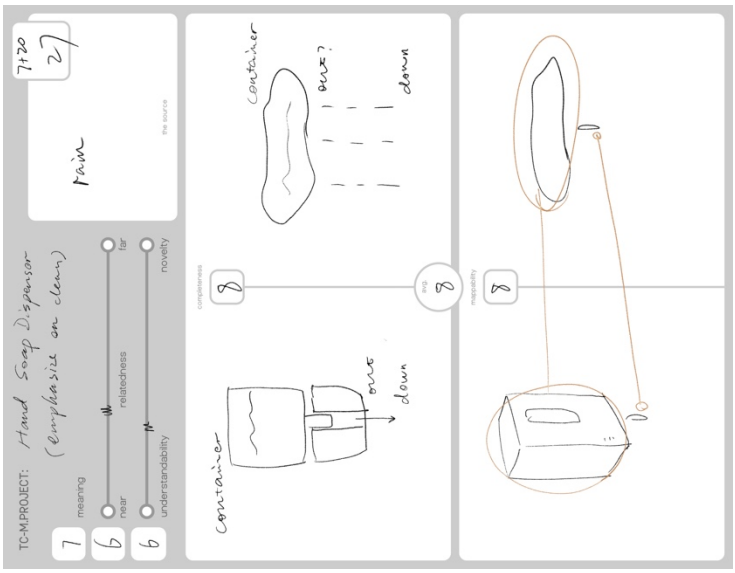


Figure 5.95 Rain and cloud metaphor again. (rotated 90° counterclockwise)

At this stage, several source candidates are evaluated using other criteria and the template TC-M. Some examples are shown in Figure 5.94. As a result, the test tube (with protective case), raining, and the eraser are some relatively satisfying concepts and will be put into the form development. The image schema worked for the evaluation on completeness and the mappability.

Since the raining concept is actually a similar solution to the one developed in the project in section 5.2, it will not be repeatedly developed and demonstrated.

5.3.5 Form-Giving

In the same way as the previous project, sketches and the Computer Aided Design are the main tools used in this demonstration. In Figure 5.96, it shows some sketches. Figure 5.97 shows the renderings of the design solution. It shows a solution with the test tube metaphor applied, which is one of possible final solutions, though with unsolved engineering issues needing further development, for example, the dual straw plugged into the nuzzle. The test tube could imply negative experiments, hazards, etc., which might give it less potential. However, the pureness (cleanliness) and being specialized and technical, which it also implies, are desired for the

project. And the feeling of experiments and hazards might be resolved by other strategies, for example, by using colors that are not offending, and likewise by using rounded shapes.

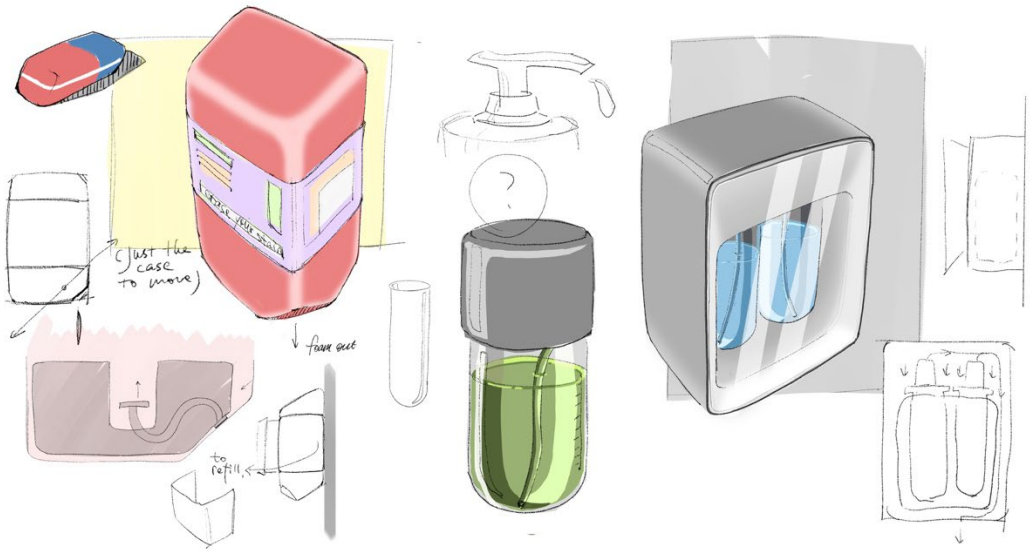


Figure 5.96 Some of sketches for this supplemental project.

Figure 5.97 Renderings of the hand soap dispenser redesign using the test tube as a metaphor.

(continuing on the next page)

Figure 5.97 (continued)

Renderings of the hand soap dispenser redesign using the test tube as a metaphor.

Chapter 6 Conclusion

6.1 Major Outcomes of This Research

How image schemas can support the development of metaphors in product design has been studied. The tools utilizing image schemas are developed through secondary research and case studies, and they are integrated in the design process with the help of the process structure provided by MWDB. Though the approach constructed in this thesis used a lot from MWDB, arguably, it could be claimed as a more detailed and defined approach than just MWDB. And more importantly, there is provided a guidance for the physical fusion, which is what MWDB addressed as an area for future research. Also, the limitation of MWDB on functionality is partially addressed. And, lastly, a possible framework for organizing some approaches regarding metaphors employed in products is proposed.

6.2 Discussions and Further Research

About organizing approaches.

The organization probably succeeds, but the content covered by this thesis is far from enough for making a clear conclusion that the continuum is appliable to a wide range of possible applications. There likely are approaches unable to be compared using the continuum, since the metaphor could be too complicated and huge. Despite this, the continuum is to some extent valuable for understanding the metaphor in product design. For this thesis, the benefits of it especially are, to imply the role of the image schema and to become the base of the roadmap for the development of metaphors in product design.

About the process and tools proposed by this thesis.

The process could be too hard to understand, and too delicate and huge to be fully practical. This is said specifically to the searching and selecting, which seems complicated and

becomes less practical than expected. Taking a step back, the two capacities of image schema are really good notions for the development of metaphors. Especially the imagery mapping for the fusion task is really helpful, meaning it is relatively concrete for designers to follow and at the same time it gives designers a lot of room for many other requirements and desirables. So, topic-wise (of using image schemas as supports), the part of image schemas in the source searching and filtering is usable but not yet very solid or practical, and the imagery-mapping should be more practical and fruitful. Further studies are needed to make it a solid approach, or even other perspectives might be needed. For example, the extrinsic messages, intrinsic messages and the physical fusion could all be the entries for designers (not just messages), after which the other two aspects play the role of evaluation or considerations with no order of precedence. The three parts are more flexible for use in design: any can be the essential for source searching and all should get involved. This could make it less hard than understanding and practicing a linear process. Though more studies and evidence are needed, this approach already shows much improvement in usefulness.

Further Research

Overall, the approach proposed does not yet fully fulfill the expectations of practicality. Finer research is needed to draw clearer conclusions. Though this, the image schema is a very potential notion and deserves more exploration. Besides, this thesis relies much on the writer as one individual, but inputs from a variety of perspectives are really welcomed for contributing to this research topic. In regard of case studies, this thesis is not done with considerable backing from secondary research but reflects the writer's understanding and collection of information, where the former is welcomed and would help the credibility of research. And, the selection of cases is not yet ideally conducted due to the limited scale of this research. Further analysis along

the lines of this project could help to explore already-existing metaphors in product design so that designers can develop a clear sense of what works and what doesn't work, in relation to the tools proposed in this project. In regard of demonstration, the limited resource is the limitation to have a strong demonstration.

A side direction could be really helpful to designers, which is to establish a library of image schema structures with associated entities, as well as a library of meaning with associated entities, for designers to reference to. Hurtienne (2011) established a related one but with a focus on interfaces and intuitive use. Taking inspiration from Hurtienne, developing more libraries for different categories of design could help to both fine-tune the tools proposed in this project as well as providing designers inspiration in a wider range.

Metaphors, as a basic human cognitive process, are fundamental to how we understand the world around us. That fundamentalness also means metaphors cover a great deal of cognitive and conceptual ground. That breadth provides considerable room for researchers and designers to carry on, much as this project jumped off from MWDB, approaches relying on image schemas and other works. So, there could be many more researchable areas.

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Appendix

Templates Shown in a Larger Scale

(Starting in next page.)

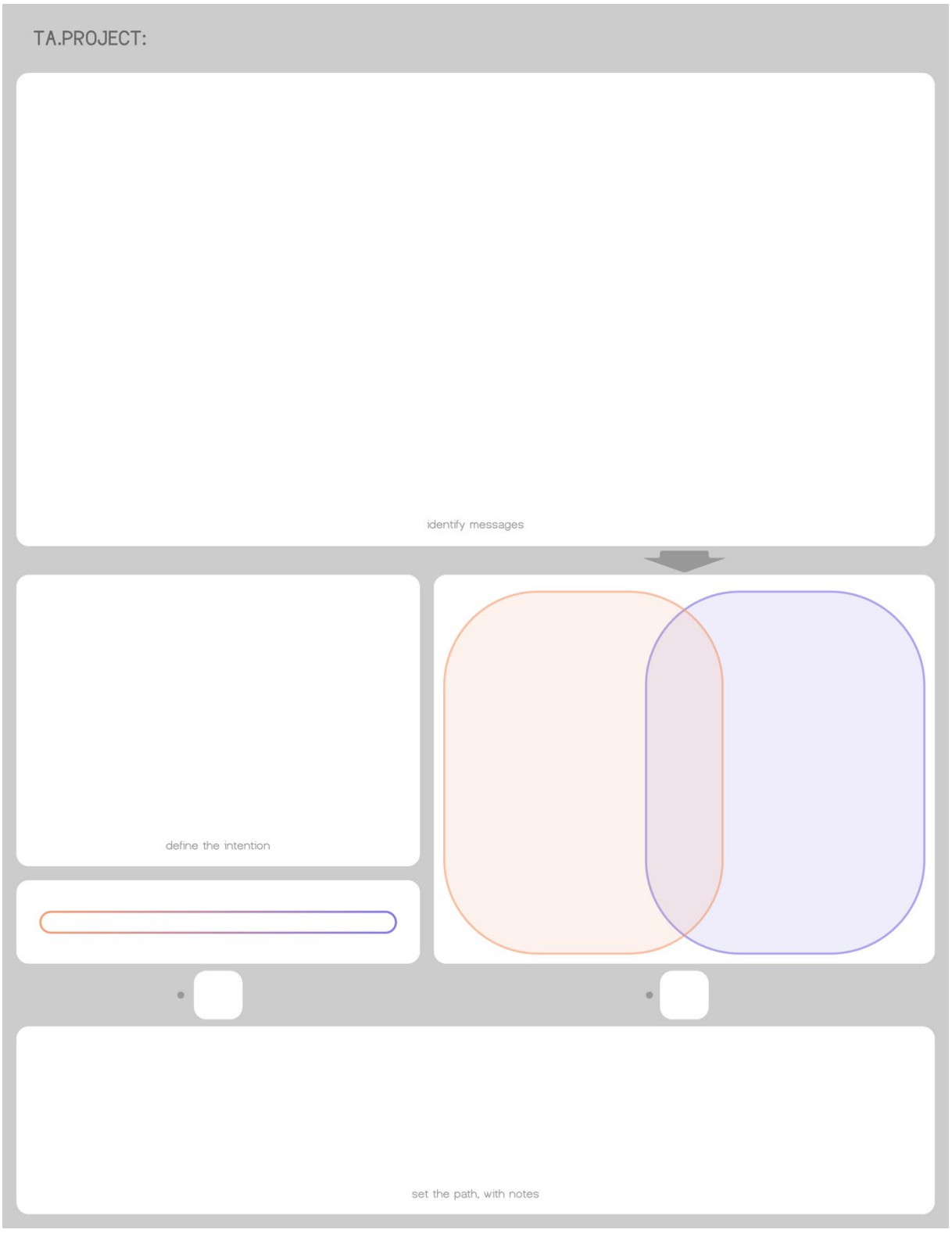

Figure A1 Template TA

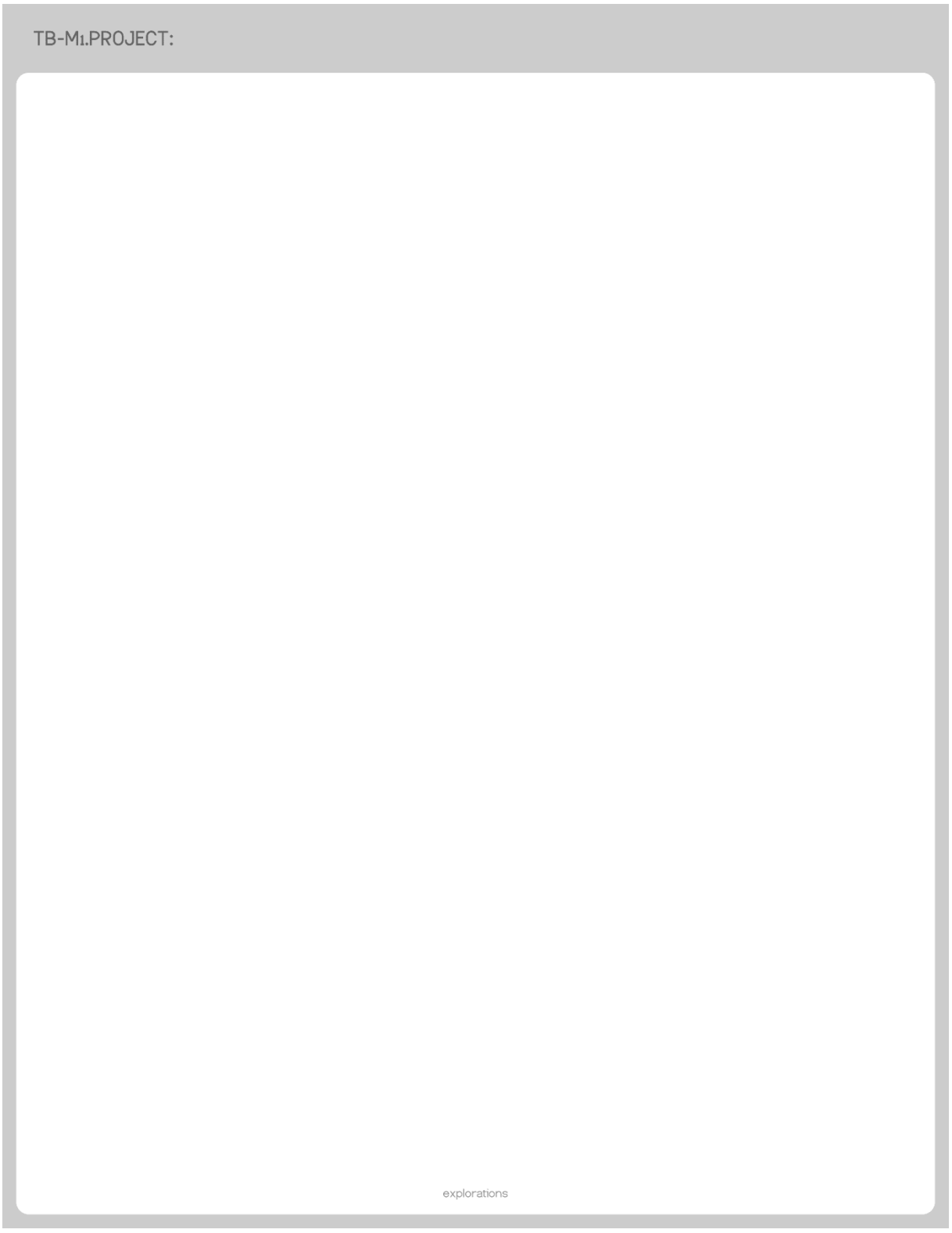

Figure A2 Template TB-M1

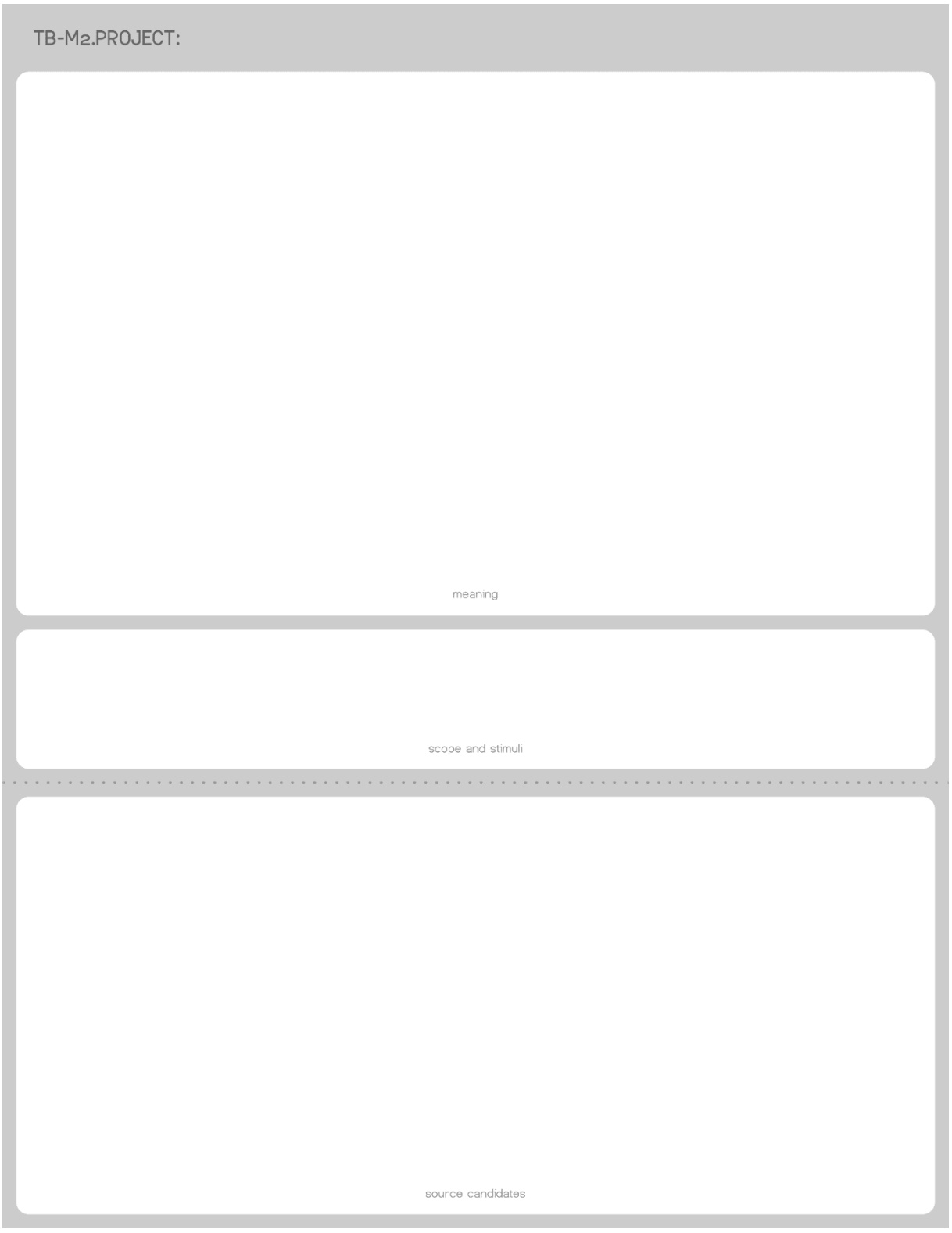

Figure A3 Template TB-M2

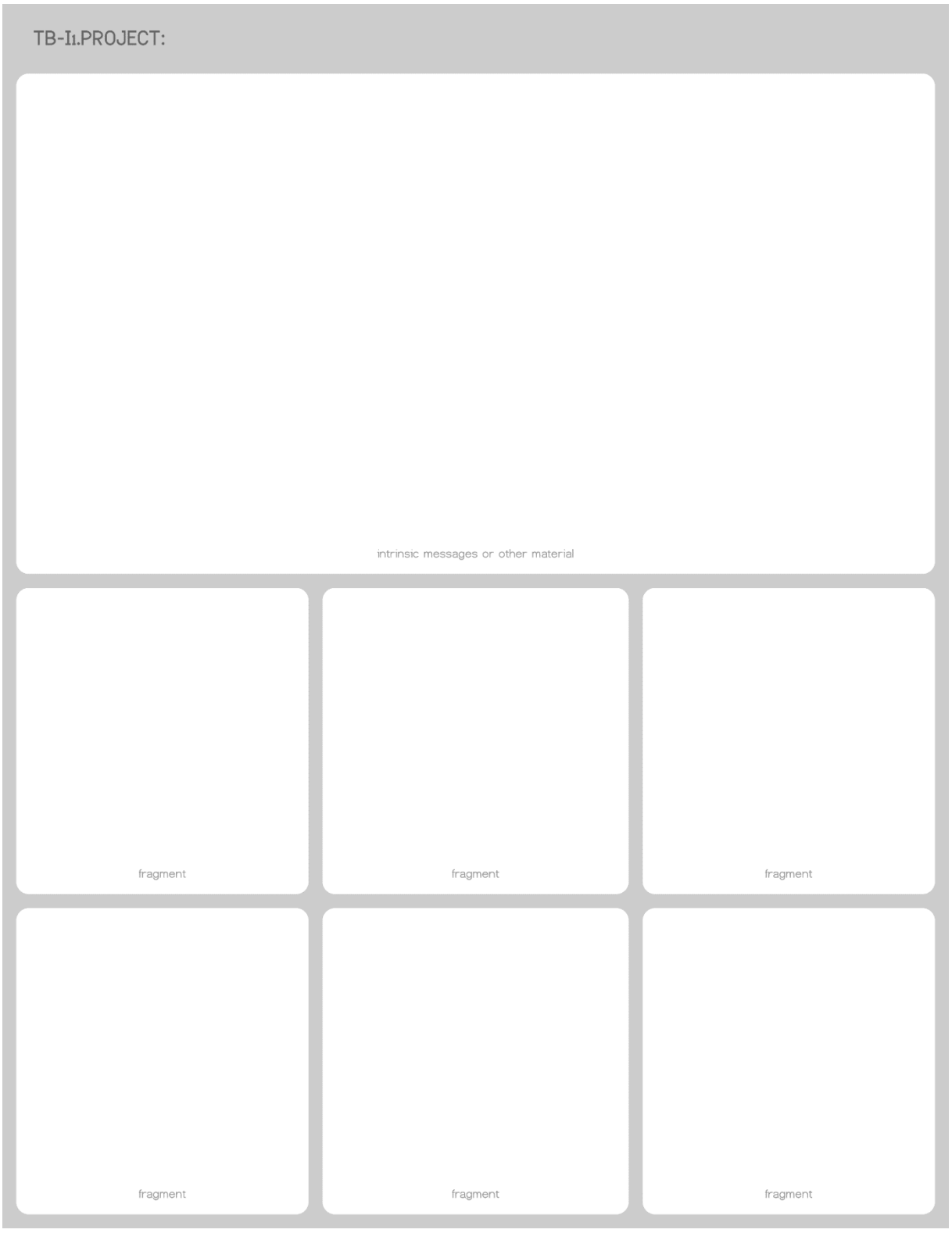

Figure A4 Template TB-I1

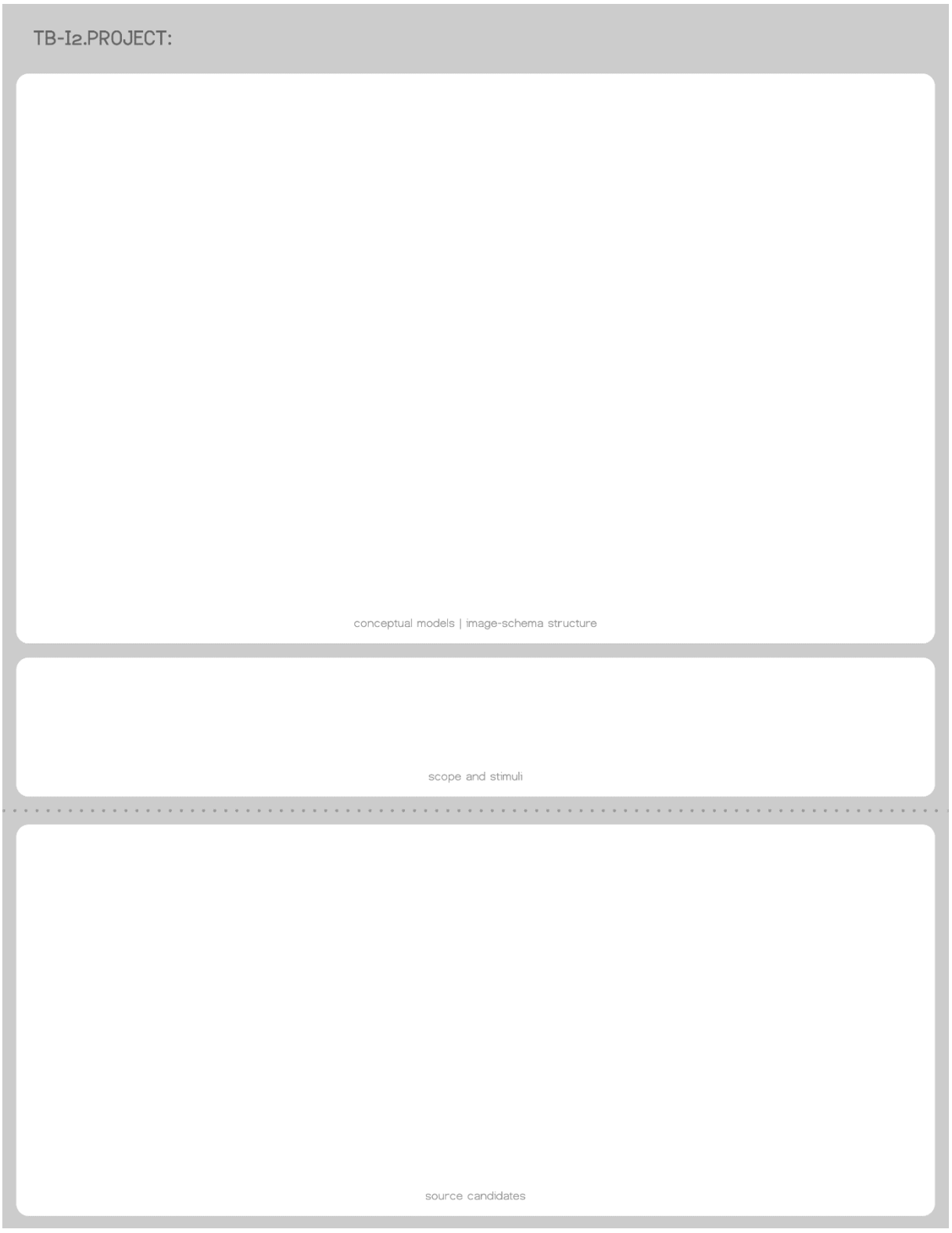

Figure A5 Template TB-I2

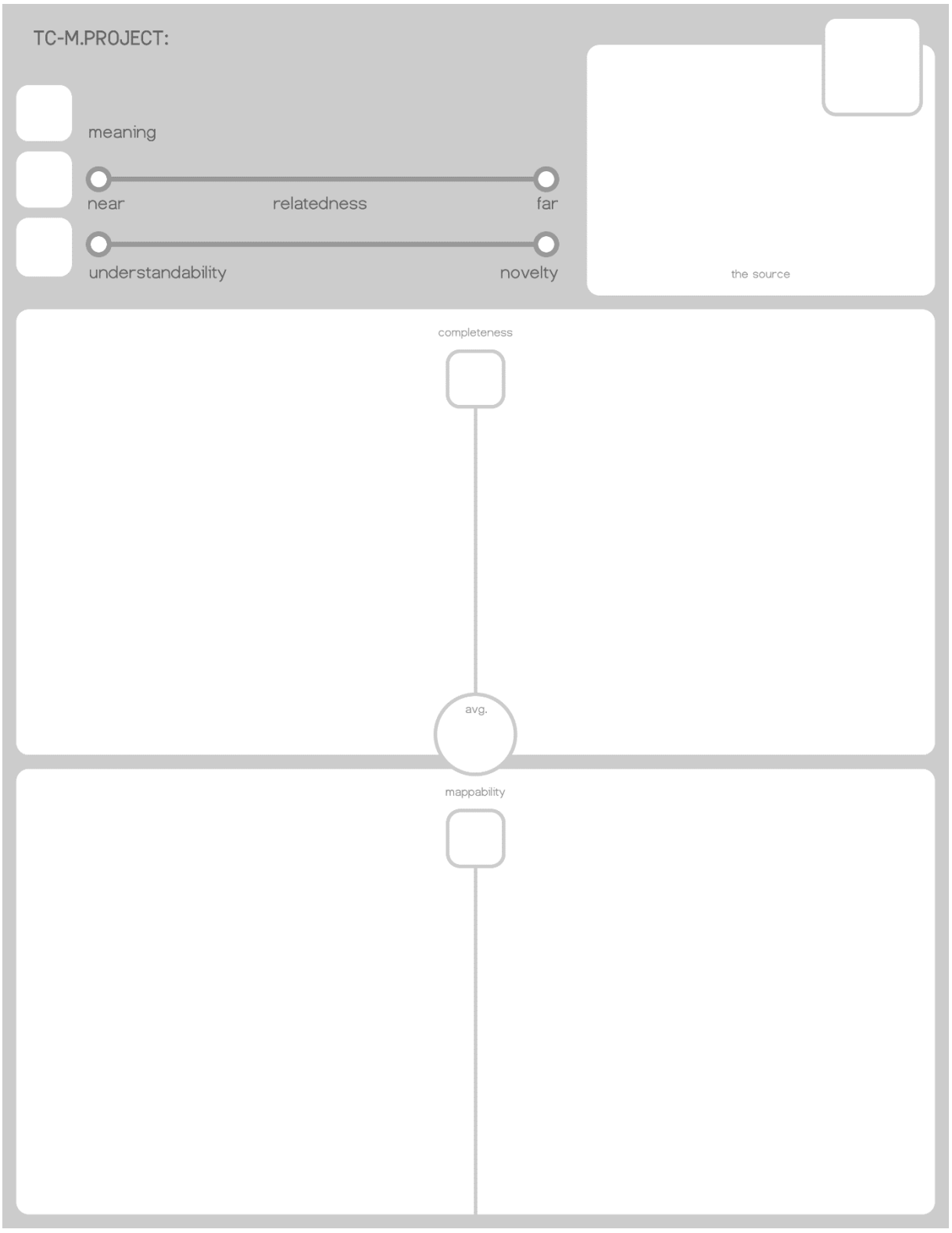

Figure A6 Template TC-M

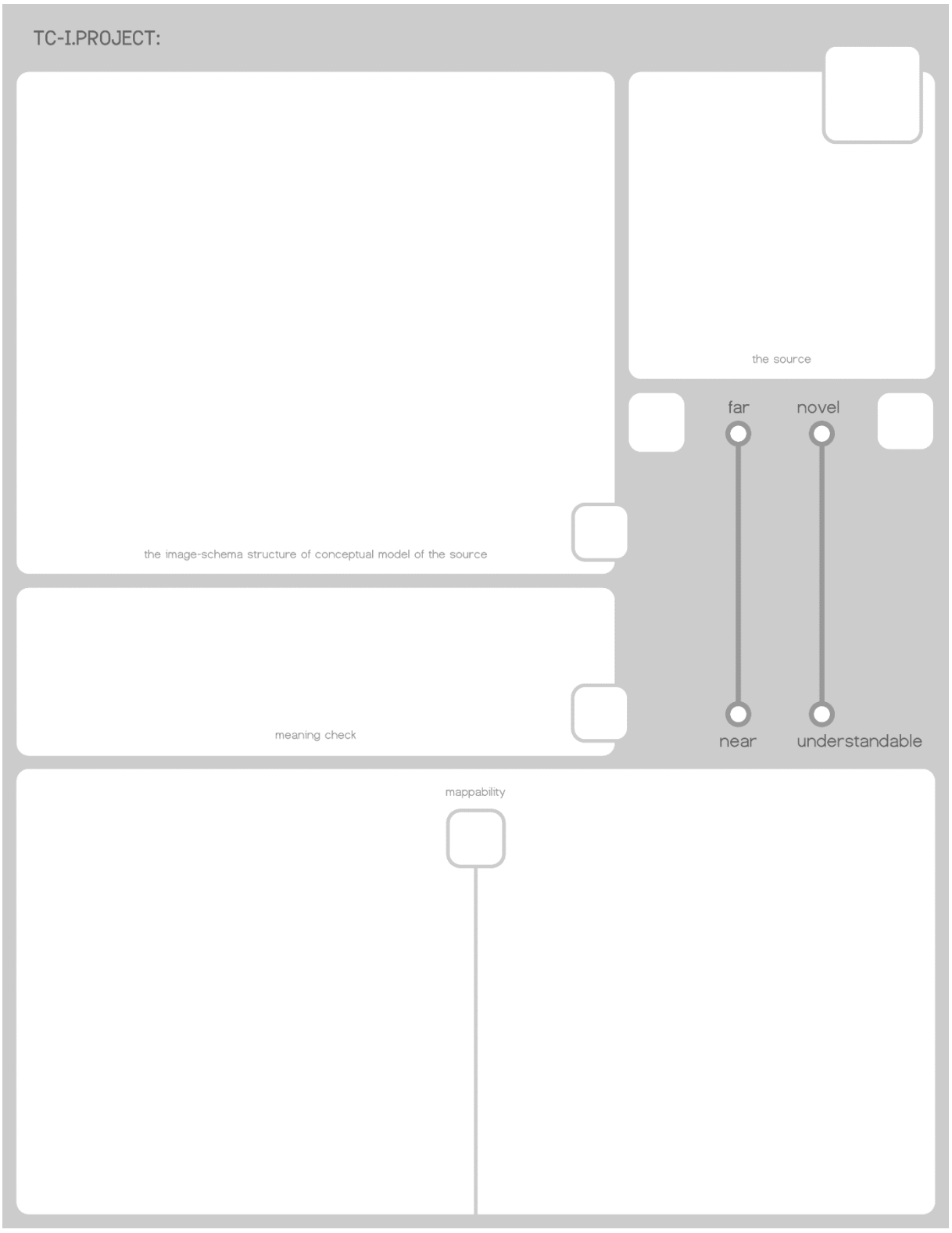

Figure A7 Template TC-I