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The use of metaphors
in product design

Nazlı Cila

Metaphors we design by:

The use of metaphors in product design

PROEFSCHRIFT

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INTRODUCTION

Maureen: "No? In what sense did we actually see an angel?"
Jess: "What do you call it in poems?"
Maureen: "I'm sorry?"
Jess: "You know, in poems. And in English Literature. Sometimes you say something is like something and sometimes you say something is something. You know, my love is like a fuck-bloody rose or whatever."
Maureen: "Similes and metaphors."
Jess: "Yeah. Exactly. Shakespeare invented them, didn't he? That's why he was a genius."

Nick Hornby, A long way down

Shakespeare is one of the most remarkable storytellers that the world has ever known. He is the creator of many greatest, textbook examples of metaphors; he used metaphors so skillfully and elegantly that the readers were immersed in very rich, imaginative, deep yet familiar stories and poems. Yet Jess is naïve, if not ignorant, to consider him as the "inventor" of metaphor. As a matter of fact, metaphors exist long way before Shakespeare's birth; they have a history that goes back at least to the era of Aristotle (1895/2008). Traditionally, metaphor is seen as a rhetorical figure of speech through which one thing is described in terms of another, as when our Shakespeare states "All the world's a stage" to point out the mechanics of life. Metaphor is so prevalent in all languages that we utter about one metaphor for every ten to twenty-five words, or about six metaphors a minute (Graesser, Long & Mio, 1989). Even the American Sign Language makes use of metaphors as frequently as spoken English (Taub, 2004).

Aristotle (1895/2008) considered metaphor as an ornament of language, which is appropriate for poetry but too ambiguous for philosophical or scientific discourse. Unfortunately, metaphor has long been acknowledged as a purely linguistic device in the realm of poets to write things that could also be expressed in literal ways. This "romantic" view on metaphors was subjected to a radical shift by the formation of the linguistics and psycholinguistics disciplines. Since then, there has been a growing recognition that the use of metaphors is not confined to spoken or written language, but metaphors underlie how we think, reason, and imagine in everyday life (Gibbs, 1994; Lakoff & Johnson, 1980; Sweetser, 1990; Turner, 1998). This means that the metaphors we use are the surfacing of the primary ways in which we conceptualize the world (El Refaie, 2003). We "think" metaphorically. We structure and experience many concepts, especially abstract ones such as time, emotion, and spatial orientation, in terms of metaphor (Kövecses, 2010; Lakoff & Johnson, 1980; Reddy, 1979). These arguments stress Ortony's (1975) claim that "metaphors are necessary and not just nice" (p. 45). Metaphor is present in all fields of human endeavor. As Geary (2011) pertinently puts forward,

> "Metaphor conditions our interpretations of the stock market and, through advertising, it surreptitiously infiltrates our purchasing decisions. In the mouths of politicians, metaphor subtly nudges public opinion; in the minds of businesspeople, it spurs creativity and innovation. In science, metaphor is the preferred nomenclature for new theories and new discoveries; in psychology, it is the natural language of human relationships and emotions." (p. 3)

Realizing the power of metaphor to underlie human cognition paved the way for studying not only the metaphorical expressions found in different kinds of discourse that Geary listed, but also the ones that are nonverbal in nature. As Gibbs (2008) proudly pointed out in his "state-of-art" overview on metaphor, metaphor research is now as multidisciplinary and interdisciplinary as any topic being studied in contemporary academia. Scholars from various fields investigate the functions and meanings of metaphor in relation to art (Aldrich, 1968; Feinstein, 1985; Kennedy, 2008), architecture (Casakin, 2007, 2011), gestures (Cienki & Müller, 2008), political cartoons (El Refaie, 2003), comics (Forceville, 2005), mathematics (Lakoff & Núñez, 2000), music (Zbikowski, 2008), cinema (Carroll, 1996), advertisements (Forceville, 2002, 2008; Phillips & McQuarrie, 2004), interface and software design (Blackwell, 2006; Fishkin, 2004; Hurtienne & Blessing, 2008), and even hobby horses (Gombrich, 1963)!

The reason that metaphor is considered as a relevant and eminent subject matter to study in all these diverse fields lies in its power to integrate disparate entities and bring new perspectives into existence by allowing us to "understanding and experiencing one kind of thing in terms of another" (Lakoff & Johnson, 1980, p. 3). This is the textbook definition of metaphor, which rightly turns up in almost every contemporary academic treatment of the subject. When Shakespeare defines the world as a stage, he urges us to perceive our lives anew from the viewpoint of a play in order to highlight its certain aspects (e.g. it is fleeting, we all make entrances and exits, we all play different roles, and so on).

In literary parlance, the world is called the metaphor's "target", which is the thing we aim to define, and the stage is called its "source", the thing that is associated with the target to assign a novel meaning to it. This terminology fits well with the etymology of the word "metaphor" itself. Derived from the Greek words *meta*, meaning "over", "across", or "beyond", and *pherō*, meaning "to carry", the literal meaning of metaphor is "to carry over" ("Metaphor", 2013, "Etymology", para. 1), as Shakespeare carried over the most salient properties of a stage/play to the world in order to define it. Correspondingly, in my mother tongue Turkish—a language that belongs to a different family than Indo-European languages—the word for metaphor is "mecaz". This word was adopted from Arabic "macāz", which suitably means a "bridge", as in a metaphor builds a meaning bridge between two distinct entities such as the world and a stage.

When we bridge two entities, we match what we know about the source with what we do not know about the target. In this way, certain aspects of each are illuminated, others are downplayed, as well as new insights emerge and deeper levels of meaning are tapped. For this reason, metaphors are often referred to as the cognitive instruments used by "creative artists" to build relationships that urge us see things in a new light (Cupchik, 2003).

This thesis – Metaphors we design by

Product designers are one group of these creative artists who frequently resort to metaphors to exhibit original and aesthetic solutions to design problems. They may use metaphors as a tool or method in the design process, which help to identify, frame and solve design problems (Casakin, 2011; Hey, Linsey, Agogino & Wood, 2008; Kirsi, Ella & Turkka, 2009; Schön, 1979), break away from the limitations imposed by problem constraints (Casakin, 2007), justifying design decisions (Madsen, 1994), develop products that resonate with users (Kolb, Hey, Sebastian & Agogino, 2008), map users' reactions to a product (Hey et al., 2008), create an intuitive language within a design team to perceive design objectives from alternative angles (Kirsi et al., 2009), and reason about the nature of a design process (e.g., design as search or design as exploration; Hey et al., 2008); or they can use metaphors in the end product as a means to render the values and meanings they want to assign to a product into a physical form. In this use, metaphors help to translate abstract concepts into concrete product properties (Hekkert, 2006; Özcan & Sonneveld, 2009; Van Rompay, 2008), which eventually communicate functional, social, psychological, and cultural meanings to users. In this thesis, the term product metaphor is used to address:

> *"Any kind of product that is shaped to reference the physical properties (e.g., form, sound, movement, smell, and so on) of another distinct entity for particular expressive purposes."*

Investigating product metaphors is in and of itself a challenging problem because metaphors are mainly discussed in the context of language. So far, only a few scholars proposed structured means to incorporate metaphor in design research (Cupchik, 2003; Forceville, Hekkert & Tan, 2006; Hekkert, 2006; Hey et al., 2008; Kolb et al., 2008; Krippendorff & Butter, 2008; Van Rompay, 2008), yet none of these studies provides a thorough analysis including a product metaphor's characteristics and the peculiar type of thought process that generates it. Metaphor generation is a topic that is mostly overlooked even in the linguistics domain, where most research on metaphor is directed towards metaphor comprehension and appreciation (Flor & Hadar, 2005; Katz, 1989; Lubart & Getz, 1997; Silvia & Beaty, 2012). This inattention is especially problematic for the design domain since metaphors are means that designers frequently and intentionally call upon to express particular meanings to users through the products, yet its use is rather intuitive and haphazard.

Prompted by these gaps in the domains of language and design, we attempt to build a framework in this thesis, which accounts for the processes underlying product metaphor generation and investigate the success of the decisions taken in this process. The key research questions that we are after are:

What is a product metaphor?

How is a product metaphor generated?

How is a metaphoric association built? Which properties are necessary for an entity to be selected as a proper source in a product metaphor?

How is a mapping from a source to the target product conducted? Which properties of the target and source are taken into account when applying the product metaphor?

Which decisions does a designer take during the generation process lead to good (i.e., comprehensible, aesthetically pleasing, effective) product metaphors?

Once we understand this process, we have the means to contribute to the disciplines of metaphor research and design research, as well as to design practice. This thesis is directed at (1) researchers who aim to broaden their view on the functions and meanings of metaphor through the analysis of metaphors found in the design domain, and (2) design practitioners who are interested in integrating metaphors in their designs as a means for creating meaningful product experiences.

Reading guide

To find answers to our research questions, we conducted a workshop and three empirical studies with designers as participants, next to an additional empirical study in which users were asked to evaluate product metaphors. All the studies were submitted to relevant journals, which are included in the thesis without making any changes in their content. This may cause some repetition in the introduction parts of each chapter in the definition of the basic terms, but also provides the chapters to be read independently of others depending on the reader's interest.

The thesis is composed of seven chapters: The first two chapters are used for explaining the fundamental concepts that will be referred to in the following chapters. On the basis of these fundamentals we build a model throughout the thesis, which is presented in the final chapter.

Chapter 1 provides an overview of the defining characteristics of a product metaphor, which includes a definition of the basic terms that will be resorted to throughout the thesis, such as a product metaphor's basic components, criteria for an associ-

ation to be considered as a product metaphor, reasons for using a product metaphor, types of metaphorical associations, and means and strategies to transfer properties of a source to a target.

Chapter 2 includes an overview of a metaphoric communication process between a designer and a user and presents a basic model of product metaphor generation. This model is elaborated and validated through a workshop conducted with design students at the second part of the chapter, which is used for setting up the further studies conducted in this thesis.

Chapter 3 and Chapter 4 focus on how a designer finds a metaphorical association to begin with; and each describes a study conducted for understanding certain decisions designers take in this regard:

Chapter 3 aims to reveal the criteria for an entity to be employed as a source in a product metaphor. In Study 1, presented at this chapter, we investigate how the extent to which a source represents the meaning a designer intends to convey and is related to a target affect the selection of that source.

Chapter 4 addresses the "depth" of a metaphorical association, which refers to the extent to which the highlighted quality of a target through association is salient for the target. In Study 2, we investigate how the level of expertise of a designer and particular intentions s/he has to generate a metaphor affect the metaphor depth.

Chapter 5 focuses on how a designer applies a metaphorical association (i.e., mapping). We defined four different mapping strategies and investigated how these strategies affect the identifiability of a source, the aesthetics of a product metaphor, and the ease of mapping with Study 3.

Chapter 6 addresses the success of the decisions taken in the generation process, and describes a study (Study 4) conducted for addressing the factors for creating aesthetically pleasing product metaphors (e.g., novelty and comprehensibility of a metaphoric association, subtlety and identifiability of a metaphor application).

Chapter 7 provides a summary of the main findings of the studies and presents provisional answers to the main research questions of this thesis by bringing together these findings. Implications of the findings are discussed from a theoretical and practical point of view, and recommendations for generating successful metaphors are given to designers on the basis of the findings. The chapter is concluded with suggestions for further research.

/01
ANATOMY OF A PRODUCT METAPHOR

This chapter is an overview of the basic concepts and terms that will be employed throughout the thesis. The structure of product metaphors, the characteristics of a metaphorical association and mapping in products, and the differences of product metaphors from their linguistic counterparts will be explained with various examples. A visual summary of the defining characteristics will be presented at the end of the chapter.

FIGURE 01.1. "Firephant" fire extinguisher is a product metaphor that employs an elephant as a source.

What is a product metaphor?

Forceville (1996, 2002) listed three questions that one should be capable of answering in order to label anything as a "metaphor". These are:

(1) Which are the two terms of the metaphor (i.e., target and source), and how do we know? (2) Which is the metaphor's target domain and which the metaphor's source domain, and how do we know? (3) Which features can/should be mapped from the source domain to the target domain, and how is their selection decided upon?

Obviously, these questions should be answered regarding product metaphors as well. As in a verbal metaphor, a product metaphor also consists of an "association" between a target and a source. The target is the "product" that is employed in a metaphor (the terms target and product will be used interchangeably throughout the thesis), and the source is the remote entity that is associated with the target to assign a particular meaning to it. Designers shape the target in such a way that it evokes the experience of the source without violating the identity of the target (Forceville, 2008). This process is called "mapping", in which a designer physically *applies* the metaphor (the terms mapping and application will be used interchangeably throughout the thesis) by projecting relevant physical properties of the source onto compatible properties of target. In every metaphor, there is at least one, but often more than one, property from the source that is transferred to the target.

Figure 01.1 illustrates an example product metaphor, in which we are invited to see and experience this fire extinguisher (target) as an elephant (source), as hinted by the name of the product: Firephant. These entities were brought together because elephants are known to spray water out of their trunks in a skillful manner, and the designer of this

product playfully intended to transfer this precise and controlled spray to the fire extinguisher he created. This association was applied by shaping the product in such a way that its outline became a stylized and vague reminder of an elephant and its trunk. In other words, the form of an elephant and the form of a fire extinguisher were merged into one coherent product by projecting the former onto the latter; the end product becomes a visual fusion of two separate entities, owing to the mapping in between.

In the literature studying linguistic metaphors, the term mapping is also used for referring to the transfer of source properties to target, but at a "conceptual level" (Gentner, 1988; Gentner & Wolff, 1997; Holyoak & Koh, 1987; Lakoff & Johnson, 1980; Vosniadou, 1989). As a linguistic metaphor consists of an association of two words (e.g., "Every child is a snowflake"), clearly we cannot talk about a physical transfer from source to target. Mapping here refers to the act of establishing a conceptual correspondence between these words, i.e., every child is unique, delicate and precious as a snowflake. Products are, however, tangible entities. In order to construe a product metaphor, designers are required to make the appearance of a source visible in the appearance of its target. For this reason, product metaphors involve two distinct kinds of mappings from source to target: a conceptual mapping as in linguistic metaphors to build the metaphorical link between target and source, and a physical mapping to manifest this link in tangible form (see Figure 01.2). The reasoning behind the designer of the Firephant to select an elephant for associating with a fire extinguisher involves a conceptual mapping between these entities (e.g., controlled water spray), and the way they shape the fire extinguisher in the form of an elephant involves a physical mapping. Throughout the thesis, the term "metaphorical association" will be used for addressing the conceptual mapping, and the term "mapping" will be reserved to address the physical application of the source on the target only.

It should be noted, however, being composed of a target, a source, and a mapping in between is not enough for something to be construed as a metaphor. The use of metaphor must involve some form of meaning attribution, which changes the experience of a product as a whole (Alty & Knott, 1999; Van Rompay, 2008). To put it differently, the association of two entities should say something meaningful and new about the product; otherwise the construction is simply juxtaposition, and not a metaphor. Krippendorff and Butter (2008) regarded the products such as these as "pretentious semiotizations" (p. 373). A telephone that is shaped like Mickey Mouse and a radio shaped like a car pretend to be something that they are not; their appearances have nothing to do with their use and meaning. Most of the products we entitle as "kitsch" are in this category. They involve a physical mapping from a source to a target, but not a meaningful conceptual mapping between these entities. In a product metaphor, however, both of these mappings are realized properly (e.g., Firephant); the meaning transfer that is achieved through the association of a particular target and source is a defining characteristic.

A designer can choose to transfer a meaning from a source to a target (i.e., build a metaphorical association) for various reasons. In the following section, we will first address these reasons and describe the types of intention that designers may have

when using a metaphorical association in their product. Then, we will present the types of target–source association that are categorized according to the "depth" of the knowledge that it can be based on.

	"Every child is a snowflake"	
Conceptual level	Association (between children and a snowflake)	Association (between a fire extinguisher and an elephant)
		+
Physical level	-	Mapping (of the trunk of an elephant to a fire extinguisher)

FIGURE 01.2. Types of mapping.

Association between target and source

Reasons for a target-source association

When generating a metaphor, designers have such intentions concerning what kind of an experience to provide the users through the product and associate a source with the product according to these intentions. Principally, they may have "pragmatic intentions" to fulfill instrumental and functional goals or "experiential intentions" to provide aesthetic, semantic, sensorial or emotional experiences to users. Hekkert (2008) defined five reasons that a designer may resort to a metaphor, and these reasons will be presented below categorized according to these two main types of intention. The effect of these intentions on the association of a target and a source will be comprehensively investigated in Chapter 4.

Pragmatic intentions

This type of intentions aims to reduce the cognitive workload of the users in their reasoning about the function, use, and meaning of a product. The main goal is to turn a complex product into a clear and comprehensible one through (1) providing identification of the product and (2) conveying information how the product is used.

Identification

Identification refers to communicating the product type and product category to users. Metaphors generated with identification intentions assist the users in recognizing the product and understanding the category to which it belongs. By this way, users can infer what the product is for. This intention is

especially important to attain when launching a new product type. For instance, when the first e-books were launched on the market, they looked like an actual book with the same size and a cover. As a matter of fact, an e-book is just a screen which can take any shape, yet an explicit reference to a book communicated that this product is "for reading". Another example is the cigarette receptacle seen in Figure 01.3, whose message is very direct: this product is only for cigarette disposal.

Use/Operation

Use and Operation refers to directing users how to approach the product and interact with it. Metaphors generated with this intention clarify the way the product is used or operated, and entail design attributes that make the product function smoothly and easily. An example might be the gestural controls of iPhone or iPad, such as making the gesture of turning a page to go to the next screen or dragging items to move them. The selection and application of these familiar gestures allow users to comprehend new or complex use situations because they rely on existing knowledge from everyday life.

Another example is the Hourglass Coffee Maker seen in Figure 01.4, which offers cold brew coffee that requires users to "flip" the machine after putting in coffee and wait for a while to have it ready. The reference to an hourglass gives an implicit clue how to operate this product, as flipping is an action that we are accustomed to do with an hourglass.

Experiential intentions

Rather than being merely utilitarian tools, products are means for pleasurable and meaningful experiences. Designers have the duty of "not only designing products that work well, but also of designing products that provide people with pleasurable experiences or the needed support in their quest for a meaningful life" (Van Rompay, 2005, p. 16). Metaphors can also be used with this intention—promoting rich sensorial and emotional product experiences. This can be attained by telling a story through the product, giving an ethical/moral message, or creating a fun/witty product.

Prose/Poetry

Prose and poetry refers to assigning an abstract symbolic meaning to the product, such as a personality, to tell a story through the product. An example can be seen Figure 01.5, which is an association between a rug and the Moon, designed with the motto of "walk on the moon without it being a giant leap" as stated in the company website.

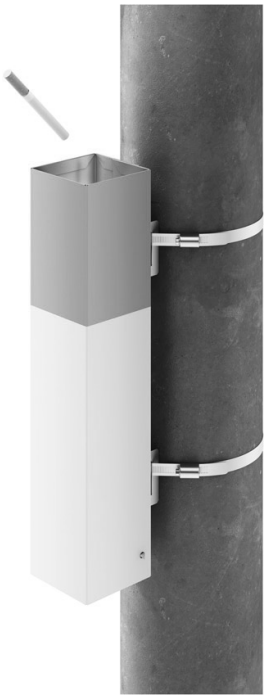


FIGURE 01.3. Pepelkus outdoor cigarette receptacle, by Art Lebedev studio.

FIGURE 01.4. Hourglass Coffee Maker

Another example, seen in Figure 01.6, is the security cameras installed at various train stations in the Netherlands. Here, the intention of the designers was assigning a friendly, unthreatening character to the cameras to lessen the feeling of being watched by a "Big Brother".

Ideology

Ideology refers to promoting (or criticizing) an ideology and giving an ethical, social or moral message through the product by using metaphors. An example is the Surveillance chandelier seen in Figure 01.7, which intends to achieve the exact opposite of what the NS camera does. It is a set of spotlights and not CCTV cameras, yet its designers want to remind us that the Big Brother is watching us everywhere by controversially bringing it to our living rooms. The metaphor was intended as a "food for thought" to reflect on the current reality of our world.

Another example is the environmentally conscious bike rack idea seen in Figure 01.8. By shaping the bike rack in the outline of a car and placing it alongside the road where cars usually park, the designer aims to return the attention bikes deserve and promote a healthy and eco-friendly life style.

Fun/Wit

Wit refers to creating a product that makes users smile. This is attained by building a surprising, unexpected and incongruent relationship between target and source. In these products, a certain degree of cleverness is involved, as in Pianobell doorbell seen in Figure 01.9. With this product, the guests can announce their arrival with a touch of creativity instead of boring 'ding dongs'. The marriage of a doorbell and piano keys is so unexpected yet meaningful, which makes the product this amusing.

Types of target-source association

In addition to differ in terms of the intentions they are created with, product metaphors can also be classified according to the "depth" of the knowledge that a target–source association is based on. Hurtienne and Blessing (2007) classify the origins of knowledge into four levels: The first and lowest level is the unconscious and universal *innate* knowledge that we acquire during the prenatal stage of development. The next level is *sensorimotor* which is acquired very early in childhood through interaction with the world. This is followed by the knowledge *specific to the culture* an individual lives in. The highest level of knowledge is *expertise*, that is specialist knowledge acquired in one's profession.

FIGURE 01.5. Luna rug, by nanimarquina.

FIGURE 01.6. NS Camera, by We Are Perspective.

FIGURE 01.7. Surveillance chandelier, by Humans Since 1982.

The association of a source with a particular target can be built in these four knowledge levels: When it is based on our innate or sensorimotor knowledge, the emerging metaphor is an "embodied metaphor"; when it is based on culture-specific or expertise knowledge, the metaphor is a "learned metaphor" ("cultural metaphor" in Forceville et al., 2006). The NS camera seen in Figure 1.6 is an embodied metaphor because the product appeals to our evolutionary and universal positive reactions towards infant-like physical traits. Friendliness and cuteness are usually characterized by disproportionately large head, large eyes, round and softer body features (Lorenz, 1950). As the designer of this camera shaped the product according to these traits, he triggers the intended embodied reaction in us.

In a similar vein, Van Rompay, Hekkert and Muller (2004) showed that our embodied interactions with the environment could predict the understanding of abstract object characteristics, such as trustworthiness, dominance, restlessness, and so forth. For instance, he found that the jugs that provide higher degrees of closure of their contents were perceived as secure and constricting. Similarly, an increase in height resulted in higher ratings on characteristics such as dominant and impressive. These jugs were perceived as this because we all have innate image schemas to associate height with dominance, and containment with safety.

Learned metaphors, however, stem from the target–source associations that are based on cultural and expertise knowledge that we acquire through time from the culture we live in and through our experience, education and occupation (The effect of expertise knowledge on the metaphors generated by designers will be comprehensively addressed in Chapter 4). The other examples we provided so far can be all considered as this kind of a metaphor. In order to generate (and also make sense of) them one should 'know' what a cigarette looks like (Figure 1.3), how an hourglass works (Figure 1.4), what walking on the moon represents (Figure 1.5) and so on. Only knowing these cultural meanings can make these metaphors special and strong; otherwise they would not achieve their communication purposes.

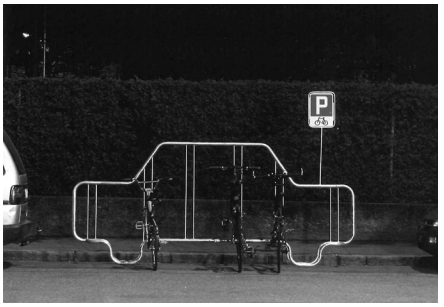


FIGURE 01.8. VD 003 bike rack, by Adrien Rovero.

FIGURE 01.9. Pianobell door bell, by Li Jianye.

Mapping from source to target

After finding an embodied or learned association between a target and a source according to his/her intentions, a designer transforms this association into a physical form. In this stage, s/he projects the "salient" properties of a source onto a target. Salient properties are defining, prominent and characteristic properties of an entity. These are the properties that should be transferred to the target; or else the reference to a particular source would not be identifiable (Glucksberg & Keysar, 1979; Jones & Estes, 2006; Ortony, Vondruska, Foss & Jones, 1985). If one aims to make a metaphorical reference to a cloud when designing a chair for instance, just coloring the chair white would not be good enough to highlight this reference. For communicating the source unambiguously, a designer (also) needs to transfer some other typical properties of a cloud such as its fluffiness.

These salient properties differ for each source, but we can classify them under eight categories. It is possible to project a source's form, interaction, material/texture, movement, sound, taste/smell, name, or graphics onto a product.

Form

Form of a source (i.e., shape, outline, color) is the most common property that is projected from source onto a target. All the examples provided so far involve a projection of form properties. Either specific details of the form (e.g., only the outline of an elephant's trunk in Figure 01.1) or its overall impression (e.g., the body, the lens, and even the cables of a CCTV camera in Figure 01.7) can be transferred.

Interaction

Interaction is the property that designers transfer to a product when they make the product be used or operated the same way as the source. In the Hourglass Coffee Maker and Pianobell examples given, the way that people interact with these sources was projected onto the respective products, i.e., we "flip" the coffee maker and "play" the bell.

Sound

Sound of a source can also be projected onto a product. In the kettle seen in Figure 01.10, there is a bird-shaped whistle at the end of the spout, which also makes a soft melodic chirp when the water boils.

Movement

Movement is the property that is transferred when the overall product or its parts move or behave like the source. An example can be seen in Figure 01.11, which is a lamp that mimics our movement of waking up and sleeping down. It wakes up to light the room when there is someone in the room and lies down when there is no one.

Material

Material or *texture* is another property that can be transferred from a source. In Figure 01.12, we see a rosary made out of bubble wrap, which surprisingly yet conveniently matches the action of moving the finger towards the cross to count the prayers and popping air balls. When the user gets to the cross, the task is finished and all the bubbles are broken.

Taste/Smell

Taste and *smell* mapping is also possible, though not that common in products. An example is the biscuit box seen in Figure 01.13, which is shaped like a biscuit and also smells like one.

Name

Name of a source can also be transferred to a product; however, it is mostly used in combination with other properties, especially with transfer of the form. In Figure 01.14, a corkscrew that references a man can be seen. This association, however, is not that meaningful without the name of this man "Socrates". Here, the designer intends an allusion to the Socratic method, namely the philosopher's art of 'extracting' the right answers from anyone. This name transfer brings a new meaning level to the product; without the title it is just a man-like corkscrew, when given the name Socrates, it starts to tell a story.

Graphics

Graphics printed on the product can be metaphorical as well. By printing Ctrl+O—the universal shortcut for "open" in computer language—on the bottle opener seen in Figure 01.15, the designer builds a humorous association between opening a document and opening a beer bottle.

As can be seen in these examples, transferring more than one of these properties is also possible. This leads to multimodal metaphors, as in Kettle (sound and form), Rosaria (material, interaction, and sound), or Mary biscuit box (form and smell).

Another insight that transpires from these examples is that there are different ways that a property can be projected onto a product. Anticipating a more detailed discussion on this topic in Chapter 5, we name these as *mapping strategies*. Here, we use the term "strategy" on the basis of a meta-analysis of the completed product designs. It is intended as a systematic way of categorizing and comparing different possible ways of transferring the same source properties to a target from a researcher-point-of-view, rather than to denote the plans and methods that designers systematically and deliberately pursue.

The first group of mapping strategies involves the degree of transformation and adaptation of source properties to the target's physical and contextual properties. This adaptation can be kept at a minimum by transferring the source properties "directly" to a target. This we call a *literal mapping* from source to target. This approach can be

seen in Surveillance chandelier or Pianobell, as the form properties of a CCTV camera and piano keys are transferred to their corresponding products in their entirety without any major changes. The source can also be adapted to the target by extracting its geometric or structural essence and projecting this essence onto target. This is an *abstract mapping* of source properties, as in Firephant fire extinguisher or Socrates corkscrew, which the sources of these metaphors are simplified into an outline.

Another difference in strategies is based on the extent of keeping or compromising the identity of the product while creating a mapping. The kind of mapping that focuses on the product and maintains its identity is a *target-driven mapping*; whereas the other mapping in which the product identity is compromised to emphasize the source is a *source-driven mapping*. In the former, the outcome resembles the typical form of the alleged target than it resembles the source, and vice versa in the latter. We will elaborately explain these different strategies and explore their effect on the metaphor generation process in Chapter 5.

Idiosyncratic characteristics

An overview of the characteristics of a product metaphor reveals some of its idiosyncratic qualities that distinguish it from its verbal counterparts. The basic definition of a metaphor applies to both—a transfer of properties from source to target—so does its power to generate novel and deeper levels of meaning. Still, there are also some differences to pay attention to. Feinstein (1982) aptly summarizes the main problem: "Since we are schooled in words more than in images, linguistic metaphor is within an already familiar symbol system; visual metaphor is not. In addition, we often erroneously take for granted that linguistic and visual metaphors stem from the same symbol system with the same rules for constructing and conveying meaning" (p. 50). Yet this is not the case; we need to address these differences in order to provide a more coherent picture for product metaphors.

The first difference is that in product metaphors *target and source are always literally merged* (Forceville et al., 2006; Van Rompay, 2008). In verbal metaphors, which are in A is B format, the target and source are signaled separately; whereas they are visually incorporated into one coherent entity in product metaphors. In other words, target and source simultaneously occupy the same space. Forceville (2008) call this type of metaphors "integrated metaphors", and Carroll (1996) name this phenom-



enon as "homospatiality". Thanks to homospatiality, target and source become parts of a unified entity, which hinders us to distinguish between them in the experience of product metaphors; what we experience is an integrated and novel phenomenon (Van Rompay, 2008). This situation, however, may pose a problem for the recipient in the identification of a product metaphor's target and source, which is not a relevant concern for linguistic metaphors in an A is B format.

Merging target and source also creates an additional task for designers, which brings us to the second difference: In product metaphors *designers are responsible for the mapping*. In other words, designers not only "see something as something else", but they also "make" something look like something else. As aforementioned, the physical application of the metaphorical association is obviously out of question for linguistic metaphors. Since designers create a tangible object in the end, they have to make a physical mapping from source to target, whereas in verbal metaphors the metaphor producer simply utters the metaphor and leaves the mapping to the recipient. The source of a verbal metaphor is generally explicit in the sentence format, e.g., "all the world is a stage", such that recipients do not need to put effort into detecting the source, but they are required to guess which attributes to map from an undisclosed source so as to grasp the meaning that emerges from the metaphor (Camac & Glucksberg, 1984; Forceville, 2008). In product metaphors, however, designers make the mapped qualities tangible and visible to users in the formal properties of the target. Through these properties, users try to recognize the source. Thus, source identification may require more effort in product metaphors.

The third difference is that product metaphors can be *multimodal*, whereas verbal metaphors are generally monomodal. Verbal metaphors are signaled in spoken or written language, yet a designer has control over different parts of a product to convey a metaphorical message. As mentioned in the previous section, they can design in eight instantiations of "mode" (note that these modes do not necessarily match up with the five senses one-to-one, such as the mapping of material can both be seen and felt, or the mapping of a name can be seen or heard).

FIGURE 01.10. Kettle, by Michael Graves.

FIGURE 01.11. Awakening lamp, by Front Design.

FIGURE 01.12. Rosaria rosary, by Joe Velluto.

FIGURE 01.13. Mary biscuit box, by Stefano Giovannoni.

FIGURE 01.14. Socrates corkscrew, by Jasper Morrison.

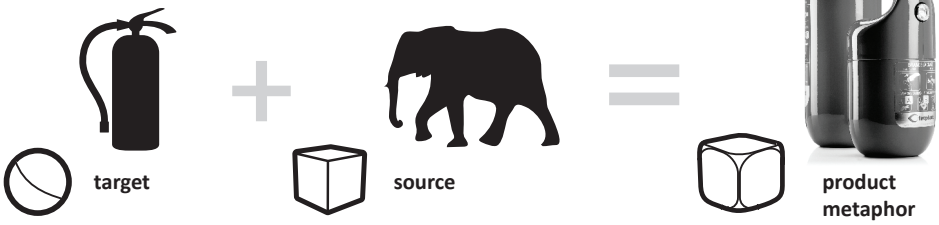
FIGURE 01.15. Ctrl+O bottle opener, by Art Lebedev Studio.

The last difference is that the s*ources used in product metaphors are always tangible*. In the classic traditions of verbal metaphor it is suggested that the better metaphor is the one which a relatively abstract target is associated with a concrete source (Katz, 1989; Katz, Paivio, & Marschark, 1985; Ortony et al., 1985), yet not all metaphors are in this structure (e.g., Rhythm is love; Seeing is believing). In product metaphors, however, the source is always concrete since products are physical entities by their very nature, and therefore, every idea we apply to them should be transformed into a tangible and perceivable form. The meaning designers want to convey through metaphor use can be abstract, but then they have to depict this meaning physically in the appearance of the product by finding a tangible carrier of it.

Summary of product metaphor characteristics

Components

Product metaphors associate ( ) two distinct entities, a product (target) and a remote entity (source), through physically mapping ( ) certain properties of the latter to the former. Two entities and a mapping is not enough to be a metaphor, there should be a "meaning transfer" provided by their association.



Product metaphors can be used with pragmatic or experiential *intentions*.

Pragmatic intentions involve providing identification of the product and conveying information how the product is used.

Experiential intentions include expressing a symbolic meaning, promoting or criticizing an ideology or social/moral issue, and making the users smile.

Association

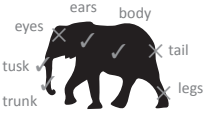
The association of a target and a source can be based on:

Innate, universal knowledge—which would lead to *embodied metaphors*,

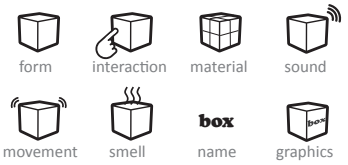
Cultural, expert knowledge—which would lead to *learned metaphors*.

Mapping

In the application of product metaphors, always "salient" properties of a source are mapped to the target.



The properties that can be mapped from a source to a target are:



There are different *mapping strategies* that can be followed when applying the metaphor. They differ on the extent of adapting the source to target (literal vs. abstract mapping) and keeping the identity of the product (target-driven vs. source-driven mapping).

Differences

Product metaphors differ from verbal metaphors in terms of (1) target and source merging, (2) mapping being designers' task, (3) multimodality, and (4) source concreteness.

/02

GENERATION OF A PRODUCT METAPHOR

The metaphor characteristics that were mentioned in the previous chapter—types of intention to generate the metaphor, target and source association, mapped properties, mapping strategies—are all manipulated by the designer, and the outcome of this manipulation is experienced by the user. Both parties are aware of the existence of the other, and therefore the product metaphor becomes a communication medium. We will start this chapter by presenting a basic model of this communication, and proceed by elaborating on the designer side of the model.

Designers go through a process that demands creativity and inventiveness when creating a metaphor. In order to uncover this process, we will first briefly discuss the current models found in linguistics to explain verbal metaphor generation process and then present our own framework that was adapted from one of these models. This framework will be validated through an explorative workshop conducted with students. On the basis of the findings, we will expand the basic model of communication and present a final detailed model at the end of the chapter, which will be used for framing all coming chapters.

This chapter is partly based on the papers:

Cila, N., Hekkert, P. & Visch, V. (2010). “As light as a leaf”: Product metaphor generation for experience-driven design. In K. Sato, P.M.A. Desmet, P. Hekkert, G. Ludden, & A. Matthew (Eds.), Proceedings of the 7th International Design & Emotion Conference 2010, Chicago USA.

Cardoso, C. & Cila, N. (2013). Analogies and metaphors. Delft Design Guide.

Metaphoric communication

In the design literature, there is a long-established tradition to address design as a process of communication between the designer and the user, and products as signs for interpretation (see for a review, Crilly, Good, Matravers & Clarkson, 2008). Designers intend to express a functional and/or non-functional meaning through the product by choosing and combining certain product features accordingly. Users construct their own interpretations over the product by combining the product features with their personal standards, expectations, and previous experiences. Generally they do not have an access to the designers of the products they use, which compels them to form these interpretations on their interaction with the alleged products (Crilly, Maier & Clarkson, 2008). The interpretations then lead to judgments about the appeal of the product (i.e., aesthetic appreciation), emotional consequences (e.g., interest, frustration) and certain behaviors (e.g., approach or avoidance, purchase, increased use frequency). Designers are also aware that users attach meanings to products and intend to create products that will be interpreted in certain ways. Therefore, there is an exchange between the expressive intent of the designers and interpretative response of the users through products.

Communication through product metaphors can also be represented in this manner. Designers and users are creative partners in the process of making the meaning of a metaphor (Cupchik, 2003). Donaldson (1978) states that, "Metaphor is the dreamwork of language and, like all dreamwork, its interpretation reflects as much on the interpreter as on the originator" (p. 31). Metaphors are never merely inherent in products but created together by designers and users, as they mediate between the aforementioned expressive intentions of the designers and the *experience* of the users. We will adapt the explanatory framework Crilly and his colleagues constructed by synthesizing the most pertinent features found in various communication-based models of design to the basic metaphoric communication process (Crilly, Good, Matravers & Clarkson, 2008; see Figure 02.1). The issues such as the possible difference of the realized product from the intended one and the iterative cycle of users to act, perceive and react on the product are also depicted in their original model, yet they are excluded here in order to give a basic understanding on this process at this stage.

In the figure, the designer and the user are represented as both being oriented towards the metaphor. This means that we can define a product metaphor from the designer or the user perspective. The product metaphor qualities that were presented in the previous chapter can all be manipulated by a designer, and these qualities eventually become a property of the product which can be experienced by a user. As depicted in the figure, designers shape the product metaphor to evoke the experience that s/he intends with an "anticipation of the user"—how that user should respond to the product. Their expertise, experience, beliefs, motivations, capabilities and culture have also a significant effect on this process.

Similarly, users also have such background characteristics to interpret the

metaphor that the designer generated. People differ widely on any number of cognitive capabilities, and these differences often have theoretical and practical implications on metaphor comprehension (Blasko, 1999; Pierce & Chiappe, 2009). First, they identify the source through the references the designer has taken from the source during the mapping, then they reason why that particular source and target have been brought together. Understanding metaphors is certainly not just differentiating target and source, but inferring the ground that relates them (Gibbs, Kushner & Mills, 1991). Following Grice's (1975) principle of communication, users try to infer the meaning that the designer aims to get across as they assume that the product has been associated with another entity for some particular purpose. In other words, the user also has a "conception of the designer" meaning that s/he is aware that the designer may have intended to convey certain messages through the product.

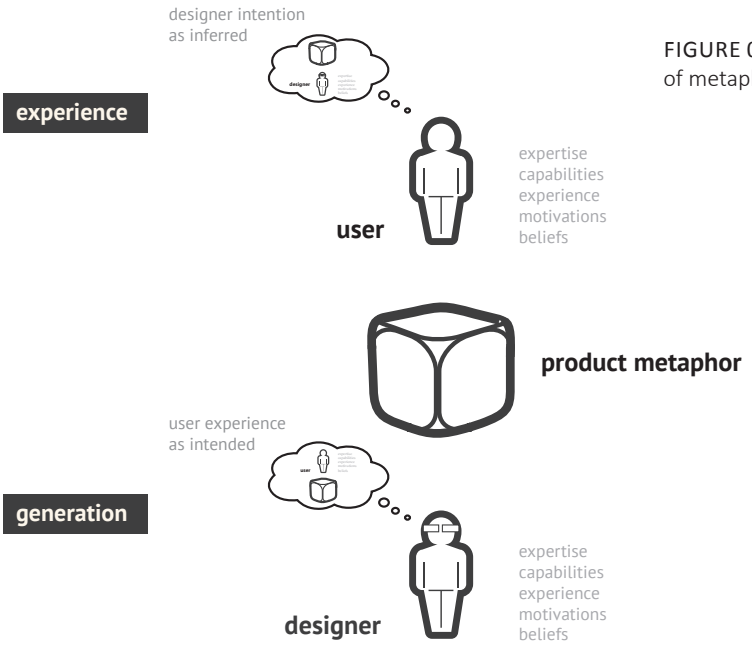


FIGURE 02.1. The basic model of metaphoric communication

To infer a meaning from a metaphor, users "read" the target–source combinations. They first look for the relevant properties of a source that are attributable to the target (Chiappe & Chiappe, 2007; Glucksberg & McGlone, 1999). If these properties are readily accessible and substantially pertinent, the metaphor is judged to be comprehensible and apt (Chiappe, Kennedy & Chiappe, 2003). Therefore, the processing of product metaphors through the temporal stages involving *perception* of the metaphor, *recognition* of the source and the target, *comprehension* of the metaphoric association, and *appreciation* of the metaphor (Cupchik, 2003). The first

three stages involve making sense of the metaphor, whereas the last stage involves its aesthetic judgment. For a coherent metaphor experience, a user needs to go through all these stages.

In general, comprehension is considered to involve initial reactions to metaphors and appreciation often follows it later. Still, there can be situations where these two phases operate at the same temporal extreme, as in easy to grasp jokes, or not all metaphoric comprehension occurs immediately; some metaphors take time to grasp (Chiappe et al., 2003). The metaphor experience of the users may also evolve through time as people interact with the product. Markussen, Özcan and Cila (2012) gave the example of how the experience of Anna G corkscrew, which alludes to a woman body, changes from the initial product categorization (a saint-like figure) to the final interpretation (a stripper) through interaction. Furthermore, the experience of a metaphor may also disappear during the course of time. There is a so-called life cycle of a metaphor (Bowdle & Gentner, 2005; Fraser, 1979; Searle, 1979), in which the metaphorical power of a product wears out through frequent encounters; the metaphor becomes an integral part of the user's knowledge structure and gradually gets disconnected from its source.

The main focus of this thesis is on the designer side of the communication, yet this communication is incomplete without the designer envisioning how users would experience the product metaphor. Metaphor producers, i.e., writers, speakers, as well as designers, deliberately address a metaphor to the receiver to be interpreted in a particular way, namely they have "an intention that is intended to be recognized" (Gibbs et al., 1991, p. 15). For this reason, the envisioned experience of the users with the metaphor is of great importance for the decisions designers take regarding the comprehensibility and aesthetic pleasantness of a metaphor.

Several authors have pointed out that metaphor comprehension requires identification of the communicative and aesthetic goals the metaphor producer had in making the association (Cupchik, 2003; Gibbs et al., 1991; Sperber & Wilson, 1995). Ideally, designers aim to realize their particular intentions through the use of a metaphor, and users discern the metaphor as it was intended. There may be, however, some miscommunication situations that hinder the effectiveness of this meaning exchange.

First, users may "miss" the metaphor that the designer intended. Metaphoric communication is a cooperative act: People construe a metaphor if and because they think that its producer intends them to do so (Forceville, 2004). Failing to give perceivable cues to users to identify the metaphor obstructs the communication. Second, users may "misinterpret" the actual intention of a designer. Interpretation cannot be reliably controlled because different people will construct different meanings depending on factors such as context, motivation and values (Crilly, Maier & Clarkson, 2008). Whenever a designer presents a metaphor, s/he takes the risk that the inferences drawn may not be the ones that were intended. In other words, like any kind of metaphor, product metaphors are also faced with the problem of plurality of readings. Third, users may construe an "unintended" metaphor. In certain situations, users are capable of eliciting metaphors from products that were not en-

visaged by their designers to be experienced as metaphors. An example is the Senseo coffee maker of Philips, which aptly alludes to a servant because of its curved "bowing" outline and the tray to serve the coffee (Forceville et al., 2006). The designers of this product, however, stated that it was not in their intention to employ this metaphor; the form of the product was a result of a technical necessity to pump the heated water up the coffee maker (C. De Bont, personal communication, December 5, 2009). Still, the servant metaphor perfectly fits the context, use and meaning of a coffee maker—it is a product to serve us coffee—and ascribes the product a deeper meaning that changes its experience as a whole.

Within the scope of this thesis, we consider that there is no reason to discard such metaphors. Even if a user (1) does not recognize the metaphor, (2) his/her interpretation does not correspond with the designer's intentions, or (3) discerns a metaphor from the product which was not intended, these situations tell something about the nature of metaphoric communication. The appropriate approach here is not rejecting the metaphor but rather investigating how communication varies among individuals and how to take safe yet interesting decisions from designers' point of view. Especially as we are interested in the generation of metaphors, these miscommunication scenarios are worthy of studying to indicate the "bad" decisions that designers need to avoid. Starting from the coming section, we will shift our attention to metaphor generation entirely and try to explicate this process and its phases.

Metaphor generation

Verbal metaphor generation

Verbal metaphor generation is usually described to involve two consecutive phases: finding a source that can be used for generating a metaphor relevant for a target, and making a mapping from this source to target (though this mapping is intended to address a "conceptual" kind of mapping as explained in the previous chapter). These two fundamental phases are explicitly mentioned in every model constructed to explain verbal metaphor generation process. We will mention two of these models, which are mainly adaptations of the two most widely accepted models constructed for explaining metaphor comprehension.

One of them is based on the "comparison view". In this view, a metaphor is considered as a comparison between target and source, and matching the attributes of these parties is seen as the basis of metaphor understanding (Guenther, 1975; Malgady & Johnson, 1976; Ortony, 1979; Tourangeau & Sternberg, 1982). To understand a metaphor, a recipient would first derive the properties of the target and the source, compare them with each other, identify the shared ones and eliminate the unshared properties.

When adapted to cover the metaphor generation process on the other hand, this approach implies a two-stage process (Pierce & Chiappe, 2009). The first phase

involves listing the attributes of a target and identifying potential sources that have similar attributes, and the second phase involves choosing a source that has the greatest overlap with the target attributes if this match also meets some criterion for appropriateness (Forbus, Gentner, & Law, 1994; Pierce & Chiappe, 2009; Pitts, Smith & Pollio, 1982). Here, the target plays a crucial role in finding a source because people are claimed to select a source that matches with the target properties as much as possible.

Some scholars, however, considered this focus on the target as problematic. For instance, Pierce and Chiappe (2009) found that there may be some cases that the selected source is not a particularly good example of the 'meaning' that one intends to attribute to a target because the metaphor producer put more attention on overlapping the source properties with the target instead of considering how to convey the meaning in an effective way. Some of the target properties may be irrelevant in the context of that meaning, yet the comparison view implies that a metaphor producer tries to match them with a source as well, which causes the main reason to use a metaphor—express a meaning—to fall to the background. Another criticism that this view faced is that it does little to explain why metaphors so often seem fresh and surprising, if they only rely on existing similarities (Tourangeau & Sternberg, 1982). For all these reasons, some contemporary scholars felt the need to come up with a more adequate model of the metaphor comprehension/generation process, which explains the aspects that comparison view failed to do.

Through many detailed studies, Glucksberg and his colleagues concluded that metaphors are not processed as comparisons but as forms of categorization (Glucksberg & Haught, 2006; Glucksberg & Keysar, 1979, 1990; Glucksberg & McGlone, 1999; Glucksberg, McGlone & Manfredi, 1997). According to the "interactive property attribution model" they constructed for explaining metaphor comprehension, target and source are never placed in direct correspondence, but people construct a superordinate category that the source typifies and consider the target as a member of this category. In this way, the target automatically inherits the relevant features of that category, which is actually the meaning that one intends to attribute to the target.

This view was also broadened to cover metaphor generation (Pierce & Chiappe, 2009). It implies that when people generate a metaphor, they have a meaning in mind that they want to attribute to the target and look for a source domain that is a good exemplar of that particular meaning. Which term best exemplifies the meaning does not depend on the target that is employed, instead, the target plays a role in indicating which properties can be attributed to it—a range of questions people likely want answered about the target (Glucksberg et al., 1997). A source is selected on the basis of these properties. Therefore, the main focus is on assigning the intended meaning effectively to the target rather than finding a target–source couple with the mimum match.

This approach has also been supported by other scholars. For instance, Clevenger and Edwards (1988) provided experimental proof that in spontaneous, expressive communication, one begins employing metaphors with a meaning or attitude that s/he wishes to communicate. Then s/he scans her cognitive schema and selects a

word that embodies that attitude. Correspondingly, Jones and McCoy (1992) offered a methodology to generate metaphors, in which a person starts to look for an appropriate source according to the expression s/he intends to convey. They also gave a detailed explanation of what to pay attention to when selecting a source among candidates, which is an issue that will be addressed in relation to product metaphors in the following chapter.

Since meaning attribution is also the main reason why a metaphor is employed in the product design domain, we have a perspective that is in line with these scholars' approach on metaphor generation. We also consider that product metaphor generation is composed of consecutive phases of finding a meaning, finding a source, and an additional phase of making a physical mapping, yet there are some minor revisions to make in their approach so as to adapt it to the unique properties of product metaphors. Below, the process will be explained in detail.

Metaphor generation in design domain

Intention and meaning

Designers hold intentions for what kind of experience to provide users through the product and they construct representations that specify the forms that are expected to evoke those experiences (Crilly, Moultrie & Clarkson, 2008). We should note that these intentions can also be realized in a non-metaphorical way. Most of the time, designers do not start creating products by explicitly stating, "I'll use a metaphor". Metaphor use may very well result by 'accident', rather than a planned decision to employ it beforehand, still it is one of the ways that a designer can effectively and aesthetically realize his/her intentions.

We have listed five different intentions in the previous chapter, which guide a designer to frame which product qualities to emphasize and come up with a source to use in the metaphor that can bring out these qualities. In this way, the designer ascribes a "meaning" to the target. In other words, the metaphoric intention is the end effect a designer aims to evoke and the attribution of a particular meaning is how to achieve this effect. The intention of We Are Perspective in designing the NS camera seen in Figure 1.5 was telling a story through the product to change the public image of CCTV cameras. To do so, they focused on eliminating the intimidating character inherent in a security camera and converted it into a friendly product by assigning a degree of cuteness to it. Had they not focused on intimidation but on other CCTV camera properties such as providing safety, being hidden, or creating a visual mess in the environment, they would be assigning a different meaning for each of these conditions. Therefore, the meaning attributed to a product is related to its inherent properties that designer wants to bring into attention. These properties can be very obvious or more concealed, which would make an effect on the quality of the metaphor generated. This "depth of meaning" will be addressed in Chapter 4.

On the basis of the meaning s/he intends to assign, a designer then comes up with a source. Aristotle (1909/1941) contended, "Metaphors, like epithets, must be fitting, which means they must fairly correspond to the thing signified: failing this, their inappropriateness will be conspicuous" (p. 1405). This "fittingness" comes from the proper selection of a source.

Source selection requires identifying candidate sources by noticing their relevance to the target when they are concealed in a large memory system and were encountered in different context, and their possible relationship is not always evident. Designers refer to wide ranging sources to shape the target. These sources may be drawn from any domain, but commonly comprise other similar/dissimilar products, historic or cultural artifacts, non-products (e.g., nature-related entities, natural phenomena, living things), works of art, and actions (Crilly, Moultrie & Clarkson, 2008; Eckert & Stacey, 2000). The success of the selected source is related to its accuracy and consistency in triggering similar thoughts in different users, which guides the them to respond to design in a particular way (Kazmierczak, 2003). This is attained by having the source a good exemplar of the intended meaning, which provides the meaning to be assigned to the target unambiguously (Glucksberg et al., 1997; Ortony et al., 1985). Through association, the target automatically inherits the meaning that the source saliently embodies, and the product quality that the designer intends to highlight is eventually addressed.

But here, product metaphors have a difference from linguistic ones: According to the original model of Glucksberg, which term best exemplifies the meaning does not depend on the target (Glucksberg & Keysar, 1979, 1990). The target only indicates if the meaning that the metaphor producer intends to convey is relevant, as "being hardworking and industrious" is a more relevant meaning to attribute to an "ant" than to a "grasshopper". In product metaphors, however, the target plays an additional role: It indicates if the physical properties of the source can be projected onto its corresponding properties. As part of the responsibility of a designer is to create functioning, efficient, and pleasurable products, it is important for them to consider whether the association they intend to make with a distant entity will fit the inherent constraints present in the product and the design brief, such as working mechanism, target group, product category, and product character. They are therefore compelled to select sources that will not physically interfere with the use and character of the target product. The degree to which a source's property can be successfully employed as a product metaphor we have described as its "mappability", which is one of constraints that limit the freedom of a designer when selecting a source. We will also elaborate on the concept of mappability in the coming chapters.

Mapping

After identifying a source that will emphasize the target's intended qualities, the designer needs to consider how to communicate this to the user. In this mapping stage, the metaphor is physically applied by providing salient cues on the target to that effect: incorporating the source's specific details or overall impression into a newly

reshaped target. To do so, a designer retrieves the properties to map and decides on which mapping strategy to follow. The properties of a source can be projected in a wide range of ways from literal adoption through essence abstraction (see Chapter 5). These properties are then transformed to match the form language of the target, and lastly, are transferred to it physically. By means of mapping, the designer construes target and source in a new way to create similarity between them (Black, 1979; Camac & Glucksberg, 1984; Indurkhya, 1989).

Notes on metaphor generation

The process that has been addressed here was also explicated by the scholars from other creative disciplines. For example, Forceville (2008) described the stages that an advertiser goes through when creating a pictorial metaphor: It starts with defining the selling position, which is the attributes/connotations of the product or service to be emphasized. This is similar to what we named as meaning attribution in product metaphor generation. It is followed by finding a source from which the desired attributes can be generated and creating a similarity between the product and the source. Lastly, the advertiser chooses in what modalities the transferred features will be cued. Similarly, Do and Gross (1995) describe the inspiration seeking behavior of architects, in which they start by thinking of forms that are linked through some concept about the design at hand, such as trying to come up with relevant and appropriate sources to shape a performing art center or a museum's form on the basis of its functional qualities. This is again in line with searching for a source according to a meaning/concept in mind. However, Do and Gross also present us with a note Le Corbusier wrote next to his sketches of Ronchamp chapel, which points out to a different kind of process that designers may use when referencing a distinct entity: "the shell of a crab picked up on Long Island in 1946 is lying on my drawing board. It will become the roof of the chapel…" (Le Corbusier, 1957, p. 89; in Do & Gross, 1995).

This is a different kind of a process, in which it seems that a designer stumbled upon a metaphor by accident (in Le Corbusier's case while walking on the beach) and incorporated the source into his emerging design spontaneously. As Clevenger and Edwards (1988) states, "The creation of metaphor may be intentional, or it may be relatively spontaneous and 'accidental' " (p. 214). In this thesis, we focus on the former process—a process that involves a deliberate search for an apt source to convey a particular meaning—yet we are compelled to say a few words about the latter process as well. A designer can also come up with a source by seeing an immediate association between the product and a potential source. In this case, she comes upon a metaphor by coincidence or the idea suddenly comes to them "in a flash of insight" (Kolb et al., 2008, p.1). The roof of the Ronchamp chapel is an example of this type of a process because Le Corbusier probably had an instantaneous thought that the shell could be an elegant way of shaping the roof.

Similar processes also abound in product design books. One of the most famous anecdote is from the acclaimed designer Philip Starck, who explained how the design of his iconic lemon squeezer Juicy Salif came about: "Once in a restaurant, this

vision of a squid like lemon came upon me, so I started sketching it… and four years later it became quite famous" (Lloyd & Snelders, 2003, p. 240). Although Lloyd and Snelders account this association for Starck's childhood memories and his early interest in Sci-Fi cartoons, the access to this metaphor is still rather instant and unplanned. It should be noted that this metaphor still involves a conceptual mapping from a squid to a lemon squeezer, which differentiates it from the pretentious semiotizations mentioned in the previous chapter. The spontaneity of the association does not carry off the meaningfulness and aptness of it.

Such a non-sequential process is more difficult to investigate from a research-point-of-view as it is based on coincidence most of the time. Searching for a source based on a plan also involves inspiration and luck, however it is not as central as in the spontaneous type of a process since the design problem at hand constrains the possible solutions. Helms, Vattam and Goel (2009) made a similar distinction regarding the biologically inspired design process. In this analogy-based process, biological systems are used for developing solutions for engineering problems. The process can be solution-driven in which a designer or an engineer extracts a principle from a biological system and looks for problems that this solution may be applied, or it can be problem-driven where s/he first identifies and reframes the problem, searches for biological solutions, extracts principles from the solution, and applies these to the problem (Helms et al., 2009). Although it mainly concerns analogical problem solving, the solution- versus problem-driven distinction somewhat corresponds with our coincidental and deliberate source access differentiation. In the former, one starts from the immediate association and evaluates if this association is or can be made meaningful within the given context, whereas in the latter, one starts by building associations based on the end effect s/he wants to achieve.

As a matter of fact, the main difference of design analogies from product metaphors emanates from this end effect. Analogies are mostly studied in the problem-solving literature to describe and clarify the problem, find appropriate solutions, and communicate solutions to an audience (Casakin & Goldschmidt, 2000; Christensen & Schunn, 2007; Dahl & Moreau, 2002; Holyoak & Thagard, 1996; Wilson, Rosen, Nelson & Yen, 2010). For instance, Schön (1979) provided an interesting case study where a product development team, in trying to improve the performance of synthetic fiber paintbrushes (target), ended up using the mechanism of a pump (source) to shape the bristles to absorb the paint.

The use of analogies and metaphors in design share the same mechanism, transferring the knowledge from a known entity to an entity that needs explanation, yet what these processes entail differs slightly. Analogies are related to the discovery of a situation where problems, somewhat related to the one at hand, have been successfully solved. Metaphors involve deciding on which inspirational source would make more sense for the purpose of communicating a particular meaning (Cardoso & Cila, 2013). As Hoffman, Eskridge, and Shelley (2009) state, "Metaphor and imagery seem to lace freely through the stream of consciousness, whereas analogical reasoning is a set of beliefs, goals, attitudes, standard formatting practices, and skills that may or may not be applied in the exploration of any given metaphor." For this reason, the use of metaphors is often for realizing the expressive intentions (func-

tional, non-functional) of its producer by conveying meaning; whereas analogies are mainly for discovering solutions to design problems.

Since we are mainly interested in the process of metaphor generation in this thesis, we aimed to check the validity of the basic model we provided before proceeding with further studies on the specifics of this process. Below, the workshop we conducted with design students for this purpose will be explained.

Workshop on metaphor generation

Context and Procedure

The goal of this workshop is to see if designers go through a similar process that we modeled when generating product metaphors, and if so, to get an initial understanding on the aspects they pay attention to in each step of the process.

The workshop was conducted within the scope of Project Exploring Interactions course at Delft University of Technology, Master of Design for Interaction. 16 master students (8 male/8 female) taking this course volunteered to participate in the workshop. Each year there is a specific theme of the course that the students are asked to design the products/services for. When the workshop took place, this theme was "lightness". As this was a rich abstract concept that is similar to what we call a "meaning" to assign and it might have had different interpretations that would lead to finding various different sources, we conveniently decided to use this theme as a meaning to trigger metaphor generation.

In order to diversify the metaphors that students could come up with and also eliminate the bias that product type might have caused, we chose to use four products to generate metaphors for: MP3 player, package for potato chips, bus stop and automatic teller machine (ATM). In the selection of these products, we paid attention that lightness was a relevant meaning that can contribute to the function, use or meaning of these products, as well as they had diverse qualities in certain aspects as size (big–medium–small), interaction type (one-to-one, one-to-many), mode (digital–analogue), and ownership (consumer product–public product).

The workshop started with a 15 minutes presentation on product metaphors in order to familiarize them with the related terms. Then, each student was assigned randomly to one of four product types, and they were given the design brief of: "Design a _____ that conveys the meaning of 'lightness' with the use of a metaphor". They were told to explore lightness concept as extensively as possible in the first hour. After this exploration phase, they were instructed to refine their metaphor ideas with a final presentation sketch. This phase took 1.5 hours. After the completion of the sketches, the group came together and each student presented his/her project. This stage was video recorded while the students explained how they chose to convey lightness, what was their source domain and why they chose it.

Defining the meaning

As aforementioned, the design process started with an exploration phase in which the students were encouraged to discover various dimensions of the lightness concept. In this stage, most of the students provided a very comprehensive presentation of lightness varying from related physical properties (e.g. transparent, odorless, lemon taste, emptiness) to associated actions (e.g. flying, jumping, floating) and concepts (e.g. simplicity, meditation, drugs, air) through mind maps or lists. An example outcome of this exploration can be seen in Figure 02.2.

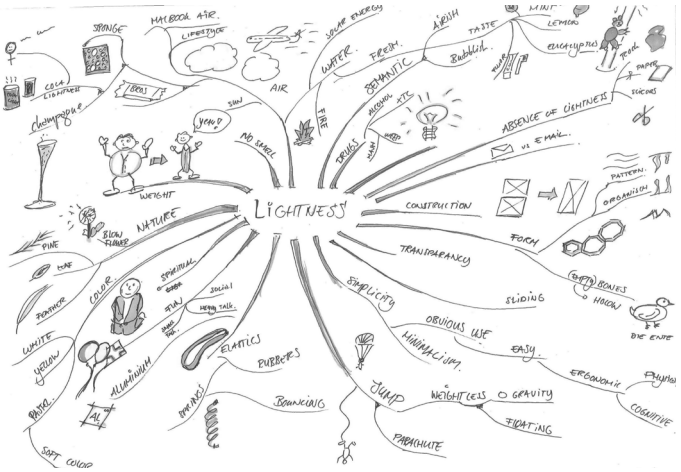


FIGURE 02.2. A mind map a student made to explore the concept of lightness.

It was observed that lightness was considered to be a vague concept, which the students felt the need to clarify. Therefore, they defined how they interpreted lightness and what kind of lightness they would convey through their designs further in detail. When these lightness types are categorized, we see the students chose four different meanings:

(1) Lightness in terms of being **light in weight** (10 out of 16 students)
(2) Lightness in terms of being **effortless, fun** (4 out of 16 students)
(3) Lightness in terms of being **diet, fat-free** (1 out of 16 students)
(4) Lightness in terms of being **peaceful, stress-free** (1 out of 16 students)

As can be seen above, most of the students focused on the weight dimension of lightness. This was an expected approach since being light in weight is the prevalent use of the word. On the other hand, the remaining six students focused on the word's more implicit meanings and preferred to emphasize different aspects of lightness through their designs.

Finding a source

After clarifying the aspect of lightness they will focus on, students began looking for potential sources that could bring out that particular dimension. This investigation included not only very typical representatives of lightness like a leaf, feather, bubble, and so on, but also more uncommon associations like a teacup and pills. As can be seen in Table 02.1, students considered various potential sources from different categories. These are man-made objects, nature-related entities, living organisms, actions, and other cultural phenomena. These categories indicate which areas designers considered when searching for sources for this specific design brief. Man-made objects referred to everyday objects and vehicles; nature-related entities involved geographic formations and natural events; living things suggested humans, animals and plants; actions involved movements including embodied ones; and lastly, cultural phenomena referred to culturally learned concepts or things that cannot be considered as 'objects'.

The students then evaluated the applicability of the potential sources for using in product metaphors and made their selections. When the reasons behind the selection of specific sources are carefully analyzed through interviews and sketches, two complementary aspects appeared:

Conveying the intended meaning saliently.
Students looked for sources that are in line with the meaning they intend to convey. If they wanted to convey lightness in terms of "lightweight" for instance, they looked for sources that have being light in weight as a salient (i.e., prominent, noticeable) property. Therefore, even though there were some potential sources that somehow had this property like falling raindrops, stingray fish and teacup, these were not selected in the final sketches since they were not good representatives of lightness and thus, they would not convey the lightweight meaning strongly. Rather, they chose comparatively more relevant sources to be able to communicate the intended meaning more effectively.

Matching with the attributes of target domain (allowing for appropriate mappings).
This aspect is closely linked with the succeeding phase of mapping. We observed that the students carefully considered if the attributes of the potential source could match properly with those of the target domain. The following situation clearly explains this consideration: Leaf is a stereotypical exemplar of lightness, and therefore, it was considered as a potential source by the students who were designing chips packaging, ATM and bus stop (see Table 02.1). But after taking into consideration the target they were assigned to, only one student proceeded to work with this source because he was able to make a sound connection between leaves and money in terms of their form and movement. The other five students dropped this potential source since they could not find a meaningful way to employ it in the form or use of a bus stop or chips package. Therefore, we can state that during the source selection process students kept in mind how they would do the mapping and decided on the

TABLE 02.1. The source domains used in the sketches.

	Man-made objects	Nature related entities	Living things	Actions	Cultural phenomena
Bus stop (5 st.)	Swing (x3) Umbrella Tent Zeppelin Curtain Mobile Lego	Smoke Snowflakes Falling rain-drops Changing light Moving grass Cloud Sand dune	Leaf (x3) Shell Flower Bird Butterfly Tree	Knitting Moving with wind (x2)	Voting poll
Packaging (5 st.)	Pills Balloon Pillow Balloon Bodum tea cup Football Balloon Bowl Steel structure	Sponge Bubbles	Fly Butterfly Insect Tree Leaf	Diving in water Being thrown from a can-nonball Getting thin	
MP3 Player (4 st.)	Post-it Zen rocks	Ice cube	Insect Feather Stingray	Adding/remov-ing sticks	Volume icon
ATM (2 st.)	Paper	Falling leaves			
	21	14	13	7	2

Making a mapping

While selecting the source, the students searched for matching properties between source and target that could lead to apt and pleasurable metaphors. When we analyzed which properties of the source were projected onto target, we identified three approaches for this specific design brief. Students shaped the target product like the source, made the product move/behave like the source or guided the user to interact with the product in a similar way of interacting with the source. In Figure 02.3a, an MP3 player that references a post-it can be seen. Post-it was chosen because it was lightweight, and its *sensorial properties* like form, color, weight and dimensions were projected onto the MP3 player. The chips packaging seen in Figure 02.3b "loses weight" every time one gets a chips out of it. In this example, the *movement* of getting smaller was projected onto the package. Lastly, in the bus stop seen in Figure 02.3c, Lego was selected as a source. The people waiting for a bus *interact* with the pieces that compose the bus stop, as they would play with actual Lego's.

It should again be noted that designers anticipated the match of these properties between target and source while they were deciding on the source. This makes source

selection and mapping closely linked phases, in which designers plan the latter one while they go through the former phase.

Another aspect that we observed was when the selected sources properly matched with the target, a rich usage scenario followed. The entire context of the source can be used for explaining and enhancing user–product interaction. To illustrate, a student used a "leaf" as a source for chips packaging. This association led him to shape the package as leaf (sensorial property mapping from leaf to package), and then he hung the packages to the sales-point stand as if they were the leaves on a tree (sensorial property mapping from tree to a stand). In his scenario, when users wanted to buy chips they would shake the stand like they would do to an actual tree (interaction pattern mapping from tree to a stand). Then, the packages would fall from the tree in a fluttering action like leaves (movement mapping from leaf to package). This selected source brought richness to the usage scenario because it had a rich context matching aptly with the context of the product.

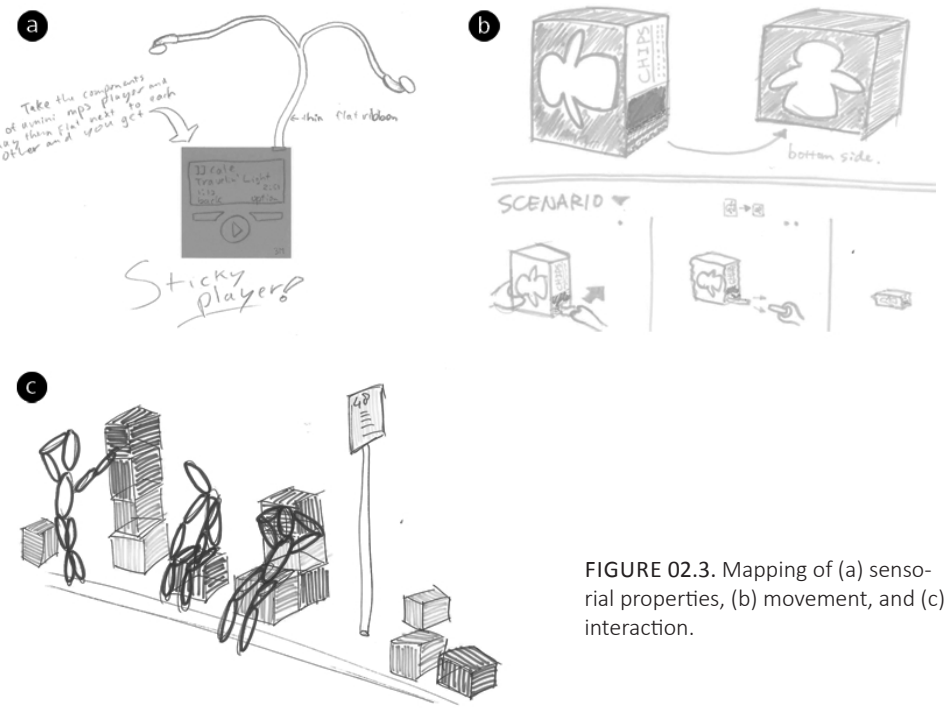


FIGURE 02.3. Mapping of (a) sensorial properties, (b) movement, and (c) interaction.

Mapping not only includes deciding on which properties to transfer but also selecting "how" to transfer these properties. With the analysis of the sketches we identified different strategies. First of all, some students wanted to emphasize the source they used in their design explicitly in order to make the metaphor identifiable and understandable, while some of them preferred to hide the reference in order to put the focus on target and its properties. In Figure 02.4a, the student created an association

between leaves and money, and put the effort to mimic the fluttering fall of leaves for giving money from an ATM. The metaphor in Figure 02.4b involves an implicit mapping of an ice cube to an MP3 player, which may not be identifiable by the users very easily because the student adapted it thoroughly to the form requirements of an MP3 player.

Another difference in terms of mapping was in the extent of how literal or abstracted the mapping was. Some students took the properties of source and transferred them to the target without making any major changes. For instance, in Figure 02.5a we can see a mapping from balloon to chips packaging, and the way a person holds and carries balloons are directly applied to package without further manipulation. On the other hand, in Figure 02.5b the student selected a sand dune as a source for her bus stop because dunes changed their forms according to the wind. With her organic and free-flowing bus stop, she abstracted the form of a sand dune for her final metaphor design.

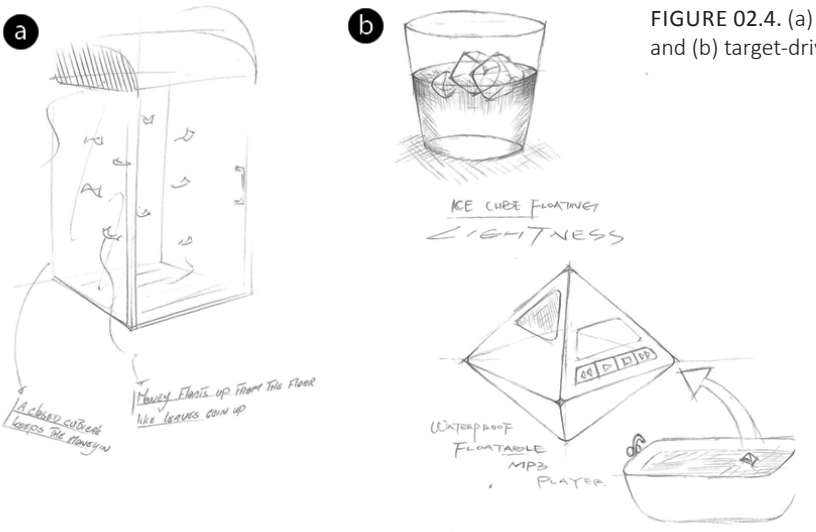


FIGURE 02.4. (a) Source-driven and (b) target-driven mappings

Discussion

This explorative workshop was intended for getting some insights about how designers deal with metaphor generation and checking if the process we modeled was valid to explain the generation process. On the basis of the outcomes as well as our observations, we consider that a process starting with meaning definition, proceeding with source selection and ending with mapping is a natural way to create a metaphor that designers intuitively follow.

Regarding the phases of this process, first of all we can state that the meaning to be conveyed through the metaphor use should be clear for designers to be able to start

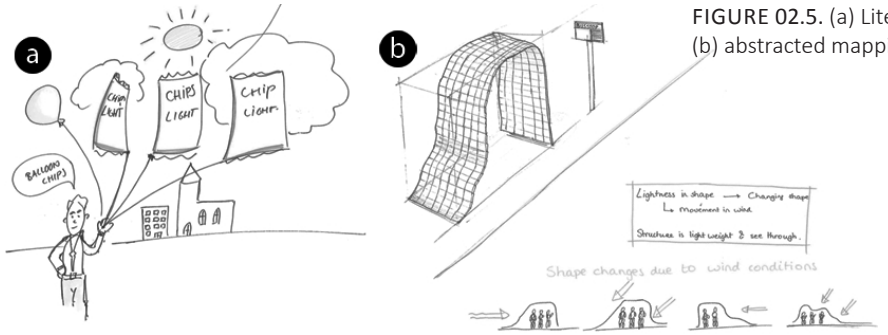


FIGURE 02.5. (a) Literal and (b) abstracted mappings

Regarding the phases of this process, first of all we can state that the meaning to be conveyed through the metaphor use should be clear for designers to be able to start metaphor generation. In a real design situation, designers would have a clear idea about this meaning and which dimensions they would want to emphasize since they would know what they want to communicate. In the workshop, however, students were asked to generate metaphor for a pre-identified meaning, which triggered the need to clarify it. We observed that lightness was considered to be rather ambiguous concept; for this reason, students described it according to their perceptions and interpretations.

After clarifying the meaning, they explored various domains to come up with an appropriate source to employ in the metaphor. These domains included nature-related entities, biology, actions, man-made products or other cultural phenomena; and they searched for appropriate sources that can convey lightness. Unquestionably, all the source domains considered in this stage are concrete entities. To select among these candidate sources, we observed that the students considered two complementary aspects: whether a source conveys the intended meaning properly or not, and whether it is reasonable to create an association between the product and the source. That is why we cannot see any feathers and butterflies in the final sketches. As the designers aim to create metaphors that convey the intended meaning in an appropriate and aesthetic way, both of these aspects are the reasons of source selection. If the source they select does not convey the intended meaning in an understandable way it is not successful in achieving the aims of metaphor usage, and if it does not properly match with the target domain it is not understandable and/or pleasurable as a metaphor. For all these reasons, our first insights tell that these two aspects are complementary and contribute to the selection of a source domain together. We will address them in Chapter 3 in detail.

We mentioned before that students kept in mind how they would do the mapping and decided on the final source according to its potential for proper mapping. This makes source selection and mapping phases intertwined. While deciding on the source, designers have to take into account the mapping process by considering the target product. We also observed that the properties they map from source they selected to the product and the way they conduct the mapping differed from student to student, even though they used the same source. This is another interesting aspect

that we believe affects the quality of a metaphor. On the basis of the insights we gained from the workshop, we will investigate mapping process more comprehensively in Chapter 5.

To conclude, we can state that metaphor generation requires a considerable amount of decision-making. Designers have to decide on the meaning they will convey, the source that can convey this meaning, which properties of this source they will map and how they will do the mapping. These phases, in practice, interact in many ways, and they are dynamic in the sense that output from later phases frequently influences previous phases. With good and creative decisions in this regard, designers can create rich user experiences. How to take these good decisions is what we will try to discover throughout this thesis.

Summary of the chapter

Metaphoric communication model

In this workshop, we observed designers at work while generating product metaphors. On the basis of their outcomes, we consider that the basic model we proposed at the beginning of this chapter is valid for explaining the product metaphor generation process. With the knowledge we gained throughout this chapter, we will elaborate this model. As can be seen in Figure 02.6, a product metaphor mediates between the "metaphor experience process" of the user and the "metaphor generation process" of the designer. A user experiences the properties that the designer likely shaped according to her background knowledge and experience. This process may also involve some inference of what response was originally intended by the designer. She goes through the stages of perceiving that a metaphor has been employed in a product, recognizing its target and source, comprehending why these particular entities are brought together, and appreciating (or not) this association.

The designer, like the user, has also her own expertise, knowledge and traits that she uses when shaping the metaphor. The target is most likely assigned to her by the client she works for, and she has a particular intention to attain through the product (she can come up with this intention with her own means or it can again be assigned by the client). On the basis of this intention, she unearths a meaning to convey, and finds a source that can assign this meaning to the target. Going through these two stages, a designer comes up with a "metaphorical association". She then conducts a mapping from this source to the target, i.e., "metaphor application"[1]. As when selecting a source she also considers how to do project it onto the product, there is also a feedback arrow from mapping to the source.

The designer also has a conception of the user, and while going through these stages, she keeps in mind how the user will experience the product she generated. There are

[1] In the model, the target and the source have been depicted as distinct entities—a sphere and a cube—but the metaphor produced through their association carries traces from both of them—a rounded edge cube. This means that through the mapping, the physical properties of the target and the source are merged.

also some external factors they play a role in the communication. Some of these include production and cost constraints, regulations, and the brand that the designer commissioned by (Bloch, 1995). The designer's task can be viewed as the planning of forms that appropriately reconcile many competing and conflicting factors (Crilly, Moultrie & Clarkson, 2008).

In actual metaphoric communication, the phases of metaphor generation and experience that we explicated in this model are not differentiated as clear and distinct as in here. As we found out with the workshop, designers intuitively go through this process, yet it is not easy to spell out the particular decisions they consider. Likewise, the process that users have when experiencing a metaphor is also automatic and non-deliberate. These phases were differentiated in the model in order to make our investigation of the subject systematic. In the coming chapters, we will address most parts of this model in detail.

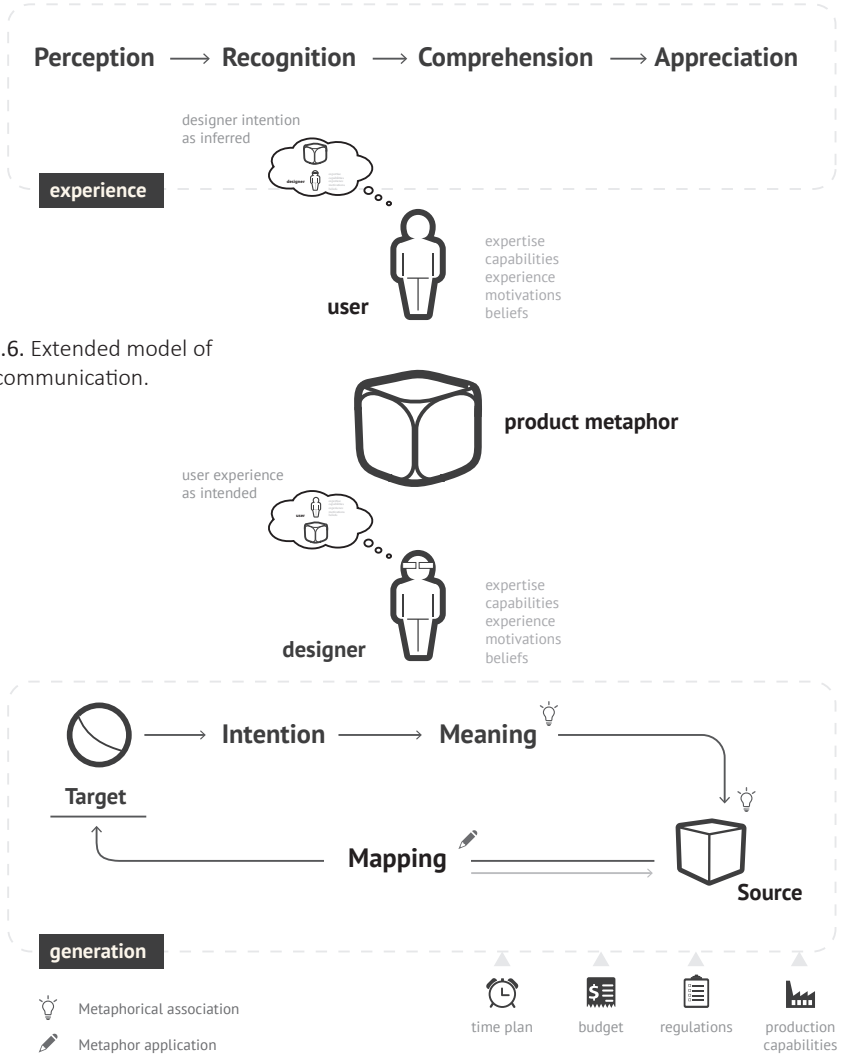


FIGURE 02.6. Extended model of metaphor communication.

/03

CREATING AN ASSOCIATION: SELECTING A SOURCE

In the previous chapter, it has been indicated that metaphors are used as a means of communication between designers and users. A designer generates a metaphor by deciding on a quality of a target to highlight and selecting a corresponding source that conveys this quality in some way; the user interprets the designer's intentions via the end product.

In this chapter, we focus on how designers come up with a target–source association, and address the "source finding" phase of metaphor generation. It is particularly difficult to identify candidate sources when they are concealed in a memory system, and when the source and target are generally encountered in different contexts and have much dissimilarity. The selection of any source in particular is affected by the extent to which it represents the meaning the designer intends to convey (i.e., its salience), and the strength of its association with the product (i.e., relatedness). We will investigate how different levels of salience and relatedness influence source selection, and also address other source selection criteria that designers take into account when generating a metaphor.

This chapter has been submitted as:

Cila, N., Hekkert, P. & Visch, V. (submitted). Source selection in product metaphor generation: The effect of salience and relatedness. Manuscript submitted to International Journal of Design (under second revision).

FIGURE 03.1. "Datenschutz" USB stick, by dialog05.

Metaphors build an association between conceptually separate entities where the attributes related to one entity are used to understand or represent another (Wee, 2005). This association is not confined solely to a linking of words, but concerns any transfer of meaning from one conceptual entity to another. Metaphor, in this wider sense, is not just a figurative aspect of language but a fundamental part of people's thoughts, reason, and communicative practices (Gibbs, 2008; Lakoff & Johnson, 1980).

The power of metaphor lies in its ability to relate two distinct entities, which in turn initiates the production of new and deeper meanings. This potential allows metaphors to be valuable aids in fostering creativity, as the creative act is often associated with the ability to find parallel patterns, see relationships, and connect remote ideas or frames of reference (Casakin, 2007; Gruber & Davis, 1988; Leite, Pereira, Cardoso & Pereira, 2000; Young, 1987). For this reason, they are often referred to as the cognitive instruments used by "creative artists" to perceive relationships that bring in novel qualities to the problem at hand (Cupchik, 2003).

Product designers are one group of these creative artists who benefit from metaphors to exhibit original and exciting solutions to design problems. In the design domain, metaphors are commonly used as a means to stimulate designers' creativity in the design process because they help to facilitate unconventional thinking by building relationships between distinct domains (Casakin, 2007; Kirsi et al., 2009; Leite et al., 2000; Snodgrass & Coyne, 1992; Young, 1987), identify design problems (Casakin, 2007; Hey et al., 2008), and 'frame' the problematic design situation by seeing it from a

novel standpoint and adopting a working principle associated with that position (Dorst, 2011; Schön, 1979).

Additionally, metaphors are used as a means to develop a form language to affect the symbolic qualities of products. Products are vehicles for communication between the expressive intentions of designers and the interpretative responses of users. They can be considered as "signs" to make sense of—a role of products that is addressed by product semantics (Boess & Kanis, 2008). Metaphors are extremely functional and effective in this respect; they imbue products with meanings and values (Boess & Kanis, 2008; Forceville et al., 2006; Krippendorff & Butter, 2008; Van Rompay, 2008), by providing clues to users about product use, thereby turning a complex product into a comprehensible one, or by emphasizing the function, social or cultural meaning and personality of the product. In this paper, we adopt this semantic approach to metaphors, and our focus is on the expressive influence of deliberate metaphor use in product design.

Designers generate metaphors by taking an attribute(s) from one distinct entity and transferring it to a product they are designing. For instance, in the product metaphor seen in Figure 03.1, the designer implies an association between a memory stick and a padlock. Rather than building a piece of software in which users type their passwords, the designer forces users to use a real key to release the shackle and access the data. A padlock is an object representing "security". An explicit reference to this object helps users to see the expressive intention of the designer: Unauthorized people do not have access. For this reason, the padlock metaphor provides the users a novel, yet straightforward interaction with the product.

In technical terms, the memory stick is a product that is assigned a new meaning and is thus referred to as the target of the metaphor, while the padlock is called the source, the entity that modifies the target in order to convey that particular meaning. The meaning in question is the "data security" provided by this particular USB, which the designer has emphasized by fashioning the product into a padlock (see Figure 03.2). This fashioning process, called mapping, physically builds metaphorical links between target and source by projecting properties of the source to compatible properties of the target. In our example, the mapping process involves an explicit projection of a padlock's form and usage to the form and usage of a memory stick.

There are many other examples of metaphor use in the design domain, yet little is known about the way they are generated by designers. Metaphor generation is a topic that is mostly overlooked even in the linguistics domain, where most research is directed towards metaphor comprehension and appreciation (Flor & Hadar, 2005; Katz, 1989; Lubart & Getz, 1997; Silvia & Beaty, 2012). In this paper, we aim to investigate the process that designers go through when generating metaphors with a specific focus on the source selection phase. More than two decades ago, Holyoak and Koh (1987) regarded this phase as "the least understood" decision among all the decisions that are made during analogical reasoning and metaphorical thinking processes (p. 332). Their argument still holds today. To our knowledge, there are no comprehensive studies that address the considerations metaphor producers have when looking for a source. In this paper, therefore, we will investigate the

criteria for an entity to be employed in a product metaphor as a source. We focus on two factors that we assume to play a key role in finding an appropriate source: the salience of the intended meaning for the source, and the source–target relatedness. Salience refers to the extent to which the meaning a metaphor producer wants to convey is a prominent attribute of a particular source (Ortony et al., 1985). As can be seen in Figure 03.2, from the various properties and associations a padlock has, in our example "security" is transferred to a memory stick. Salience addresses how central and prominent this property is for a padlock, relative to other aspects of a padlock. Relatedness has to do with the conceptual positions of a source and a target in one's representational system and refers to the association strength of these two domains. In our example, it refers to how easy it is to relate a padlock to a USB stick (see Figure 03.2). These two factors have mainly been studied in the context of metaphor comprehension and rarely in the context of production. Moreover, as far as metaphor generation has been studied, this research is primarily from the domain of linguistics.

Following this introduction, we will first present the relevant research on metaphor generation and source selection, and discuss the roles of salience and relatedness in this process. Next, we will present the study we conducted on source selection during the design of product metaphors, and finally discuss our findings in the light of metaphor and design theories.

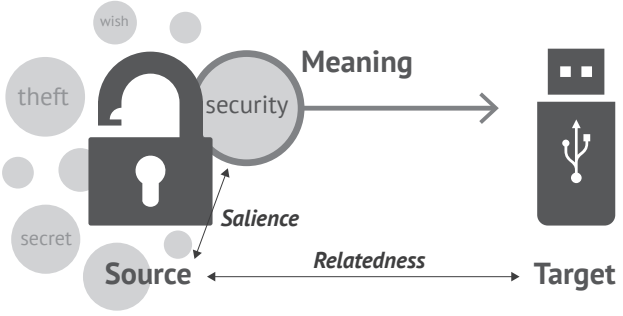


FIGURE 03.2. The correlation of the terms used in this paper.

Source selection

By definition, metaphors have a communicative role that entails a transfer of meaning from one entity to another. This meaning transfer alters target perception in a novel way according to the expressive intentions of its producer (Forceville et al., 2006). Therefore, when people generate a metaphor, they have a particular meaning in mind that they want to attribute to the target and look for an entity that embodies this meaning (Chiappe & Chiappe, 2007; Clevenger & Edwards, 1988; Jones & McCoy, 1992; Pierce & Chiappe, 2009). A proper selection of the exemplar enables the most effective expression of the meaning. In relation to products, this means that metaphor generation starts with deciding which particular quality of the product to emphasize and what kind of experience to offer users, and then seeking out a relevant source.

Creating a metaphor that is both appropriate and pleasurable demands a careful selection of the source. The use of the term "selection" is also metaphorical to some extent. In the creativity research domain, a creative problem-solving process—of which the product metaphor generation process is also an example—is considered to involve two kinds of thinking patterns: divergent and convergent (Brophy, 2001). While a range of ideas and concepts are generated in the divergent mode, the most appropriate solution among them is chosen in the convergent mode. As Brophy (2001) pertinently puts forward, "More divergent thought occurs while generating problem definitions and solutions. More convergent thought occurs while selecting and developing them" (p. 440). In product metaphor generation, during the exploration phase of the design process, divergent thinking takes place when designers look for a source to associate with a target and create imaginary sets of potential sources. For instance, a possible set for the previous example could be "things that protect what is inside", and might include a vault, chest, castle, padlock, nest and so forth; this list is a product of the divergent thinking mode. Deciding which is the most fitting source out of the set—a padlock, in this case—displays a form of convergent thinking, which is influenced by various constraints. Our study focuses on this convergent selection phase, where designers come up with, decide on, or "select" an appropriate source to associate with a target. In other words, why the designer in our example selected a padlock, out of all the other possible sources, is the question we aim to answer.

There is a small body of work on source selection in the domain of metaphor studies. For example, Clevenger and Edwards (1988) tested for the ideal proximity of target and source in the semantic space by asking their participants to match a famous person with an animal from the set they provided. Pierce and Chiappe (2009) had participants complete metaphorical statements (e.g., "Some smiles are _____") with appropriate source terms, after providing them with a meaning to be attributed to the target (e.g., "Something that draws things to you"). In this way, they were able to investigate the effect of selected sources' aptness and conventionality on the quality of metaphors produced, and the time it took to produce them. To explore the link between target–source distance, source concreteness, and imagery of the metaphor producer, Katz (1989) took a similar approach by asking participants to complete metaphors, but this time participants were expected to choose sources from a set of pre-determined alternatives. Source selection is also occasionally addressed in the creativity literature as a means of establishing a link between creativity and intelligence. For example, Silvia and Beaty (2012) studied the role of intelligence in creative metaphor generation by providing their participants with examples of emotional experiences and asking them to define these situations by using metaphors. Similarly, De Barros and her colleagues tested whether completing metaphors with appropriate sources might be a valid way to measure intelligence and creativity (De Barros, Primi, Miguel, Almeida & Oliveira, 2010). Although these studies make a contribution to understanding the nature of verbal metaphors and metaphorical thinking, their main focus is not directly on the dynamics of the metaphor generation process or on the source attributes that might influence it.

We argue that in order to generate comprehensible metaphors, when a designer is selecting a source, two considerations should be taken into account. Firstly, the

designer should consider the communicative role of the metaphor, and aim to emphasize the desired meaning as clearly as possible. For this reason, she should narrow down the number of potential sources by focusing on those that are "an ideal and salient exemplar of the category it represents" (Glucksberg & Haught, 2006, p. 375). The second consideration has to do with the relationship between target and source and involves whether the potential source enables an appropriate association to be built between these domains. In this paper, we examine how these two factors affect designers' selection of sources used in product metaphors, by employing a variant of the metaphor completion procedure used by Katz (1989) and Pierce and Chiappe (2009). Before proceeding with the study conducted for this purpose, we will further elaborate on the concepts of salience and relatedness.

Salience

Salience refers to the significance of a property in a person's representation of a "category" and is characterized by the qualities of importance, characteristicness, distinctiveness, and conceptual centrality (Katz, 1982; Ortony, 1979; Ortony et al., 1985). Each category has a graded structure, comprising members varying from "good" examples to "not-so-good" examples of that category (Barsalou, 1983). The sources considered in metaphor generation are also (ad hoc) categories comprising various dimensions and properties. Correspondingly, the graded structure implies that some properties of the sources are more important, distinctive and central than others. In order to convey a new meaning, a person is likely to select a source that has this meaning as a salient property, as compared to other candidate sources. For instance, in Glucksberg's celebrated metaphor (2003), "My lawyer is a shark", the lawyer's viciousness, aggressiveness, and mercilessness are emphasized using the salient properties of the source shark. Although other entities like a dictator or the Devil may also embody viciousness, the statements "My lawyer is a dictator" and "My lawyer is the Devil" do not convey viciousness very accurately. The reason is that viciousness is not a particularly salient property of these entities; a dictator and a devil both have other properties that are more salient than viciousness. The former metaphor connotes the authority of the lawyer, rather than his/her viciousness, because being authoritarian and powerful are arguably the most salient properties of a dictator. For similar reasons, the latter metaphor stresses the lawyer's dangerousness and malignity.

It should be noted that, for a source, there is a difference between "having X meaning as a salient property" and "being a typical example of X meaning". When we consider the two statements "speed is a salient property for a lion", and "a lion is a typical exemplar of speed" for instance, it is highly probable that every person would agree with the first statement, but not with the second. Although lions are notorious for hunting their prey with immense velocity and agility, a lion is not an entity that best exemplifies speed. A cheetah, a Ferrari, or a bullet may symbolize speed more adequately. Typical entities surely have the most salient properties for that category (Murphy, 2004; Rosch & Mervis, 1975), while merely having a salient property does not automatically make an entity typical for that category.

We would argue that in metaphor generation, finding a typical source for a particular meaning is not required. It is important, however, to find a source that represents that meaning strongly in order to communicate the meaning effectively. Therefore, the first hypothesis that will be tested in our study is:

H1: Designers will prefer to employ the sources that have the intended meaning as a salient property than the sources that have it as a less salient/unsalient property.

Relatedness

Salience is a necessary condition, but it is not sufficient on its own for source selection; a metaphor producer should also take the relationship between target and source into account. As Aristotle (1895/2008, p. 47) stated, "to make good metaphors implies an eye for resemblances." At least some similarity between target and source is necessary for their combination to be construable as a metaphor (Forceville, 2012).

In some metaphors, the relationship of a source and a target may be obvious. For instance, it is easy for one to grasp the intention behind the statement "a rooster is an alarm clock", as a rooster and an alarm clock both wake people up. Alternatively, the relationship may be latent-but-pre-existent (Forceville, 2012). We do not usually see any similarity between lips and corals, but in his Sonnet 130, Shakespeare defines the redness of his lover's lips by comparing it to a coral. Then, we start to perceive the relation of these two distinct entities: They are related in terms of belonging to the category of "red things". Whether an existing or a latent type of relation, we maintain that the target and source of a metaphor must involve some degree of relatedness. Given the assumption that metaphors are generated to communicate, if one selects a source that has little overlap with the target, obviously the metaphor that links them would be un-interpretable.

In the field of linguistics, some scholars have asserted that the more two domains overlap the better the metaphor becomes (Johnson & Malgady, 1977; Malgady, 1976; Marschark, Katz & Paivio, 1983). Although one should avoid bringing entities that are "too similar" together, so as not to end up with dull and uninteresting metaphors (Ortony, 1979; Tourangeau & Sternberg, 1982), one does need to associate entities that share some meaningful properties (e.g. alarm clock and rooster). Good metaphors have targets and sources that belong to distinct categories, yet have a high degree of similarity between them. We believe this is also valid for the metaphors used in product design: A high degree of relatedness between target and source generates a higher potential for appropriate associations, and a designer will associate them because of this relatedness. Therefore, the second hypothesis we will investigate in the study is:

H2: Designers will prefer to employ the sources that are highly related to a target than the sources that are less related or unrelated to it.

Method

Participants

Thirty-three MSc. students (14 male and 19 female) in the Industrial Design Department at Delft University of Technology took part in this research. All of them were volunteers who received no additional course credits or financial compensation for their participation.

Design brief

In order to confine our study to source selection only, we decided on the target and the meaning to be communicated beforehand. We asked participants to design a vacuum cleaner (i.e., target) that conveys "power" (i.e., meaning to assign) using a metaphor. Such a task, where the designer is commissioned by the client to create a specific product with a specific character, is common in design practice (Rodgers & Milton, 2011). In our study, we chose a vacuum cleaner because it is a product that allows for the exploration of various multimodal interactions related to form, movement, sound, touch, and even smell. Power is a main feature of vacuum cleaners, and it is an open concept that can be conveyed through a product in different ways. We considered this target–meaning combination as favourable for the exploration of metaphors focusing on different aspects of vacuum cleaners.

Stimulus material

Generation and Rating

To investigate the effects of salience and relatedness on product metaphor generation, a set of sources had to be identified that showed differing degrees of salience for power and relatedness to vacuum cleaners. For this, we followed a two-stage process. In the first stage, we conducted a creative session in which three experts with a BSc and a MSc degree in industrial design and several years of design teaching experience participated in an extensive 2-hour brainstorming session on "things that have power" and "things that are related to vacuum cleaners" for one hour each[2]. The colloquial word "thing" was used here in order to guide the experts to think of entities with a 'physical substance', which can cover various areas from natural phenomena to man-made objects. We prompted the experts to not only come up with things that display high degrees of power and relatedness to a vacuum cleaner, but also to consider other degrees and levels. In this way, we intended to cover all possible salience–relatedness combinations: Some salient sources could also be related

[2] We considered that asking "experts" to come up with sources within this time frame is sufficient to find interesting associations, as we found earlier that the time limit a designer has for creating a metaphor is not a relevant constraint on his or her ability to come up with an appropriate source. If the designer is experienced, s/he can generally find sources to emphasize the hidden qualities of a target better than novices regardless of the time given (Cila, Hekkert & Visch, in press-b).

to a vacuum cleaner (e.g., tornado), while some others are of low relatedness (e.g., crown). Similarly, vacuum cleaner-related sources could display low and high degrees of power-salience (e.g., dust buster and elephant, respectively).

At the end of the session, we obtained a list of 103 items that, for participants, evinced varying degrees of power and relationship to vacuum cleaners. In the second stage, the items were listed in an online questionnaire, and 35 independent judges, who did not participate in the creative session and are from different professions and within an age range of 26–35, rated both the extent to which power was a salient property for each item, and the relatedness of each item to vacuum cleaners. We defined and exemplified salience as, "*The extent to which an item expresses power. For instance, referring to an item as having power, being representative of it, or being frequently mentioned in conjunction with power makes that item express power.*" In a separate question, judges were asked about relatedness by assessing "*The extent to which an item is associated with a vacuum cleaner. For instance, sharing similar sensorial and functional properties, or being mentioned together frequently makes that item associated with vacuum cleaners.*" Judges were asked to rate each item on a scale from 1 (not at all) to 10 (very strongly).

Selection

After obtaining these ratings, we categorized them into nine groups according to their levels of salience and relatedness (Salience: High, Medium, Low; Relatedness: High, Medium, Low). As can be seen in Figure 03.3, the distribution of the items was not homogeneous. Items that have power as a highly salient property and are at the same time highly related to vacuum cleaners are less common than items having only one of these qualities. This unequal distribution is caused by the instruction we gave to our experts in the creative session: They generated sources for salience and relatedness separately. For this reason, we categorized the items according to their "relative" distance to each other by using 33rd and 66th percentiles (the lines in Figure 03.3 represent these values). Consequently, for the power dimension, items having a score equal to or higher than 6.33 referred to high salience, scores equal to or lower than 3.47 referred to low salience, and the scores between these values referred to medium salience. For the relatedness to a vacuum cleaner, these values were 2.47 and 1.72. With this categorization, we placed the items in a 3 x 3 matrix.

We then selected three items from each of the nine cells of the matrix to use in the study. These items were selected to "best" represent a particular cell while maximally varying in salience and relatedness between conditions. For instance, from the high salience/high relatedness cell we took the three items that got the highest scores on both dimensions, and from the medium salience/low relatedness cell we selected the ones whose salience scores were average within the cell while having the lowest relatedness scores compared to the others items in the same cell. Mean salience and relatedness scores of the final selected items are presented in Table 03.1. The selection of three items from each cell instead of one was to minimize selection bias. By selecting three items and using one of these three in the source sets given to participants, we aimed to ensure the proper representation of each cell in the study.

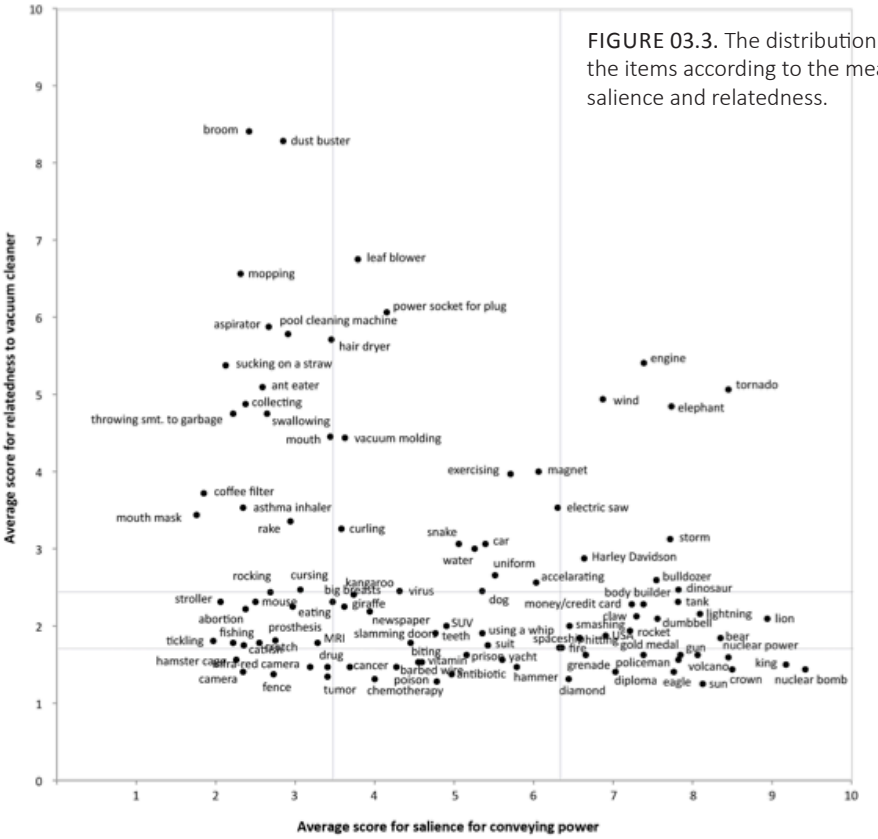


FIGURE 03.3. The distribution of the items according to the means of salience and relatedness.

Procedure

Each participant ($N = 33$) was tested separately. They first received a 2-minute introduction on what a metaphor is through examples of a verbal metaphor ("Football is war") and a product metaphor (Senseo coffee maker from Philips, which alludes to the shape of a butler). Then, they were given the design brief along with a source set specifically assigned to them. We created these sets by taking one item out of three from each cell of the 3 x 3 matrix, resulting in a total of 9 items in each set for each participant. In this way, all items were used 11 times in the experiment, but in different random combinations. No two participants were given the same source set.

After receiving the design brief, first the participants were given 10 minutes to select three sources from the set of nine sources which they felt would make a good metaphor, and then sketch initial concept ideas. Then, they were instructed to select the one they found the most appropriate from these three sources, and work on this design concept for another 10 minutes.

At the end of the design phase, we conducted an interview with the participants during which we asked them to talk about the design concepts, why they selected one particular source and eliminated the other two, and why they did not consider

the six rejected sources. Asking participants for positive selection reasons as well as negative ones was to see if these two were actually polarized, i.e., if the reason for selecting a source was similar to the reason not to select a source. It also gave participants an opportunity to express reasons using a wider vocabulary.

The interviews were video-recorded with the permission of participants, and later transcribed verbatim by the first author. Content analysis of this data was made as a secondary observation tool for checking if the participants actually considered the criteria of saliency and relatedness during source selection as expected and identifying other possible source selection reasons in interview transcripts. The results of this analysis will also be presented in the next section and will be used in the discussion section to further explain our findings.

Table 03.1. Items used in the study with their respective salience (Sal.) and relatedness (Rel.) scores

	High Sal.	Sal. score	Rel. score	Medium Sal.	Sal. score	Rel. score	Low Sal.	Sal. score	Rel. score
High Rel.	Tornado	8.45	5.06	Magnet	6.06	4.00	Dust buster	2.85	8.28
	Engine	7.39	5.41	Power socket	4.15	6.06	Broom	2.42	8.41
	Elephant	7.74	4.84	Leaf blower	3.79	6.75	Mopping	2.31	6.56
Medium Rel.	Lion	8.94	2.09	Teeth	4.76	1.91	Tickling	1.97	1.81
	Lightning	8.09	2.16	Using a whip	5.35	1.91	Abortion	2.38	2.22
	Tank	7.82	2.31	SUV	4.90	2.00	Stroller	2.06	2.31
Low Rel.	Nuclear bomb	9.42	1.44	Antibiotic	4.97	1.38	Camera	2.34	1.41
	King	9.18	1.50	Poison	4.78	1.28	Hamster cage	2.26	1.56
	Crown	8.50	1.44	Vitamin	4.59	1.53	Fence	2.73	1.38

Results

Comparisons of Salience and Relatedness Levels

Figure 03.4 indicates how many times each of the nine salience–relatedness combinations was selected by participants, together with the selection frequency of the particular items belonging to that category. As can be seen, the most selected combination was high salience–high relatedness, and tornado was the most selected item, which was followed by elephant, engine, and tank.

To determine which item characteristics contributed to source selection, we employed a 3 (Salience: High, Medium, Low) x 3 (Relatedness: High, Medium, Low) ANOVA[3]. The final selection of the participants was used as the dependent variable. Consistent with our predictions, there was a significant main effect of salience and

[3] Although it is sometimes considered as controversial (Stevens, 1946), it is common practice in many social sciences studies to recode categorical variables to scale variables in order to perform ANOVA (see Lord, 1953, for a discussion).

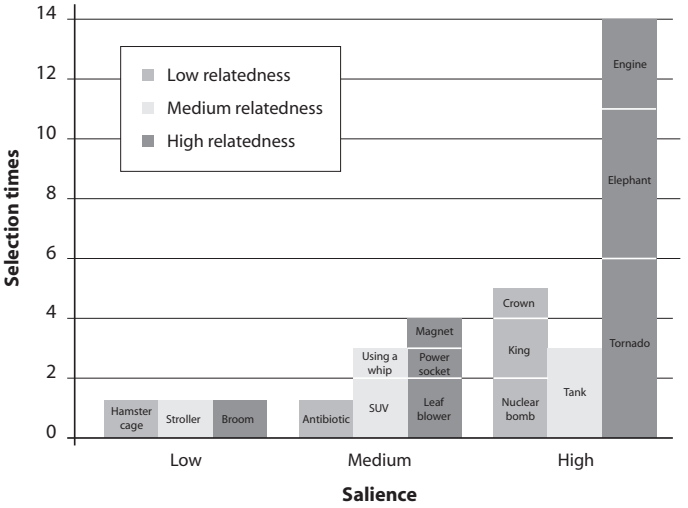


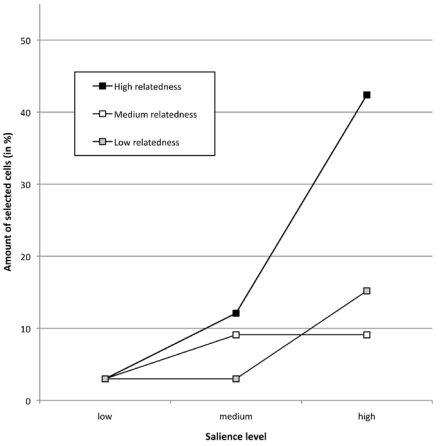
FIGURE 03.4. Item selection frequency.

relatedness on source selection, $F(2, 288) = 11.22$, $p < .001$, $\eta^2 = .072$ and $F(2, 288) = 5.55$, $p < .01$, $\eta^2 = .037$, respectively, thus demonstrating that the salience of the meaning for a source and the relatedness of the source to the target directly influence the likelihood of its being selected for a product metaphor.

In order to obtain between-group differences on means of salience and relatedness, two separate Games-Howell post hoc tests were conducted. As expected, participants selected the sources that have power as a highly salient property significantly more often than the sources with power as a moderately salient, $MD = 0.14$, $p < .02$, or low salient property, $MD = 0.19$, $p < .01$. The selection of sources with medium and low salience was not significantly different. The results for relatedness showed a similar pattern. The sources highly related to vacuum cleaners were selected more often than the medium-related, $MD = 0.12$, $p < .05$, and low-related sources, $MD = 0.12$, $p < .05$, and the difference between the selection of medium- and low-related sources was non-significant. Results thus indicate that sources that have the intended meaning as a highly salient property and are highly target-related were preferred over their moderate- or low-degree alternatives during product metaphor generation. Therefore, the results confirmed both hypotheses.

A significant interaction effect was obtained between salience and relatedness, $F(4, 288) = 3.58$, $p < .01$, $\eta^2 = .047$ (see Figure 03.5). This interaction indicates that the effect of relatedness differs according to the level of salience, and vice versa. Specifically, simple effects analyses of the interaction indicate that there was an effect of relatedness on source selection only if the source had power as a highly salient property, $F(2, 96) = 6.64$, $p < .01$, $\eta^2 = .122$. When there was medium or low salience, the results were not significant for the effect of relatedness. Therefore, only when the salience was high were high-related sources preferred over medium ($p < .01$) or low-related sources ($p < .05$). The reverse situation was also observed: There was an effect of salience on source selection only when the source was highly related to the target, $F(2, 96) = 10.74$, $p < .01$, $\eta^2 = .183$.

FIGURE 03.5. Salience and relatedness factor interaction.



Analysis of Interviews

Coding schemes were developed from natural-language data in the transcriptions. The transcriptions were segmented into short phrases, and a total of 559 segments were identified. The segments that included the physical descriptions of the products (e.g., "The main body has this accordion-like structure" [Participant 1], "It has sphere shaped wheels" [Participant 29]) were removed since these statements explained the final design solution rather than indicating any potential reasons for employing a particular source. The remaining 482 segments were used as the main unit of analysis (i.e., unit of meaning; Henri, 1992).

The first author did the initial segment coding. Coding was based on "latent content" (Graneheim & Lundman, 2004, p.106), meaning that the coder not only coded what was explicit in the data (e.g., "I chose the elephant because it is a powerful animal" [Participant 12]), but also inferred intentionality from the statements of the participants (e.g., "SUV is something very strong and big" [Participant 4]). The segments were classified into two main categories: reasons for selecting a source and reasons for not selecting a source. This coding scheme was checked for reliability by having the segments coded by a second independent judge. Agreement was found for 71.5% of the segments. This was followed by an elaboration phase, where the coder and second judge discussed discrepancies, re-named criteria where necessary, and tried to resolve conflicts. On the basis of consensus, the coding scheme was considered to be sufficiently reliable to proceed with further analysis.

A third independent judge—who had received training in this coding scheme and in protocol analysis in general—coded the segments using the scheme. Intercoder agreement was computed between the first and third judges' scores for selection and non-selection reasons, Scott's pi = .75, and .77 respectively, demonstrating a highly acceptable level of reliability[4]. Coding disagreements were resolved through discussion. The coding scheme is presented in Table 03.2 and Table 03.3, where the subcategories denoting reasons for selection and non-selection are listed together with a brief characterization and example segment in each case. Also listed is the number of participants who had responses in each subcategory.

We categorized participant comments under six main categories of "source selection reasons" including criteria from both Table 03.2 and Table 03.3. Their combinative percentages are as follows:

1. Having the intended kind of power as a salient property (46.5%): This category includes statements of participants concerning the extent to which a potential source conveys the "intended" meaning. Segments coded as *Being powerful for selection*; *Being non-powerful* and *Conveying a different kind of power* for non-selection are included in this category.

2. Being optimally related to a vacuum cleaner (30.9%): This category includes statements concerning the relationship/match of a potential source with certain properties of a vacuum cleaner. Segments coded as *Related in terms of function, Related in terms of appearance, Related in terms of sound, Related in terms of movement, Related in terms of interaction pattern for selection*; *Unrelated in terms of function, Unrelated in terms of interaction pattern, Unrelated in terms of appearance,* and *Being too related to the target* and *Being irrelevant* for non-selection are included in this category.

3. Being novel, yet understandable (6.5%): This category includes statements concerning the extent of novelty or creativity of a potential source. Segments coded as *Being novel* and *Being familiar* for selection; *Being hackneyed* and *Being common* for non-selection are included in this category.

4. Having application potential (6%): This category includes statements concerning the possibility to project a particular source onto a vacuum cleaner physically. Segments coded as *Being abstract* and *Being concrete* for both selection and non-selection reasons are included in this category.

5. Creating a complete, functional product concept (5%): This category includes statements concerning the contribution of the source to the unity and functionality of the end product. Segments coded as *Affecting major components of a target* and *Contributing to functionality* for selection; and *Affecting non-salient components of target*, *Being used for decoration only*, and *Being kitsch* for non-selection are included in this category.

6. Other (2.4%): This category includes statements concerning other factors that were mentioned to hinder selection of a source. Segments coded as *Being beyond design skills* and *Having negative associations* are included in this category.

The results of the content analysis indicated that more than 75% of the (non) selection reasons mentioned by participants concerned salience and relatedness of a source. The interviews were also helpful to identify other considerations that the participants had when selecting a source, which will be discussed in the next section.

[4] Scott's pi is considered as a highly conservative index for reliability. For the coding of a variable to be reliable, it was required that Scott's pi be .70 or higher (Lombard, Snyder-Duch & Bracken, 2002).

TABLE 03.2. All criteria mentioned for selecting a source

Criteria	Freq.[a]	Part.[b]	Brief characterization	Example segment
Being powerful	56.4%	19	The source is powerful or represents power.	Tornado was the one that represents power mostly among them. (P6)
Related in terms of function	11.55%	19	The correspondence in the main function and/or operation.	[Tornado] sucks everything wherever it goes. So, I considered this one to be the most relevant with the vacuum cleaner. (P27)
Related in terms of appearance	6.22%	8	The correspondence in the form, color, size, material, texture and/or posture.	I was like "Wow, they [tank and vacuum cleaner] look really alike!" It's very straightforward if you want to make really fast solutions. (P33)
Related in terms of sound	3.55%	8	The correspondence in the sound they produced.	Since it [lightning] makes a lot of noise, I was able to build a connection. Vacuum cleaners also make a lot of noise actually. (P22)
Related in terms of movement	3.55%	8	The correspondence in the way their parts move.	The turret moves like the hose of a vacuum cleaner. (P28)
Related in terms of interaction pattern	2.22%	5	The correspondence in the way they are used and/or operated.	The part you hold in vacuum cleaners is the hose, not the whole body. As it is also the same with the whip I selected this one. (P6)
Being novel	4%	8	The source brings in a new design concept that has not been created before.	'Nuclear bomb' can lead me to a very interesting point. I can go beyond the picture and come up with a new solution. (P18)
Being familiar	2.66%	5	The source is familiar, recognizable and understandable.	I prefer something more common to people, to a housewife for instance. She'd prefer to work with a broom instead of some sci-fi engine stuff. (P8)
Affecting major components of a target	1.77%	4	The transfer of the source influences all the key components of the target.	More important parts of the vacuum cleaner are influenced by this metaphor. (P11)
Being abstract	1.77%	3	The source does not have a well-defined visual form.	The king is not a product yet. So, it is interesting to think how can a king be a product. (P15)
Being concrete	0.88%	2	The source has a well-defined visual form.	I selected whip because it is more tangible and a visually defined object. (P5)
Contributing to functionality	0.44%	1	The implementation of the source contributes to the function of the target.	Here the engine has a function.... So, I thought that would work better than just taking a vacuum cleaner and shaping it like a tank. (P2)

[a] The percentage of the responses among all the criteria mentioned by participants ($N = 33$).
[b] The number of participants who mentioned that criterion at least once.

TABLE 03.3. All criteria mentioned for not selecting a source

Criteria	Freq.[a]	Part.[b]	Brief characterization	Example segment
Being non-powerful	24.15%	28	The source is not powerful or does not represent power.	With 'antibiotic' I don't really have the power association. (P3)
Unrelated in terms of function	12.45%	20	The mismatch of the main function and operation.	The fence is more about keeping things out than cleaning things up. (P12)
Unrelated in terms of interaction pattern	2.26%	6	The mismatch of the way they are used or operated.	Because the movement we do actually with whip does not fit with it. (P6)
Unrelated in terms of appearance	1.13%	3	The mismatch of the form, color, size, weight, material, texture and/or posture.	It was not easy to find a way to communicate the shape of tornado in an object like vacuum cleaner. (P26)
Being irrelevant	15.09%	19	The source is considered irrelevant regarding the design brief.	Camera… I don't see a relation. Both with a vacuum cleaner and power. (P17)
Conveying a different kind of power	12.45%	19	The source emphasizes a different dimension of power.	A king is more like a political power. (P24)
Being abstract	6.79%	12	The source does not have a defined visual form.	'Antibiotic' is too abstract. I can't really think of a shape to copy the style into a vacuum. (P20)
Being hackneyed	4.15%	8	The source is blatant and obvious, which anyone can come up with.	The lion is the first thing that came to your mind. That's why I preferred something interesting. (P8)
Being too related to the target	3.77%	10	The source is extremely similar to a vacuum cleaner.	The dust buster already has dust inside. So maybe it's too close. That means there is little for exploration. (P24)
Being kitsch	3.39%	8	The association of the source leads to toy-like or kitsch products.	I thought it was quite funny [tank-shaped vacuum cleaner], but I don't really see it as an actual product. (P2)
Having negative associations	2.64%	7	The source is associated with negative situations.	Poison is a mean thing. (P31)
Being concrete	2.64%	5	The source has a well-defined visual form.	I didn't choose the dust buster because it is already a product. So then you are a bit stuck by the ideas you have about that product and how the product should look like. (P15)
Being used for decoration only	2.64%	3	The implementation of the source is just for styling and decoration.	With the tank it more comes down to styling rather than incorporating in functional way into the design. (P2)
Being very common	2.26%	5	The source is already used commonly in other products.	I didn't want to pick 'tornado' because I mostly associate with Dyson. Most of the vacuum cleaners are concentrated on tornado. (P28)
Being beyond design skills	2.26%	3	The source is difficult to draw and visualize.	So 'engine' was a really good one for a metaphor, but my drawing skills are…. It became a mess. (P20)
Affecting non-salient components of target	1.88%	5	The transfer of the source affects only unimportant components of the target.	They are focusing on small function that I could apply in the final product. I need something giving me general concept. (P10)

[a] The percentage of the responses among all the criteria mentioned by participants ($N = 33$).
[b] The number of participants who mentioned that criterion at least once.

Discussion

The results indicated that sources that have the intended meaning as a salient property are likely to be selected over ones that do not, and sources that are highly related to a target are preferred over moderately and little related alternatives. The interaction between salience and relatedness suggests that these main effects of both variables only operate when the value of the other variable is high. This effect, albeit significant, must however be treated with caution since there were, as predicted, only a few sources selected from the middle and lower ranges of each variable.

The interviews conducted after the design phase provided converging evidence to support our main hypotheses. Corresponding with the first hypothesis, all of the participants asserted that they had selected a source because it referred to something really powerful (see Table 03.2), or used similar reasoning to explain why they had eliminated a particular source (see Table 03.3). Being powerful, however, was not the only concern. Participants also took into consideration whether a potential source expressed power in the intended way (see *Conveying a different kind of power* in Table 03.3). For instance, while many participants appreciated the power a crown confers upon its owner, they also explained they would not select the crown because the power of a vacuum cleaner was physical and related to suction, whereas a crown refers to political and social power. Therefore, in order to provide effective communication, a source's ability to accurately convey a particular meaning drives its selection. As demonstrated during content analysis, almost half of all criteria mentioned as the reason for selection or non-selection concerned whether the source had the intended kind of power as a salient property or not (46.5%), which makes it a highly significant factor.

The results of the content analysis were also in line with our second hypothesis. The second most often mentioned criteria in relation to the (non-) selection of a source involved its relatedness with a vacuum cleaner (30.9%). Many participants argued that they employed a particular source in their designs because they were somehow able to see a relation between the two. Similarly, the lack of any relationship led to the elimination of some sources. This is in line with the results of the statistical analysis, whose results indicated that sources with a low relatedness level were not preferred during metaphor generation. However, some participants also mentioned that they did not choose a particular source because it was "too related" (see *Being too related to the target* in Table 03.3). While this remark should not be seen as contradicting the main finding of the study, it will be useful to examine the difference between being highly related and overly related. The sources that were most preferred by participants were tornado, engine, and elephant, all of which share properties with a vacuum cleaner, but also have some clear dissimilarities. As briefly mentioned in the introduction, when two entities are members of a similar domain, resemble one another physically, or function in a very similar fashion, the metaphor they produce starts to lose its interestingness and metaphoricity. During the interviews, a comment was made that reflected the overly close relationship between a dust buster and leaf blower and a vacuum cleaner. If one takes into account the practical function and mechanical operation of these two products, both could

be considered members of the same product category; for this reason (and besides their inadequately conveying power), the metaphors generated by blending each with a vacuum cleaner were not considered to be appropriate. On the other hand, sources with equally similar traits to a vacuum cleaner but belonging to a different domain (e.g., tornado–natural events, elephant–animals) were very popular. Thus, we reiterate that those sources that are highly related to the target product, yet belong to another domain are favoured in metaphor generation.

The analysis of the interviews also made a valuable contribution to our research by clarifying what relatedness entails in relation to product metaphors. The statistical results indicated what degree of relatedness should exist between target and source, but the interviews allowed us to distinguish the kinds of relatedness that may exist between the two. Upon analysis of interview transcriptions, we were able to identify five types of relatedness: appearance, sound, function, movement, and interaction pattern (see Table 03.2 and Table 03.3). When participants recognised a similarity between target and source in any of these respects, they concluded that (should they select that particular source) the property could be transferred with ease. To elaborate on this, we want to present three sketches that include a reference to a tank in Figure 03.6. There are some components shared by a stereotypical tank and a stereotypical vacuum cleaner, e.g., both use wheels to move. In all three designs, participants used the appearance of the wheel of a tank (i.e., caterpillar tracks) to shape the wheel of the vacuum cleaner. Similarly, the correspondence between the form and movement of a tank turret and the hose of a vacuum cleaner was used in the last example.

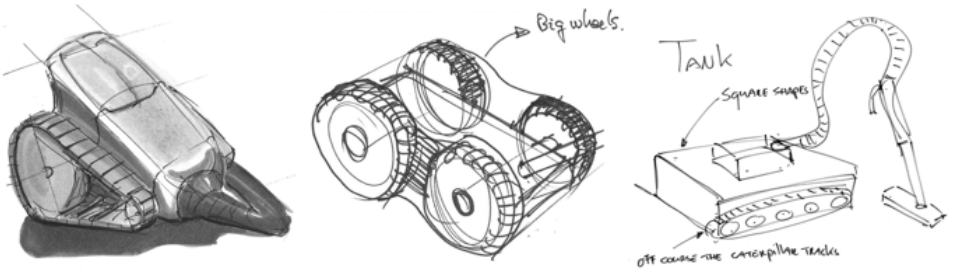


FIGURE 03.6. Extracts taken from sketches made by three participants who used tank as a source.

Mappability

These results indicate that a designer considers the subsequent mapping phase when selecting a source. After finding a source that has the intended meaning as a salient property, they carefully consider if its properties can be matched to those of the target, which properties to transfer from it, and what kind of a mapping strategy to follow. Here, the "mappability" of the source—the potential of a source's properties to be transferred to a target—plays an important role. Mappability explains why the relatedness of target and source domains affects source selection in product meta-

phors: When a target and a source carry corresponding properties, the source becomes more "mappable" as it is relatively easy to transfer its relevant properties to the target. Eventually the source becomes preferable over other possible sources, which do not possess this relationship with the target. Highly target-related sources, especially if this relatedness is in terms of visual qualities, also have a high mappability. As mappability pertains to the application potential of a source, it includes not only target–source relatedness, but also the level of a source's abstractness. Some participants' remarks also referred to this potential (6%). The positions taken here were rather conflicting: Some participants preferred to use a concrete source with a well-defined form that gives them clear directions on where to start and how to do the mapping (see *Being concrete* in Table 03.2). They considered this kind of source to have a greater application potential. Other participants, however, preferred abstract sources without any defined form, which would not constrain their exploration and imagination and force them to employ the source as it is (see *Being abstract* in Table 03.2). The only thing they agreed on was that neither too much abstractedness nor too much concreteness was desired. When the source is too abstract, it becomes difficult to come up with an image supporting a source's application on the target by projection (see *Being abstract* in Table 03.3); when it is too concrete, it limits the exploration of different properties might be applied to the target (see *Being concrete* in Table 03.3).

Novel concepts

Another point we want to elaborate on is the potential of metaphors to produce new concepts/products. As mentioned in the introduction, metaphors encourage us to see things in a new light and bring novel perspectives to the topic at hand. Similarly, in our study we observed that participants "invented" various vacuum cleaners through associating them with different things. In one case, a participant created a new vacuuming concept in which the vacuum cleaner makes the dust magnetic first and then attracts the dust without any effort. In another case, a participant got inspiration from the majestic attitude of kings and royalty and designed a vacuum cleaner whose form does not require users to bend over while cleaning. The creative power of metaphor usage is apparent in these cases. Correspondingly, the analysis of the interviews also indicated that the designers took into account the originality of the metaphors they would produce when selecting and not selecting sources (6.5%). They aimed for novel product concepts and tried to avoid common and hackneyed associations between the source and target. However, they also considered whether an association they made would be recognized and understood by users. That is why *Being novel* and *Being familiar* are both mentioned as source selection reasons (see Table 03.2). Establishing a balance between source novelty and comprehensibility is one of the major factors that play a role in metaphoric quality (Cila, Borsboom & Hekkert, in press), which the participants also considered as a source selection criterion.

A small number of participants (5%) also considered whether a source leads to a complete design concept that helps them to shape the whole product accordingly instead of addressing only a small part of the design problem (see *Affecting major components of a target* in Table 03.2, and *Affecting non-salient components of target* in

Table 03.3), and makes a contribution to the functionality of the product, or instead it is a mere styling issue (see *Contributing to functionality* in Table 03.2, and *Being used for decoration only* in Table 03.3). Lastly, whether a source has negative connotations, or the implementation of its association with the target is beyond designers' skills was also considered (2.4%).

Limitations

With respect to these considerations, we want to say a few words regarding the limitations of the study. The first one is the omission of other factors that affect source selection. Although salience and relatedness make up the major portion of these factors, the interviews pointed out that there were other factors taken into account by some participants. We were able to identify four extra categories from interview content analysis and consequently attempted to include their role in source selection during our discussion of the findings. However, none of these considerations were systematically included in the experimental set-up. They surely affect source selection to some extent and should be investigated in future studies.

Our second remark concerns the methodology. Making the participants select from a set of items allowed us to have experimental control over the salience and relatedness factors while, at the same time, permitting a wide range of selection options. In a free-generation process, one cannot guarantee that designers would consider unrelated or non-salient sources. By structuring sets including sources that have different degrees of salience and relatedness, we were certain that the designers would consider sources of varying levels of salience and relatedness. We are aware that designers are normally not provided with such external lists. Although there is a theoretical possibility that the selection of items in the sets might have affected the results of the study, the chances for this are considered limited.

Lastly, we want to remark on the duration we gave to participants to select the most apt source from three candidates. In the limited time frame offered (10 min), participants might have preferred to incorporate sources that are more intuitively applicable than sources that need a complex transformation to be integrated into a vacuum cleaner. We aimed to limit this possible effect by giving the participants freedom and flexibility in the expected level of detail in their final designs. They did not have to worry about production constraints or feasibility and practicality of the metaphorical products they generated. We consider that with this approach they could just have focused on evaluating the application "potential" of a source. There may certainly be a difference between envisioning the applicability of a source and actually producing it, but we believe that designers' gut feeling is a major cause of source selection, and they would most often find a creative way to implement their ideas into the product. How the actual (i.e., with a real design brief from a real client) application of a source would affect the selection of a source and metaphoric quality is an issue that needs to be addressed in further studies.

Conclusion

Currently, there is little empirical knowledge regarding the metaphor generation process in the design domain. The study reported in this paper focused on the source selection phase of this process and explored the effect of different levels of salience and relatedness on this particular activity. It was found that a source is selected when it has the intended meaning as a highly salient property and it is at the same time highly related to the target product. Furthermore, the study revealed three extra criteria for source selection—being novel yet understandable, having application potential, and creating a complete, functional product concept—and indicated five types of relatedness between a target and a source of a product metaphor—function, appearance, sound, movement, and interaction pattern. The aim of a designer is to create comprehensible and aesthetically pleasant metaphors. Selection of a suitable source, which conveys a certain meaning effectively and can be meaningfully associated with the target, helps to realize these goals. Our study is one of the first attempts to systematically include metaphor generation as a research subject in the product design domain, within which we intend to lay a foundation for future study to obtain an overall understanding on metaphor generation.

We can state that metaphor generation requires a considerable amount of decision-making. Designers have to decide on the meaning they wish to convey, the source that can convey this meaning, which attributes of this source they will project onto target and how they will execute the mapping. Understanding this process can help designers to make appropriate, creative decisions regarding these aspects, and create comprehensible and aesthetic metaphors that provide rich user experiences.

/04

CREATING AN ASSOCIATION: METAPHORICAL MEANING

In the previous chapter, the criteria for a designer to select a source to associate with a target were investigated. In this chapter, we will continue focusing on the metaphorical association and turn our attention to the meaning that a designer intends to convey through a target–source association. We will investigate both the effect of the expertise level of the designer (i.e., novice or expert) and different types of intention (i.e., pragmatic or experiential) on the depth of the meaning that is conveyed.

This chapter has been submitted as:

Cila, N., Hekkert, P. & Visch, V. (submitted). “Digging for meaning”: The effect of a designer’s expertise and intention on depth of product metaphors. Manuscript submitted to Metaphor & Symbol (under second revision).

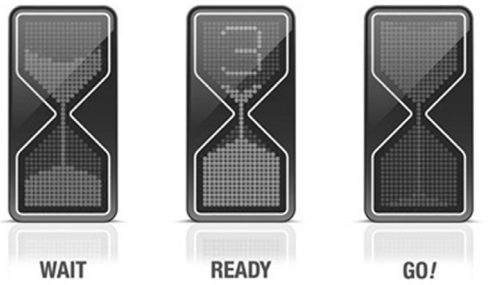


FIGURE 04.1. "Sand Glass" traffic light, designed by Thanva Tivawong.

The Sand Glass is a future concept design for traffic lights (see Figure 04.1). Here, the designer employs a *product metaphor* by referring to an hourglass (*source*) to develop the idea behind a new traffic light (*target*). In the design concept, LED light pixels fall down the waist of the lamp as if they are actual sand grains. In this way, the digital sand left in the top part of the hourglass indicates the amount of time left before the light turns green or red. Through this metaphor, this traffic light becomes a more informative signal than a standard set of traffic lights, as it gives visible feedback to drivers on how much longer they have to wait at a junction. Moreover, watching the sand running out is a fun and intuitive way of keeping time. For these reasons, the hourglass metaphor provides drivers with an entertaining yet functional experience with the product.

By creating this product, the designer's *intention* is to make the time spent waiting in traffic less of a burden for drivers. He attains this goal by revealing one of a traffic light's hidden qualities: the internal time counter, which is mostly invisible to drivers and pedestrians. A traffic light is generally considered to be a product with a binary mode, i.e., stop or go. Although our interaction with it is limited in this regard, waiting for the counter to change is nevertheless an important part of our interaction with this product. In the Sand Glass example, the designer focuses on this non-salient quality of traffic lights and transforms the traffic light into a product that also measures and displays the passage of time (the *meaning* expressed). This property is intrinsic to an hourglass but is new and informative for traffic lights, which makes us perceive traffic lights in a novel way.

When a metaphor highlights such non-salient qualities of a target (e.g., time keeping) as in the Sand Glass, we term it as a "deep metaphor": Designer makes

a break with the expected functions and meanings of a target and instead chooses a hidden dimension to focus on through the metaphor. Conversely, a "surface metaphor" highlights salient qualities of a target. Its salient qualities are a target's defining qualities, ones that come to mind on all occasions, such as "controlling traffic" being a highly salient quality in a traffic light. Thus, a possible product metaphor that consists of a traffic light (target) shaped like a traffic police officer (source) emphasizes this function of the traffic light; the metaphor pertains to an aspect that is clearly obvious and commonly known about traffic lights.

The *depth of a metaphor* can range from surface to deep. The use of these terms is itself metaphorical: Their application is defined by the extent to which the quality highlighted by the metaphor is salient for the target. This definition is essentially in line with the term "aptness" used in relation to linguistic metaphors for addressing the extent to which the source's meaning expresses an important quality of the target (Jones & Estes, 2006; Pierce & Chiappe, 2009). We maintain that both surface and deep metaphors can be highly apt, as a particular source is associated with a target on the basis of the target quality to emphasize (Glucksberg & Haught, 2006; Glucksberg & McGlone, 1999) and this quality can be salient or non-salient for that target. Their difference, however, comes from the "ease" with which a designer finds a quality to highlight. In general, highly salient and visible features of things are accessed more easily than non-salient ones (Barsalou, 1982; Christensen & Schunn, 2007; Holyoak & Koh, 1987). These typically eclipse certain deeper, more concealed qualities, which require more cognitive effort to notice. Thus, a designer needs to "dig deeper" under the target's surface qualities in order to uncover an interesting dimension to highlight. This situation implies that the creation of deep metaphors is a more sophisticated way of building associations. Barsalou (1982) maintains that the best metaphors are those in which the shared property between target and source is hidden in the target, but salient in the source. This means that metaphors that focus on a less obvious quality of the target are better than ones that highlight an obvious quality that can be readily ascertained.

The assessment of depth is thus directly connected to the quality of a metaphor; it influences people's appreciation of product metaphors. By using a large set of product metaphors to investigate people's aesthetic preference, Cila, Borsboom and Hekkert (in press) demonstrated that the aesthetic quality of a metaphor is greatly affected by the novelty of a target–source association, which is based on bringing a surprising, hidden dimension of the target to light by associating it with a source that does not have an obvious relationship to the target. This is precisely what deep metaphors accomplish. However, this does not imply that surface metaphors are of no value. We believe particular design contexts may require different metaphor design strategies. Depending on their abilities and the design brief they are commissioned for, designers may wittingly revolve around a particular level of metaphor depth. In this paper, we investigate how different types of intentions designers may have influences the depth of the metaphors they generate, and whether their level of expertise plays a part in this aspect of metaphor generation.

Understanding the notion of metaphor depth can inspire designers and provide them with insight into generating more sophisticated, clever, and interesting meta-

phors. The scope of this paper is restricted to product metaphors; however, the theoretical knowledge provided can be applied to metaphors found in any other type of communication. Before presenting the methodology and results of the present research, we will first elaborate on how metaphor depth plays a role in the communication between a designer and a user (the addressee of the product metaphor), and how a metaphor is related to the expertise level of the designer and his/her design intentions. In the last part of the paper, we will discuss the results of this study in light of various metaphor theories and product design practice.

Metaphor Depth

Product metaphors are a means of communication between designers and users, and are employed by designers to convey particular meanings and elicit cognitive or emotive effects in users (Cupchik, 2003; Forceville et al., 2006; Krippendorff & Butter, 2008; Van Rompay, 2008). A designer typically has particular intention(s) concerning the kind of experience to provide to users through the product. This is the end result that a designer aims for (e.g., making the user smile, improving the usability of the product, evoking interest), and these aims will be further explained in the coming section. Intention is used here in a restricted sense, to refer to the designers' "deliberate" actions to elicit a specific response from people. Steen (2008a, 2008b) draws an explicit distinction between intentionality and deliberateness: All communication is intentional in some sense (Gibbs, 1999), whereas deliberateness in Steen's terms is a conscious discourse strategy that aims to change the addressee's perspective on the target by making the addressee look at it in the light of a different conceptual domain. Within the scope of this paper, we address such deliberate product metaphors, which designers purposely ascribe a functional or symbolic meaning to a product by associating it with a distinct source, as in the Sand Glass example[5].

Guided by their expressive intentions, designers look for a source to associate with the target for bringing out the target's intended qualities, and "physically" project the specific details or overall impression of this source onto the product. This act of property projection gives a deliberate sign to users to construe a metaphor. The term user is used throughout this paper not only to refer to those involved in purchase decisions of a product, but also to include those involved in any kind of instrumental or non-instrumental interaction with it (e.g., seeing, operating, playing with). Just as a designer follows a metaphoric process to create a product, the user also follows a metaphoric process to interpret it. Users are not passive receivers of metaphors; they

[5] The non-deliberate use of metaphors is also possible in the design domain. Especially when generating "embodied" product metaphors—the metaphorical associations that are based on people's innate or sensorimotor knowledge of the world (Forceville et al., 2006)—designers may often not be aware that they are actually employing a metaphor in a particular product, as they do not purposely try to reference a distinct concrete entity. The examples can be making a water jug higher intuitively for it to be perceived as more dominant or making it more 'closed' to be perceived as safe and trustworthy, because we all have innate image schemas to associate height with dominance and containment with safety (Van Rompay et al., 2005).

"experience" the metaphor by constructing their own interpretations of the product through combining the product features with their personal standards, expectations, and previous experience (Cupchik, 2003).

Understanding metaphors is certainly not just differentiating target and source, but inferring the ground that relates them (Gibbs et al., 1991). To infer this meaning, users "read" the target–source combinations by looking for the relevant qualities of a source that are attributable to the target (Chiappe & Chiappe, 2007; Glucksberg & McGlone, 1999). The target plays a role in this process by constraining the kind of qualities that can be meaningfully assigned to it (Glucksberg & Haught, 2006; Glucksberg et al., 1997; Pierce & Chiappe, 2009). The chosen quality is always more salient for the source than it is for the target because the new information communicated about the target is contained in the source as a subset of the source's attributes (Ortony et al., 1985).

In surface metaphors, the quality that is transferred from source to target is salient for both (albeit to a lesser degree for the target than it is for the source), whereas in deep metaphors it is salient for the source and non-salient for the target. To clarify this, let us compare the Sand Glass with the traffic police officer-shaped traffic light metaphor example given before. In the latter, a highly salient quality of a policeman's role—controlling traffic—is transferred to the traffic control function of a traffic light, which is also a salient quality. Therefore, when users encounter the traffic light–traffic police association, it is easy for them to see the relationship between the target and the source, and correspondingly, to instantly understand the quality of the target that is emphasized through their association. On the other hand, noticing the relationship between a traffic light and an hourglass is relatively more difficult for a user. Although a salient quality of the hourglass has been mapped in this deep metaphor (i.e., displaying duration), this is a non-salient quality for a traffic light. For this reason, the user needs to ponder the reasons why these entities have been brought together. As an extraction of principles, elaborate exploration, and abstraction are to some extent necessary, it is cognitively more demanding for the recipient to explore the terrain of the metaphor, and understand the quality of the traffic light that is emphasized in the metaphor.

In brief, the relationship of target to source is obvious in surface metaphors, whereas it is deeply rooted and less evident in deep metaphors. This situation enables the user to easily travel the distance between the target and the source of a surface metaphor. It is for this reason that we have operationalized metaphorical depth in this study in terms of users' ease in seeing the relationship between the target and source, i.e., "salient similarity" in Vosniadou's terms (1989, p. 419).

Factors Affecting the Metaphor Depth

A source is selected on the basis of the quality of the target to be emphasized. This selection is considered to be "the least understood" decision among all the decisions that are made during a metaphor generation process (Holyoak & Koh, 1987, p.

332). In a previous study, we investigated the properties of a source that are necessary to be employed in a metaphor (Cila, Hekkert & Visch, in press-a), yet we did not focus on the designer and design brief related factors that might have affected this process. Designers may have different functional and non-functional intentions related to the design task at hand, and these intentions may necessitate focusing on

Expertise of the designer

Expertise is defined as skills, knowledge, and abilities in activities, tasks, and jobs (Farrington-Darby &Wilson, 2006). The major difference between an expert and a novice is that experts tend to be more knowledgeable about their domain and have experience using this knowledge effectively (Kolodner, 1983). Novices may also have considerable knowledge, but typically lack the field experience that experts enjoy. The study of expertise has become an area of interest to scholars from various disciplines, including physics, chess, music, sports, architecture, medicine, and so forth, where the scholars investigate the development and functioning of expertise (see Feltovich, Prietula & Ericsson, 2006, for a review). Regardless of the discipline, a common observation that emerges from these studies is that the behavior of experts and novices differs when faced with the same problem. One of the main skills of an expert is "the ability mentally to stand back from the specifics of the accumulated examples, and form more abstract conceptualizations pertinent to their domain of expertise" (Cross, 2004, p. 432). Their representations of a problem include the problem's abstract and solution-relevant features, in addition to the problem's visible features (Novick, 1988). Novices, on the other hand, tend to focus mostly on these visible features. For novices, the invisible, dynamic and interdependent features of things and events are difficult to understand (Hmelo-Silver, Marathe & Liu, 2007). Therefore, the development of expertise is related to the acquisition of skills needed to abstract the essence of things and see the hidden qualities that are concealed beneath those on the surface.

The same expert behavior also applies to the design domain. Expert designers are able to see the underlying patterns of the problem at hand more readily than novices, and are able to make a connection with a possible solution that might be from an entirely different context (Casakin & Goldschmidt, 2000; Hey et al., 2008). With regard to product metaphors, this would imply that experts are better at analyzing the different features of a target and recognizing its non-salient qualities, since they are able to make abstractions regarding its use, function, or physical features. In this way, they can unearth less accessible sources whose relationship with the target is not obvious. On the other hand, the abilities of novices are limited to seeing easily recognizable features and dimensions. Therefore, the first hypothesis we will investigate is:

H 1: Experienced designers will tend to emphasize non-salient qualities of the target when selecting a source to generate metaphors, while novice designers will focus on salient qualities and select sources accordingly.

Crilly and his colleagues identified eight different types of intention that a designer may want to realize through a product: draw attention to the product, encourage recognition of the product type, support comprehension of a function, generate attraction or desire, foster attribution of qualities, promote personal identification, stimulate emotion, and/or provoke action (Crilly, Moultrie & Clarkson, 2008). Of this classification, the first three intentions are instrumental, concerning the function, identification, and use of the products. The remaining intentions have to do with influencing the non-instrumental experiences that a user may have with the product. In line with this, Hassenzahl (2003) defines two main types of attributes that designers should consider when creating products: Pragmatic attributes refer to the practical aspects of the product that support efficiency and effectiveness in usage (e.g., being useful, controllable, and supportive), whereas hedonic attributes are the aspects that affect psychological well-being of the users by providing stimulation, identification, and evocation.

A similar distinction can also be made concerning the use of metaphors in the product design domain. First of all, if the quality that a designer intends to emphasize through metaphor use is related to the so-called pragmatic attributes of the product, we call this use of metaphors (to fulfill instrumental and functional goals) a designer's *pragmatic intention*. This can involve subtle or explicit cues that identify the product category, or direct how users approach and interact with the product, or may entail design attributes that make the product function more smoothly and easily. Proceeding with traffic lights, an example of this type of an intention can be seen in Figure 04.2. This futuristic traffic light metaphor employs a wall as a source. When the light turns red, laser beams projected between two stakes mounted on either side of the road create a large, red, virtual wall. In this design concept, the designer aims to promote pedestrian safety by assuming that the presence of a wall will psychologically force drivers to stop or slow down. It is a pragmatic and entirely new way of approaching the traffic light concept: The designer has converted the standard pole shape into a large display with an intention of improving the effectiveness of a traffic light by providing users with a strong intuitive cue to stop at the junction.

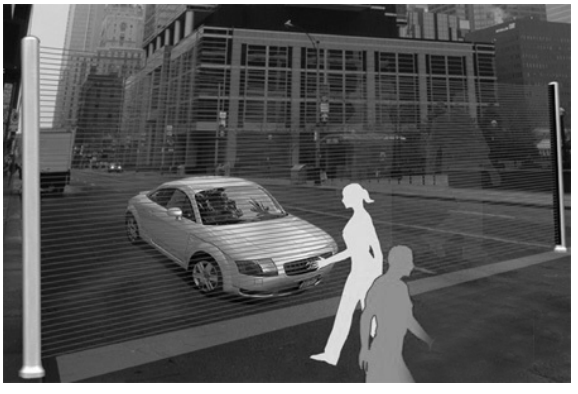


FIGURE 04.2. "Wall" traffic light, designed by Hanyoung Lee.

Secondly, a designer may wish to provide aesthetic, semantic, social, sensorial, or emotional experiences to the user, each of which we call an *experiential intention*. For instance, stimulating the senses, conveying an ethical, environmental, or political message, attributing an abstract character to the product, and evoking surprise, interest, amusement, or excitement in the user belong to this category. An example is the traffic light seen in Figure 04.3, which refers to the famous Möbius Strip. The twist of the strip is used to separate the vehicle signal from a pedestrian signal and a lamp used for street lighting. In contrast to the previous example, this metaphor does not make any major contribution to the function of a traffic light; here the intervention of the designer is more on the surface, aiming to create a neat, stylish shape that is beautiful to look at. The Möbius metaphor imparts a sleek character to the traffic light that minimizes roadside visual disarray caused by numerous different signals and lights, and provides a rich aesthetic experiential metaphor resulting here in pleasant emotional consequences.

FIGURE 04.3. "Möbius" traffic light, designed by Kisung Lee.

It should be noted that having a pragmatic intention does not necessarily mean that a designer does not pay attention to the experiential aspects of the product, and vice versa. When creating a new concept for the improvement of the product's effectiveness in the Wall traffic light for example, the designer most likely envisaged the potential experience that users will have with the product, or in the Möbius, the designer probably considered whether the new form he created would work efficiently or not. Findeli (1994) proposed an axis for product categorization stretching between a "purely utilitarian" (e.g., machines, weapons, specialized instruments used in surgery or measuring) and a "purely symbolic" pole (e.g., cult objects, religious objects, souvenirs), but he still indicated the practical difficulty in isolating a purely instrumental or symbolic object. Designers certainly act, deliberately or non-deliberately, for multiple reasons, but one can still recognize the differences of intention in designing a fiber optic endoscope and a censer. There are certain requirements of these products that motivate the intentions that are held, and constrain the forms that can be realized (Crilly, Moultrie & Clarkson, 2008). In considering such issues, certain intentions will predominate others; designers are generally required to prioritize their intentions.

If a designer primarily has the pragmatic intention to clarify how a product should be used or what its function is, then the target metaphor should be clear, systematic, and easily comprehensible to the user. Thus, we expect designers with pragmatic intentions to focus on a target's salient and obvious qualities, select a source accordingly, and communicate their intention through a clear and easily accessible design. Experiential intentions, on the other hand, allow for richer, more complex, and original metaphors. Highlighting a non-salient quality, one that the user must dig around in his or her mind to uncover, demands surprising, clever, and more

interest-garnering choices of metaphor. Therefore, the second hypothesis we will investigate is:

H 2: Pragmatic intentions will promote emphasis of a target's salient qualities, whereas experiential intentions will promote the exposure/illustration of non-salient ones.

The Study

To investigate the effect of expertise level and intention type on metaphor depth, we followed a two-stage process. First, we asked expert and novice designers to generate product metaphors under different experimental conditions, and then we asked external judges to assess the depth of the metaphors for the ease with which they were able to perceive the relationships between the targets and sources associated by the designers. Below, the study methodology and procedure will be presented in detail.

Method

Generation of the product metaphors

Participants

In the present research, 24 expert designers (20 male and 4 female) and 25 novice designers (12 male and 13 female) took part. The designers in the expert group either had their own design studios, or had worked in the design department of a firm in the Netherlands, averaging 6.5 years of working experience in the field, and ranging from 2.5 to 16 years of experience in total. The novice designers were 2nd year Bachelor students from the Industrial Design Department at Delft University of Technology, each of whom had taken two design courses during the first year of their education, and thus have a general knowledge about form giving, the design process, and production methods. All participants were compensated for their participation.

Procedure

Each participant (N = 49) received an initial introduction to product metaphors and a detailed explanation about their pragmatic and experiential uses in the design field, together with some examples. They were then given several sheets of A3 paper, a pen, and four design tasks, one at a time. As this study focuses on the qualities of a target that might be emphasized during metaphor generation, a target product for the participants to work with was required. In order to minimize the possible effect of product type on the experimental task, we selected four very different products: an MP3 player, a chair, a set of nail clippers, and a self-cleaning trash bin. These products present varying levels of "relevant attributional dimensions" (Glucksberg et al., 1997, p. 58)[6], meaning that the number of meaning attributions that are relevant differs from product to product. For example, a set of nail clippers would be considered a high-constraint target, as it has a stereotypical image and a single function that everyone

is familiar with; while a chair is a low-constraint target, as it can take any shape and allows for the attribution of different meanings depending on context of use, user group, current fashion, and so forth. These products also have diverse qualities in various respects such as familiarity (everyday–novel), mode (digital–analogue), size (big–small), reason for use (practical–decorative), and functioning (inner mechanism–no mechanism).

Two separate time limits were used in the study: short and long[7]. The shorter time limit gave participants 8 minutes to find an idea and employ the metaphor, whereas the longer limit allowed them 40 minutes to explore various possible sources to associate with the targets. Each participant from both groups generated a metaphor for all the targets through four specifically assigned design tasks that systematically varied the combination of task duration, product type and intention type, and systematically varied the order in which the tasks were presented. In this way, no participant within each group was given the same brief in the same order. The structure used in the design briefs was as follows: "Design a _____ by using a metaphor with a pragmatic/experiential intention. You have 8 minutes/40 minutes for this task." The design session always followed the sequence of long task (40 min)–short task (8 min)–long task (40 min)–short task (8 min), and a break was given after the second task. The whole study took around 2 hours 15 minutes. Upon completing the session, participants were asked to explain their designs and explicitly point out the sources they associated with the target products together with their reasoning. Their explanations were audio-recorded with permission of all participants. Participants were debriefed and compensated for their participation after the study was completed.

Assessment of the Metaphor Depth

The sources used by the designers were put in an online questionnaire, and 142 judges, blind to the aims of the study and the experimental conditions of its participants, individually evaluated the depth of the metaphors created by the designers. We considered that not only could the target products themselves come in various shapes that we did not wish to dictate, the subject treatment, sketching quality or detailing of participants' designs might also have an effect on the judges' ratings. To ensure that the targets and sources were evaluated as "concepts", and to limit any

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[6] Glucksberg and his colleagues maintain that the number of relevant attributional dimensions may vary from target to target in relation to verbal metaphors, and these dimensions influence the sources associated with targets and the interpretation of the metaphor recipients (Glucksberg et al., 1997).

[7] Silvia and Beaty (2012) conducted an experiment in which they asked undergraduate psychology students to generate metaphors and found that the students who generated metaphors in brief response times used a memory-based retrieval strategy, meaning that they searched memory for an apt metaphor and then used it. This strategy yielded common idioms and clichés. However, the students who took their time when responding produced impromptu answers that were more original. On the basis of this study, we intended to investigate whether there is an unintended effect on seeing either salient or non-salient qualities of a target.

evaluations of an image drawn by the participants or ones the judges may make in their minds from a visual stimulus, the questionnaire deliberately presented judges with target and source ideas as pairs of words (e.g., *nail clipper–scissors*, *chair–cloud*). We also considered that if the two distinct entities of target and source were successfully combined in a product, literally "seeing" their relationship could affect rating responses more than "imagining" it. For these reasons, we made a transition from products to word pairs, and based the ratings on the conceptual distance between target and source. For each product type, these pairs appeared in random order and the judges were asked to rate "*how easy it is to see the relationship between the items*" on a 9-point-scale (1: extremely difficult, 10: extremely easy). The presentation order of product types was also randomized.

As a subtle way of verifying that the judges took the survey seriously, we added four filter questions after the rating section for each product. The question structure was: "Name something you think is related to a _____ that is not on the list above." In this way, we expected judges to spend time identifying and evaluating different dimensions of the target products and their relevant features. Completing the questionnaire took around 25-30 minutes and the judges also received compensation for their contribution.

Results

The responses of 24 judges were eliminated because they were either incomplete, answers to the filter questions were missing or the same rating was given for every question. For the remaining scores (N = 118), inter-rater reliability was assessed by calculating Cronbach's α. A high degree of agreement was obtained between the judges in terms of the level of metaphor depth (α > .80). The ratings of the judges were averaged to form an overall depth score for each generated metaphor. The sources employed by the designers for each product type, and the scores given by the judges can be seen in Table 04.1.

Before investigating the effect of designer expertise and intention on metaphor depth, we first checked whether product type and task duration had an (unintended) effect on the findings. A paired samples t-test was performed on the metaphor depth scores with "Short task duration" and "Long task duration" conditions. The results indicated that giving the participants either a short time (M = 4.86, SE = .20) or a long time to complete the task (M = 5.00, SE = .22) did not influence the depth of the metaphors generated ($t(48)$ = .53, p > .05). In addition, a one-way repeated measures ANOVA was employed with "product type" as the independent variable. Results showed no significant effect of the products we used in the study on the scores given by the judges ($F(1, 34)$ = 2.03, p > .05).

A mixed ANOVA was performed with metaphor depth as dependent variable, intention type (Pragmatic vs. Experiential) as independent within-subjects variable, and designer expertise (Expert vs. Novice) as independent between-subjects variable. There was a significant main effect of both intention, $F(1, 47)$ = 31.10, p < .001, η^2 = .39, and expertise, $F(1, 47)$ = 24.21, p < .001, η^2 = .34, and there was no interaction effect between these variables, $F(1, 47)$ = .98, p > .05. These results demonstrate

TABLE 04.1. The sources employed by the participants and their mean depth scores

Expertise level	Intention type	Nail clipper	*M*	MP3 player	*M*	Chair	*M*	Self-cleaning trash bin	*M*
Novice	Pragmatic	Nails (2)	7.33	**Cassette player**	7.25	**Sitting body (4)***	8.04	**Garbage bag**	7.14
		Biting nails*	7.31	Walkman	7.25			Paper recycle bin	7.06
		Scissors (3)*	7.23	**Ear***	7.10	Car seat	7.84	Trash tube	7.02
		Finger*	6.64	CD (2)	7.00	Cushion	7.00	Recycle sign	6.19
		Nail polish	6.42	**Cassette**	6.63	Trace of buttocks	6.03	**Toilet flush (2)***	6.19
		Teeth (3)*	5.06	Turn table	6.60			Broom	6.00
		Clothes pin	4.50	**Music note (2)***	5.97	Clothing	3.12	Drain	5.36
		Fingerprint	4.01	Music sheet (2)	5.93	Arrow*	2.62	**Wiping hand**	5.34
		Beaver	3.18	Battery	5.76	Cave	2.34	Droid	3.86
				Guitar amplifier	5.68	Stop sign	2.31		
				Clef	5.51				
	Experiential	Guillotine*	6.15	Headphones*	7.57	**Sitting body (2)***	8.04	**Garbage bag**	7.14
		Pencil shar.*	5.26	LP player*	7.53			Cleaner	6.67
		Teeth (2)*	5.06	**Cassette player**	7.25	Bottom	6.69	Maid	6.54
		Crocodile (2)	4.10	**Ear (2)***	7.10	Hammock	6.16	**Toilet flush***	6.19
		Shark	3.82	**Cassette**	6.63	Vertebrae	5.22	Trash car	6.10
		Door*	2.34	**Music note (3)***	5.97	Dinnerware	4.51	**Wiping hand (2)**	5.34
		Caterpillar	2.07	Disco ball	5.04	Mushroom	3.46	Soap bar*	5.00
		Ladybug	2.03	Samba balls	3.66	Cloud (2)*	2.86	Space pod	2.91
				Frog	1.76	OK gesture	2.66	Elephant	2.73
								Rug	2.73
								Canon	2.09
								Red cross	2.06
	Total		*M* 5.15		*M* 6.15		*M* 5.44		*M* 5.26
			SD 1.72		*SD* 1.27		*SD* 2.33		*SD* 1.68
Expert	Pragmatic	Scissors*	7.23	iPod Nano	8.45	Sitting body (2)*	8.04	**Toilet flush***	6.19
		Finger*	6.64	Headphones*	7.57			Hygienic smell	5.98
		Paper cutter	6.39	LP player*	7.53	Log	5.33	Clean. wipes (2)	5.82
		Guillotine*	6.15	Car radio	7.12	Supporting hands	5.00	Soap bar*	5.00
		Pincers (2)	5.90	Ear*	7.10			Paper bag	4.99
		Stapler	5.49	Microphone	6.09	Pants	4.18	Kitchen roll	4.75
		Pencil shar.*	5.26	Music note*	5.97	Bird nest	3.93	Windshield wipers	4.50
		Cutlery	3.97	CD rack (2)	5.90	Birthday decoration	3.39		
		Animal	2.94	Storage box	5.29			Dyson fan	3.51
		Door*	2.34	Navigating in car	4.01	Wheel	3.34	Tongue	3.43
		Washing machine	1.95	**Necklace**	3.92	Being in dark	2.18	Twisting screw	2.40
				Clam	2.63				
	Experiential	Biting nails*	7.31	**Necklace**	3.92	Toilet roll	3.46	Vacuumer	6.43
		Heart	1.79	Sea shell	3.38	Tensegrity cons.	3.06	**Toilet flush (2)***	6.19
		Monster toy	2.57	Rubik's cube (2)	3.08			Bleach bottle	5.08
		Perfume bottle (2)	2.55	Roulette	2.62	Nail bed	2.95	Shower	4.50
				Cap	2.39	Cloud (3)*	2.86	Dining plate	3.32
		Snake	2.06	Stone	2.38	Arrow*	2.62	Lotus flower leaf	3.27
		Teeth (2)*	5.06	Cloud	2.06	Piece of a pie	2.56	Supermarket belt	3.06
		Vending machine	1.91	Dragonfly	1.89	Thread ball	2.55		
				Pirate's hook	1.76	Cake	2.51	Transparency	3.06
		Whale	1.88			Alarm clock	2.18	Hourglass	2.79
		Pincers	5.90			Shovel	2.18	Jail	2.38
	Total		*M* 4.31		*M* 4.52		*M* 3.63		*M* 4.49
			SD 1.98		*SD* 2.12		*SD* 1.69		*SD* 1.37

Note. The numbers in brackets indicate the number of participants that used the same source. The sources used by both novices and experts are indicated with an asterisk, and the sources employed both for pragmatic and experiential intentions are in boldface.

that being an expert or a novice designer, and having a pragmatic or experiential intention to employ a metaphor significantly influence the depth of the metaphors generated by the designers. The depth scores for each expertise level and intention type can be seen in Figure 04.4. In accordance with our first hypothesis, novice designers tended to generate surface metaphors (M = 5.61, SD = 1.37) and experts generated relatively deeper ones (M = 4.29, SD = 1.31). Consistent with our second hypothesis, having a pragmatic intention led to the generation of surface metaphors (M = 5.74, SD = 1.35) whereas having an experiential intention led to the generation of deeper metaphors (M = 4.19, SD = 1.63).

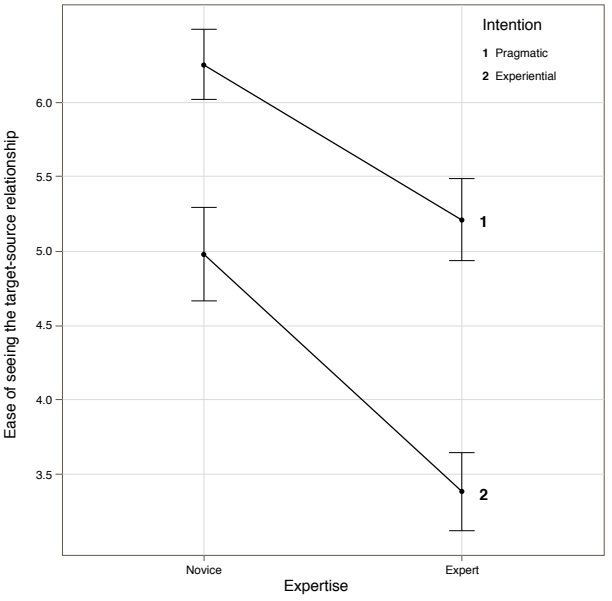


FIGURE 04.4. The means for the ease of seeing the target–source relationship in relation to the intention type and expertise level of designer (error bars represent standard errors)

Discussion

The study reported in this paper investigated the effect of the level of a designer's expertise (novice vs. expert) and the metaphorical intention (pragmatic vs. experiential) on the depth of the metaphors generated. In line with our hypotheses, we found that designers show a general tendency to create surface metaphors if they are novices or have pragmatic intentions, and create deeper metaphors if they are experts or have experiential intentions. The lack of interaction between the type of intention and the expertise level indicates that these factors are independent from each other. Having a pragmatic intention led the experts to focus on a salient quality of the target, but it was usually not as salient as the qualities emphasized by the novices when they had pragmatic intentions. Similarly, the scope of research for non-salient qualities is extended with the acquisition of expertise irrespective of intention type. In general, experts highlighted a target's less salient dimensions regardless of their intention (see Table 04.1 for the means).

The sources associated with the MP3 player by the novices included a *cassette*, a CD, an *ear*, *headphones*, *music notes*, and a *guitar*, all of which are obviously related to an MP3 player as they are all in the music playing/listening domain (see Figure 04.5a). However, the experts employed some distant sources like a *dragonfly*, a *Rubik's cube* and a *seashell* in their designs (see Figure 04.5b). Building a relationship with these sources is more difficult both for the designer and the user because source and target belong to entirely different domains. The association with a *dragonfly* emphasizes that an MP3 player might buzz in one's ear, the *Rubik's cube* association focuses on the song selection process by transforming it into a game where the user needs to put in a specific combination to listen to the song s/he wants, and the reference to a *seashell* transfers the associations related to the experience of "listening to the sea" with a seashell (e.g., peacefulness, nostalgia) to the MP3 player, and intends to evoke similar emotions in the user. As can be seen, these subtle associations emphasize some of the non-salient qualities of an MP3 player.

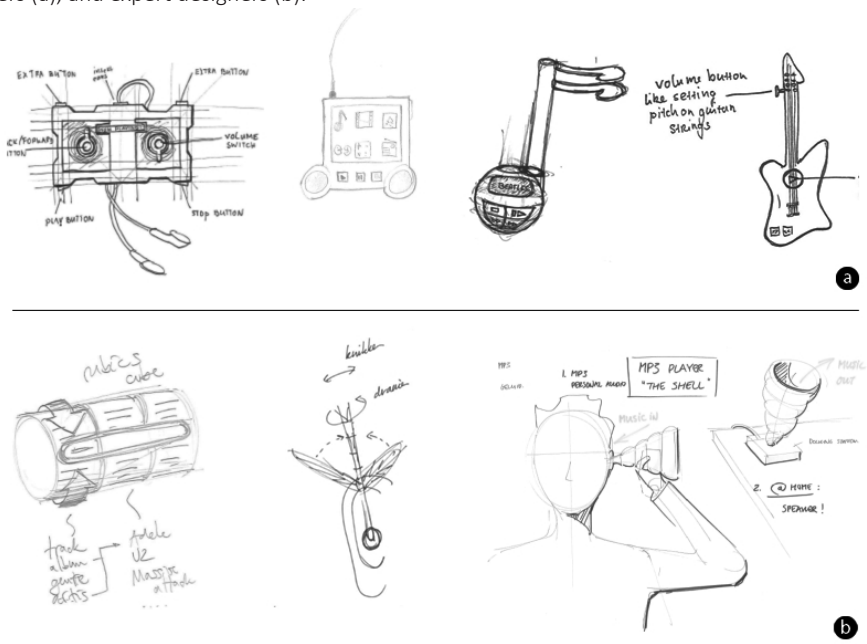
As aforementioned in the introduction of this chapter, the quality of a metaphor is based on bringing a surprising, hidden dimension of the target to light. These non-salient qualities require more cognitive effort to notice, which leads to more sophisticated and interesting associations (Barsalou, 1982). Correspondingly, the professional designers' tendency to focus on a non-salient quality of the target, and employ sources that have a subtler relationship with the target to emphasize this quality, may have been initiated by their desire to attain metaphors that are of higher quality. We maintain that uncovering qualities and relationships that require detailed exploration and abstraction is a natural tendency acquired through experience. Although experience is thought to contribute to being a good designer, in this study no attempt was made to assess the caliber of any design work. Therefore, by selecting experts with a minimum of 2 to 3 years of experience in practice and choosing students as novices, it was assumed that the novice designers had not yet reached the level of expertise required to be good designers. Surely, experts and novices are not uniform populations. During the study, the same meanings were sometimes conveyed using the same sources by both novice and expert participants (e.g., *biting nails, ear, cloud, teeth*), and some novices also came up with a target's hidden qualities to emphasize something that some experts did not catch (see Table 04.1). Nevertheless, we can conclude that expertise generally implies the production of better metaphors and better metaphors imply the communication of original and interesting meanings and the use of sources that have a distant relationship with the target.

Regarding the intention type, results demonstrate that 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. We believe that this attitude is a result of the nature of communication between designer and user. Metaphors mediate between the intentions of the designer regarding the forms, uses, and symbolic meanings of the product, and the relevant interpretations of the user. However, user interpretations may or may not correspond with those that were intended by the designer. Successful communication occurs when the user identifies the informative intention underlying the designer's decisions, and these decisions accurately and consistently trigger similar

reactions in different users and guide them to respond to a product in a particular way (Kazmierczak, 2003). While designers may attempt to create products that promote certain interpretations and prevent others, they should keep in mind that interpretations can never be fully controlled as each person constructs meanings in different contexts (Crilly, Maier & Clarkson, 2008).

Designers aim for the best match between their intention and the possible user interpretation when it comes to expressing what the product does and how it works, because a mismatch regarding these functional aspects may cause the product to fail, or in the worst case, put the user in danger. This consideration also influences the generation of product metaphors: Having a pragmatic intention implicitly guides designers to express the function of the target as clearly and effectively as possible, and this is facilitated by associating it with a source whose selection the user can easily deduce. Consequently, there is a tendency to generate surface metaphors so as to prevent confusion, misuse, and other unpleasant usage scenarios. The risk of this type of failure is diminished when designers prioritize experiential goals. In order to attain exciting, interesting, or surprising metaphors, designers need to be bold and creative in finding novel associations. Thus, experiential intentions allow designers to reveal non-salient qualities of the target, and generate deep metaphors. Designers look for meanings that are more difficult to come up with, and as a result, employ sources that do not have an obvious relationship with the target. Compared to pragmatic intentions, it is less important if the meaning is unclear to the user. This ambiguity may even be intended by the designer to foster deeper and more personal relationships with the product (Gaver, Beaver & Benford, 2003).

FIGURE 04.5. Examples of sources employed for MP3 players by novice designers (a), and expert designers (b).



If we take the self-cleaning trash bin as an example, the approaches taken in conjunction with experiential intentions were mainly focused on the symbolic associations evoked by the product. For example, many participating designers aimed to transfer the "cleanliness" message through visual means by using *soap*, a *maid*, or a *bleach bottle* as a source, and shaping the trash bin in line with the forms of these entities. Another designer made reference to a *space pod* so as to emphasize the "high-tech" impression given by the self-cleaning function, which is relevant but not the most visible feature of this type of trash bin. Informed by this association, the trash bin acquires the futuristic and sleek character of a space pod.

The pragmatic intentions for the self-cleaning bin, on the other hand, were mainly focused on embodying and communicating the "self-cleaning" function, which is one of the most salient features of this product. By associating the trash bin with a *windshield wiper* for instance, the goal was to provide a mechanism for the bin to clean itself, while the association with a *toilet flush* was intended to help users identify the self-cleaning function. In another design concept, one designer intended to provide users with clues about how to operate the trash bin for it to clean itself by referring to a *screw*. Similar to the action of turning a screw into wood, the trash bin is rotated to get rid of the trash; this function is supported by the shape of the bin, which imitates the spiral of a screw's threads.

During the study, some sources were used for both pragmatic and experiential purposes by different designers (see Table 04.1). One explanation for this might be that some designers did not find the opportunity to consider the consequences of designing with a pragmatic or experiential intention as requested, especially when given a short time to come up with a metaphor. However, in the interviews we conducted after the design phase, where participants were asked to explain their designs, we did not find indications for this explanation. A more plausible explanation might be that a source with various salient qualities can fulfill different intentions. For example, two expert designers associated a *toilet flush* with the self-cleaning trash bin. In one of them, the entire form of a toilet was projected onto the trash bin, creating a rather kitschy product in which the user is straightforwardly asked to throw trash in the toilet bowl by lifting the lid. In the interviews, the designer explained his intention that the controversy of seeing a toilet in the kitchen—a clean and hygienic place—would provoke surprise, and the realization that it is not a real toilet but a trash bin would lead to amusement (i.e., an experiential intention). However, another expert designer employed the same source by just borrowing its working mechanism and transferring it to the trash bin, instead of using the entire toilet form as in the former example. In the designer's description, this reference was meant for the pragmatic purpose of providing a solution to the self-cleaning problem. Similarly, four novice designers used the form of a *sitting human body* when designing a chair with pragmatic intentions. Their aim was to show the user where and in which position to sit, whereas two other designers employed the same form to fulfill the experiential intention of imparting a friendly character to the chair. On the basis of these different applications, it seems possible that a source can be used for attaining different intentions for the same product, if it has various salient qualities that can lead to different interpretations.

The number of salient qualities has also an effect on the meanings that emerge when the same source is coupled with different targets. Bowdle and Gentner (2005) gave the examples of associating the source "snowflake" to two semantically related targets, "Youth is a snowflake" and "A child is a snowflake", and pointed out how the emphasized meaning changes: The first metaphor brings out the transience of youth and the second one brings out a child's uniqueness and delicateness. Although the same source is employed, the conveyed meaning changes according to the specific target–source combination. This is because the targets of metaphors constrain the relevant properties that can be ascribed to them (Chiappe & Chiappe, 2007; Glucksberg et al., 1997; Glucksberg & McGlone, 1999; Pierce & Chiappe, 2009). The targets of product metaphors have the same power. In our study, one of the expert designers referred to an *hourglass* in order to provide a solution to designing the self-cleaning mechanism of the trash bin. As opposed to the action of inverting an hourglass when the top bulb is empty, this trash bin is rotated when the top bulb is full so as to transfer the trash to an underground garbage system. Compared to the Sand Glass example used before, here a different quality of the hourglass is employed. When associated with a traffic light, the hourglass functions as a display, showing the passage of time, whereas its association with the trash bin yields a mechanism that must be rotated when it is full. It should be noted that both of these aspects are salient qualities of an hourglass, however which one stands out depends on the product it is associated with. Kövecses (2000) defines this as the *scope of metaphor*—each source is assigned to play a specific role in characterizing a set of targets to which it applies. Thus, it appears that the source 'hourglass' has a wide scope; provided by its numerous salient properties it can apply to different products, which is most likely not limited with a traffic light and a trash bin.

As it is possible for a source to convey multiple meanings, there can also be a variety of sources that convey the same meaning, such as the function of "cutting" was conveyed through the usage of sources like *scissors, guillotine, paper cutter*, or *cutlery*. The strength of association between these sources and cutting action varies; some of them are more commonly associated with cutting, e.g., *scissors*, and thus, are relatively more "conventional" than the others (Bowdle & Gentner, 2005; Jones & Estes, 2006). Both conventional or unconventional (i.e., novel) sources can lead to apt metaphors (Camac & Glucksberg, 1984), yet the reason why one source is preferred over the others lies in the power of the source to convey the intended meaning, properties of the target, the design brief, and capabilities of a designer (Cila, Hekkert & Visch, in press-a).

Regarding the relationship between a target and a source, scholars working in the analogical reasoning domain commonly make a distinction between surface similarity and structural/deep similarity (Christensen & Schunn, 2007; Gentner, 1989; Goldstone, Medin & Gentner, 1991; Holyoak & Koh, 1987). The differentiation we proposed in this paper between surface and deep metaphors is in parallel with this distinction except for one major difference. As aforementioned, in a surface metaphor—where the target quality that is highlighted is obvious—the relationship between the target and the source becomes also obvious. Hence, the similarity of a target and a source in a surface metaphor is a "surface similarity". For similar reasons, the target–source similarity in a deep metaphor is a "deep" or "structur-

al" similarity. The difference arises, however, from how the content of these types of similarity are defined. Most of the time, surface similarity is defined in terms of similar physical descriptive object attributes between two entities such as color and form, and deep similarity as the similarity in their abstract relational structure (Gentner, 1989; Holyoak & Koh, 1987). Vosniadou (1989) argues, however, this argument fails to take into account the status of these similar attributes in people's underlying representations. If the attributes in question are salient with respect to underlying representations, the easily accessible similarity (i.e., surface similarity) can also be based on relational, abstract or conceptual properties. Our argument is in line with Vosniadou: Having a look at the sources employed by our participants also indicates no tendency to use perceptually or conceptually target-similar sources according to the level of expertise or type of intention. The sources that the novices associated with the targets were as conceptually similar as the sources used by the experts (e.g., for a nail clipper: *beaver, shark*), and the experts also used perceptually similar sources (e.g., *stapler, guillotine*). Correspondingly, pragmatic intentions did not necessarily guide the participants to use perceptually similar sources, and experiential intentions did not lead them to conceptual similarity. For these reasons, we can state that our sample supports Vosniadou's (1989) view that surface similarity is not necessarily perceptual, and deep similarity is not always conceptual.

Our final remarks concern the methodology of the present research. As previously indicated, we employed two different task duration conditions and four different product types in the study in order to control their effect on the depth of the metaphors generated by designers. The results showed no effect of these factors, however we consider that this issue requires further exploration. Regarding task duration, the lack of effect on metaphor depth may be due to the time limit a designer has for creating a metaphor not being a relevant constraint on his or her ability to come up with surface or deep metaphors. If s/he is experienced, the designer can generally find relatively interesting meanings to ascribe to a product regardless of the time given. The other reason may be that the difference between the two durations used in the study (8 min vs. 40 min) was not noticeable enough to influence the depth of the metaphors generated. In any case, further research is required to thoroughly investigate whether the lack of effect is due to the nature of the product metaphor generation process in general, or to limitations in methodology. The same also applies to the product types used: The selection of these products was based on our insight rather than on any kind of systematic method to check the number of their attributional dimensions. Further study will need to be conducted in order to gain a detailed understanding of the effect of product type.

Conclusions

Contemporary metaphor theories extend the use of metaphors beyond language by considering them as a part of one's thoughts, reason, and imagination (Gibbs, 2008). This understanding has invited studies from various academic fields to explore the nonverbal expressions of metaphors. Product design is one of those fields where metaphors abound, yet the inclusion of metaphor as a research subject in

the literature is limited. The study reported in this paper investigated the effect of the level of a designer's expertise (novice vs. expert) and the metaphorical intention (pragmatic vs. experiential) on the depth of the metaphor generated by designers. We found that there is a tendency to create surface metaphors when the designer is a novice or s/he has pragmatic intentions. On the other hand, being an expert or having experiential intentions was shown to allow for generating deeper metaphors, which are expected to be more interesting and original.

If the metaphor has been constructed properly, even a mundane, standard product like a traffic light can have an exciting, rich design. For this reason, a designer needs to be able to use metaphors effectively. Understanding how to take proper and creative decisions in this respect means that designers can attain more fitting, interesting, and pleasant metaphors, and communicate better with users. The present study is one of the first attempts to address some of these decisions. With improved understanding of the tendencies that may be exhibited by novice and expert designers, we can more effectively harness and educate novices' design problem solving abilities. Furthermore, by relating linguistic theories of metaphor generation and comprehension to the domain of designed products, we intended to demonstrate that the realm of the product metaphor is a viable arena for existing linguistic theories to be examined and broadened. Research into product metaphors is necessary to provide metaphor producers in the linguistics and product design disciplines with essential insights and inspiration to generate successful metaphors, and contribute to the metaphor research domain by providing a more comprehensive understanding of the functions and uses of these metaphors as a whole.

/05
MAPPING STRATEGIES

After coming up with a metaphorical association, designers are required to turn this idea into a physical reality. They do so by mapping certain properties of the source to the target. While conducting this mapping, they decide on the extent to which they should preserve the typical product identity and abstract the source properties. On the basis of these decisions, we will define four mapping strategies and investigate their strengths and weaknesses regarding the experience they envision to provide the users and their generation process in this chapter.

This chapter has been submitted as:

Cila, N., Özcan, E. & Hekkert, P. (submitted). “My adventurous teapot”: Mapping strategies in product metaphor generation. Manuscript submitted to Design Studies.

FIGURE 05.1. Samurai umbrella designed by Materious.

Metaphors are ubiquitous in our inner and outer worlds. They appear in linguistic, visual, auditory, and gestural disguise. Regardless of the mode of communication, metaphors provide us with a simple means of transmitting complex information, allow us to express ideas that are difficult to express, and convey experiences in a vivid, emotion-arousing manner (Ortony, 1975). Generating metaphors is an act of bringing fresh perspectives into existence, enabled by one's "understanding and experiencing one kind of thing in terms of another" (Lakoff & Johnson, 1980, p. 5). Metaphor, in this wider sense, is not just a figurative aspect of language but a pivotal part of our thoughts, reason, and imagination (Gibbs, 2008). Any kind of non-verbal communication can involve metaphors (e.g., cinematography, architecture, music, and so on). Properly used, metaphor can also be a powerful ingredient in the process of designing products. It helps designers identify, frame and solve design problems (Hey et al., 2008; Kirsi et al., 2009; Schön, 1979), break away from the limitations imposed by the constraints present in the initial problem (Casakin, 2007), develop products that resonate with users (Kolb et al., 2008), charge an idea with new excitement through its affective role (Gruber & Davis, 1988), create an intuitive language among design team members, allowing them to perceive design objectives from alternative angles (Kirsi et al., 2009), and improve designers' performance by encouraging them to reflect on design problems (Casakin, 2011).

Designers also benefit from metaphors when translating abstract concepts into concrete product properties (Hekkert, 2006; Özcan & Sonneveld, 2009; Van Rompay, 2008). They locate representations of the values and meanings they

intend to attribute to a product and render these in visual form via metaphor. In this way, products can provide operational cues, and express social, psychological, and cultural values to users. Metaphor is thus a means of communication employed by designers to express meaning and evoke user emotion. To enhance not only the efficiency but also the pleasantness inherent in this kind of communication, we believe there are several strategic decisions to be made regarding a metaphor's comprehensibility and aesthetics. Our focus in this paper is on the effect of these strategies upon both the quality of the end product and the design process itself.

Investigating metaphors found in the design domain is a challenging problem in and of itself, because metaphors are mainly discussed in the context of language. So far, only a few scholars have acknowledged that products are a viable means for the application of metaphors and incorporated them in design research (Cupchik, 2003; Forceville et al., 2006; Hekkert, 2006; Krippendorff & Butter, 2008; Van Rompay, 2008). However, there still exists a fundamental need for a systematic study that accounts for the processes underlying metaphor generation, and investigates the perceived success of the decisions taken in the process, in order to support designers with the necessary insight, inspiration, and theoretical knowledge required to create good metaphors.

In this paper, we will first present a short theoretical introduction into the use of metaphors in the product design domain, and introduce strategies designers can employ when generating metaphors. Thereafter, we describe an empirical study conducted with design students in order to lend a practical perspective to our examination. Finally, the results of the study including the designs created by the students will be discussed in relation to product design and metaphor theory knowledge, and recommendations for a successful metaphor generation process will be offered.

Product Metaphors and Mapping

Metaphors build an association between two distinct entities, where the qualities of one are used to describe the other. In cognitive linguistics, these entities are called target and source (Lakoff & Johnson, 1980). For instance, in the verbal metaphor "a best friend is an anchor", the anchor's (i.e., source) properties of being solidly embedded in the ground and preventing drift are transferred to the best friend (i.e., target). The metaphor emphasizes the trustworthiness and stability of a best friend—a person who keeps your feet on the ground and your efforts on track no matter what. In product metaphors, correspondingly, the target is the "product" that is employed in a metaphor (these terms will be used interchangeably throughout the paper), and the source is the remote entity whose qualities are associated with the target so as to assign a particular meaning or value to it.

In a product metaphor, the target is designed in such a way that it evokes in users some perception or experience of the source. In Figure 05.1 we are invited to see and experience an umbrella (target) as a Samurai sword (source). These entities are playfully brought together in order to gratify the evolutionary nature of men as aggressive creatures who must meet the demands for conformity placed upon them

in our era of civilization. In other words, it combines a symbol of gentlemanly refinement—carrying an umbrella—with an element of manly sword-bearing times ("Umbrellas for the civil but discontent man", 2009). Their association is enhanced by the elongated shape of the handle and the way the object is to be slung over the shoulder; both are qualities—albeit stylised ones—adapted from a Japanese sword. To create a product metaphor, a designer merges target with source by projecting certain physical, functional or operational properties of the source onto compatible properties of the target (e.g., form, colour, material, texture, movement, activation, use, sound, smell). This association, called a *mapping*, transforms the metaphorical idea into a concrete physical entity.

In the literature studying linguistic metaphors, the term mapping is also used for the transfer of source properties to a target, but at a "conceptual level" (Gentner, 1988; Gentner & Wolff, 1997; Holyoak & Koh, 1987; Lakoff & Johnson, 1980; Vosniadou, 1989). As a linguistic metaphor consists of an association between two terms (e.g., a best friend and an anchor), clearly we cannot talk about a physical transfer from source to target. Mapping here refers to the act of establishing a conceptual correspondence between these words, i.e., deciding which properties of an anchor are transferrable to one's best friend, why, and how.

Products are, however, tangible entities. In order to construe a product metaphor, designers are required to make the physical appearance of a source visible in the appearance of its target. For this reason, product metaphors involve two distinct kinds of mappings from source to target: a conceptual mapping—to build the metaphorical link between target and source, similar to that of a linguistic metaphor—and a physical mapping, to manifest this link in tangible form. The reasoning behind the Samurai umbrella designer's decision to associate a sword with an umbrella involves a conceptual mapping between these entities (e.g., the playful and fantastical experience of carrying a sword in daily life), while the manner and extent to which the designer chooses to shape the umbrella like the sword involves a physical mapping. Elsewhere, we have used the terms "metaphorical association" and "application" to address conceptual and physical mapping, respectively (Cila, Borsboom & Hekkert, in press). In this paper, we again reserve the term mapping to connote the physical application of a source's appearance to the target.

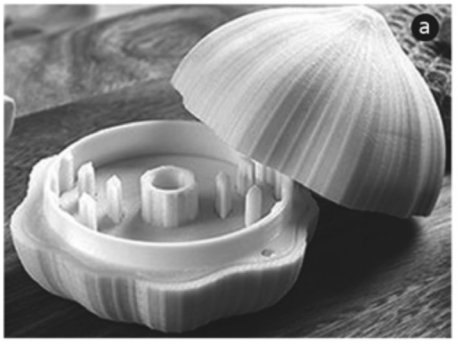
Mapping strategies

Products are multimodal entities that allow for numerous metaphorical mappings through their stylistic, formal, and structural properties (Özcan & Sonneveld, 2009). How the mapping is conducted is a highly important factor contributing to product metaphor quality. The first decision a designer needs to take in this regard is the extent of a source's abstraction. Creating a mapping involves a transformation and adaptation of a source's perceptual properties to the visual language expressed by the target's physical properties. A designer can keep this adaptation to a minimum by projecting source properties directly onto a target. We call this a *literal mapping* of source properties. The designer could also adapt the source to the target by extracting its "essence"—which may include its latent properties—and infusing the target with it. This we call an *abstract mapping* of source properties.

To illustrate, consider the two garlic presses in Figure 05.2; each refers to a garlic bulb—the source—to convey its main function. The first example evinces an obvious use of the garlic form, which has been transferred to the product in its entirety. The plastic press looks like an actual head of garlic, with the same shape, colour, and texture. Many properties of the source were directly copied to the target, i.e., the designer created a literal mapping. In the latter example, on the other hand, the geometric essence of a head of garlic was extracted: The bulb becomes an elegant glass vase to store garlic cloves, the sprout-inspired shape of the metal press rising from it. This exemplifies an abstract mapping in which the designer simplified the appearance of a garlic bulb to create a functional and attractive shape.

In fact, the mapping approach taken by the designers of these two products actually differs in another related, yet distinct sense. The garlic press tool has a typical form, one which is likely familiar to most people who like to cook: a two-handled device hinged together by a flat metal press on one side, and a bowl with a grid of small holes on the other. When the handles are squeezed, the press fits into the bowl and forces garlic cloves through the holes. Because the designer of the press in Figure 05.2a directly replicated the shape of a head of garlic, the resulting product then loses that "typical garlic press" identity. The product resembles a garlic bulb more than it does a traditional garlic press. In the second example, however, that identity has been maintained to some extent, as the garlic bulb form has been adapted to the form and usage conventions of a prototypical metal garlic press.

This difference highlights the other decision that a designer needs to take when creating a mapping: the extent to which a product's identity (if one exists) is kept or compromised. A mapping that preserved the product's traditional identity we call *target-driven mapping*, since the designer's main focus is on the target product to be designed, and the metaphorical outcome calls to mind the stereotypical version of the product rather than the source of the metaphor, as in Figure 05.2b. The other kind of mapping, in which designers compromise prototypical or traditional product identity, we call *source-driven mapping*, as the form of the source is emphasized, and the outcome resembles the source more than it does the target of the alleged metaphor, as in Figure 05.2a.



One may naturally expect to have the outcome resemble the source more when conducting a literal mapping and have it resemble the target more after an abstract mapping, yet this does not need to be the case. To demonstrate, we will present two baby feeding bottles in Figure 05.3. The bottle shown in Figure 05.3a mimics the size and shape of a take-away, paper coffee cups, a strategy intended to tap into the lifestyle and social cues of 21st century parents (Montgomery, 2013). The off-centred positioning of the teat and size of the bottle especially are "literal" copies of a standard coffee cup. Still, the reference is so subtle that the product solidly projects its identity as a typical feeding bottle (i.e., a target-driven mapping). In the feeding bottle shown in Figure 05.3b, the designer used a mother's breast as the inspiration for the teat's shape, and made this the immediately discernible, main focus of the design (i.e., a source-driven mapping), yet abstracted the appearance of said source by using an outline barely reminiscent of a breast rather than copying the appearance directly.

On the basis of these examples, we define four distinct kinds of "mapping strategies" by crossing the dimensions of abstraction and product identity (see Figure 05.4). The first strategy refers to the combination of a source-driven and literal mapping (SD–Lit), where a designer compromises the traditional/stereotypical identity of the product to some extent by literally projecting source properties directly onto it. In the opposite corner, there is the combination of a target-driven, abstract type of mapping strategy (TD–Abs), in which the designer abstracts the essence of source properties and blends them thoroughly with the target. The remaining two strategies involve either a literal mapping of source properties while keeping the target identity (TD–Lit), or conversely, abstracting the source properties yet still emphasizing the visual reference to them (SD–Abs). It must be stressed that these strategies should be seen as poles of dimensions rather than distinct categories.

Mapping Strategies and Design Decisions

We posit that each mapping strategy impacts the decisions a designer must take when creating a product metaphor. In this section, we will focus on three decisions we deem particularly important in the context of metaphor generation, and present the hypotheses we will investigate in this paper.

FIGURE 05.2. (a) Literal mapping, The Garlic Chop by Koopeh designers, (b) Abstract mapping, Garlic press by Eva Solo.

FIGURE 05.3. (a) Target-driven mapping, Innosense by Mothercare, (b) Source-driven mapping, Very Hungry bottle by Mimijumi.

Identifiability of source

The first step in understanding and experiencing a metaphor is identifying its source, because the target–source pair has to be "read" in order to infer meaning from a metaphor (Cila, Hekkert & Visch, in press-b). When shaping the product, any visual reference that a designer makes to the source helps people to work out the metaphor. This is why designers are required to ensure source identifiability: it is fundamental to effectively communicating that a metaphor has been used in a product.

In order to be identified, the source needs to be perceptibly drawn to our attention. Since source properties are highlighted at the expense of losing traditional or conventional product identity in source-driven mappings, we believe that the source of a metaphor generated through this kind of mapping to be highly identifiable. Correspondingly, literal mappings involve a direct transfer of source properties to target, and leave clear, visible cues on the product for easy identification. For these reasons, we expect that a combination of these approaches (i.e., a SD–Lit mapping strategy) will lead to metaphors with the most identifiable sources (*Hypothesis 1*).

In target-driven mappings, on the contrary, a designer so subtly incorporates the source into the product (to preserve its original identity) that the effect of the reference can barely be perceived in its appearance; it is only upon close examination that the metaphor can be explicitly pointed out. The source is also hinted at discretely in the metaphors created through abstract mappings, because the designer has taken its essence and eliminated any properties irrelevant to the context of the target. Therefore, we hypothesize that a combination of these approaches (i.e., a TD–Abs mapping strategy) will lead to metaphors with the least identifiable sources (*Hypothesis 2*).

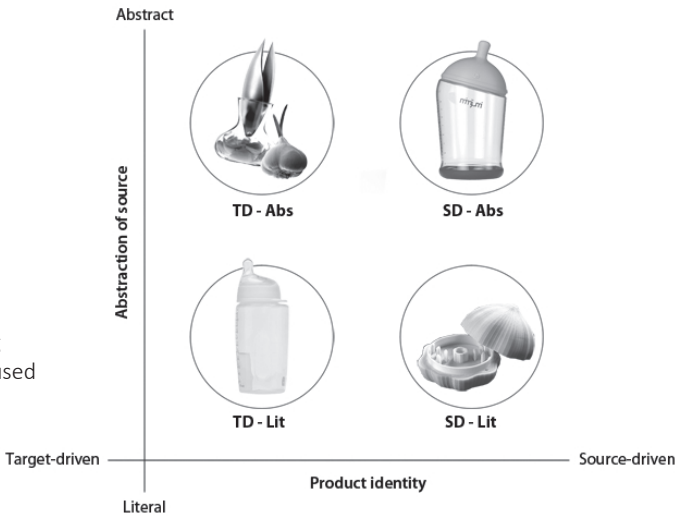


FIGURE 05.4. Four mapping strategies and the strategy used in each product.

The phases of source identification and metaphor comprehension are followed by an assessment of the merits offered by a particular target–source association (Gibbs, 1994). Thus, the aesthetic appreciation of the products they create is another goal to consider. In many theories of art, aesthetic pleasure is thought to be elicited by the act of solving perceptual puzzles (Berlyne, 1971; Ramachandran & Hirstein, 1999). Recognizing a property immediately is paradoxically less pleasant than discovering it after a struggle (Armstrong & Detweiler-Bedell, 2008). Correspondingly, Sopory and Dillard (2002) argue that elaborating upon a metaphor and resolving the mystery it presents results in pleasure. To create a visual puzzle, any reference made to a source should be subtle in its application. This means that a designer needs to keep the properties mapped from source to target at a minimum, and tailor these properties in a way that blends them into the product, rather than "forcing" them onto the target too coarsely and explicitly.

As a designer's main concern is maintaining target identity when creating target-driven mappings, and simplifying the source properties as much as possible when conducting abstract mappings, each of these approaches accomplishes its intended subtlety effectively, and provides a visual puzzle to solve for users. For this reason, we hypothesize that their combination, i.e., a TD–Abs mapping strategy, will lead to more aesthetically pleasing metaphors than the others (*Hypothesis 3*).

Incorporating source properties into a target in too direct and unsubtle a fashion inhibits the pleasure of "discovery", as the metaphor is perceived as too straightforward and obvious. Furthermore, with these kinds of mapping, there is always a possibility that properties essential to the source but inapplicable or irrelevant to the target might also be transferred (see Knappett, 2002, for a discussion on "skeuomorphism"), which in turn may cause the reference to interfere with the natural context, form, or use of the target. For this reason, a combination of the strategies that run the risk of generating these outcomes, i.e., a SD–Lit mapping strategy, will lead to product metaphors that are less aesthetically pleasing than the metaphors produced by other strategies (*Hypothesis 4*).

Ease of mapping

The SD–Lit mapping strategy, however, actually presents designers with one distinct advantage: Transferring source properties directly to the target is an expeditious way of creating a mapping. In general, the extraction of principles and properties and the formulation of an abstraction out of these are considered by creative cognition researchers to be cognitively more demanding (Helms et al., 2009; Ward, 1995). Ease of mapping therefore becomes crucial when a designer is required to meet external, organizational concerns, such as a tight budget or deadline; in these situations, completing the design process may necessitate generating a metaphor as quickly as possible, using minimal means. Under these conditions, adopting a straightforward approach, whereby source properties are transferred directly to the target—without exerting any extreme cognitive effort to preserve the product's identity—is rather

favourable. For this reason, we hypothesize that an SD–Lit mapping strategy is the easiest strategy to follow when generating metaphors (*Hypothesis 5*).

We might say that the more abstract and target-driven a mapping is, the more difficult it becomes to create. Yet, we believe another strategy is more challenging than the TD–Abs strategy. To create a TD–Lit mapping, a designer is required to keep the source concealed to prevent its interference with a product's identity, but must still copy its properties directly. This is a rather conflicting approach, which can require considerable effort to develop. For this reason, we consider that among all four mapping strategies, TD–Lit is the most difficult for designers to follow (*Hypothesis 6*).

With these hypotheses in mind, we will explore the effect of the four mapping strategies on the three design goals of metaphor identifiability, product aesthetics, and the mapping ease, through a study in which designers are first asked to generate metaphors by implementing all four strategies, and then asked to compare the perceived strengths and weaknesses of each strategy regarding these three design goals.

Method

Participants

Participants were 29 MSc. students (17 male and 12 female) studying industrial design in the Netherlands (N = 18) or Australia (N = 11). They received course credits for their participation.

Design task

In the product design field, it is common practice for clients to ask designers to create products according to a specific product expression, where the designer needs to enable this expression via concrete product properties (Özcan & Sonneveld, 2009). Correspondingly, we asked participants to employ a metaphor to design a teapot "with an adventurous character". We chose a teapot because it is a familiar object both in terms of its form and use, and also has distinct product parts (e.g., spout, handle, lid, belly) that would allow for various design manipulations. The adventurous character was chosen because it is a broad and familiar concept encompassing a wide network of semantic associations, with the potential to be interpreted by each designer in different ways. Furthermore, this particular product–expression combination was considered novel and challenging for participants, compelling them to generate new ideas rather than recalling existing products.

Procedure

Participants (N = 29) first received a brief introduction on metaphor use in the design domain, with an emphasis on the mapping phase. They were then provided with several sheets of A3 paper, pens, and the design task. They were asked to explore the adventurous concept by recalling relevant personal experiences; listing

the events, activities, or objects they consider adventurous; and thinking over the reasons why they consider these to be adventurous. This exploration phase was conducted as a group activity. On the basis of their explorations, each participant was asked to make an individual mind map, and build an association network using the adventurousness concept and adventurous qualities. These mind maps were intended to be used as tools to help participants make the abstract concept more concrete (Özcan, 2011), and guide them to a source that they could associate with the teapot. After a source had been selected, they were asked to create a mapping from it to a teapot, using each of the four mapping strategies (TD–Abs, TD–Lit, SD–Abs, SD–Lit), the intention being that each participant would consciously experience all four strategies, and therefore be able to consistently compare the process and outcome of each strategy with the other three. At the end of the session, participants presented their concepts by explicitly indicating the source they employed in the metaphor, and how they created the mapping. They were also asked to complete a short, forced-choice questionnaire evaluating the strategies as they experienced them, i.e., to choose the mapping strategy that led to "the most aesthetic product", "the least aesthetic product", "the most identifiable metaphor", "the least identifiable metaphor", and was "the easiest strategy" and "the most difficult strategy". They were allowed to select the same strategy more than once. Statistical analyses were performed on participants' responses.

Results

The sources employed by participants to convey adventurousness were: bomb, bungee jumping (x2), cactus, chameleon, chilli pepper, climber (x3), climbing, clown, fire, fuel pump, gambling, globe, haunted house, karabiner, lion, tightrope walker, monkey, parachute, rabbit, skydiving, snake, stone, Superman, tent (x2), and tiger.

Figure 05.5 indicates the number of times each mapping strategy was selected for the most/least aesthetic product, the most/least identifiable metaphor, and the easiest/most difficult strategy. We employed separate Cochran's Q tests to determine whether there was a difference in selection frequencies of the four mapping strategies regarding each design goal. The test statistics revealed that there existed a significant preference for certain strategies with regard to all six goals we surveyed, the most aesthetic: $Q(3, 29) = 10.86$, $p < .05$, the least aesthetic: $Q(3, 29) = 21.34$, $p < .001$, the most identifiable: $Q(3, 29) = 71.82$, $p < .001$, the least identifiable: $Q(3, 29) = 58.31$, $p < .001$, the easiest: $Q(3, 29) = 46.44$, $p < .001$, and the most difficult: $Q(3, 29) = 36.24$, $p < .001$.

To compare the strengths (and weaknesses) of each strategy, pairwise comparisons using McNemar's tests with Bonferroni correction (for six comparisons: $p = .0083$) were conducted. The results can be found in Table 05.1, and showed that significantly more participants selected the TD–Abs mapping strategy over the TD–Lit strategy in order to create more aesthetic products, and believed that the SD–Lit strategy generated the least aesthetic products. Regarding identifiability, the SD–Lit mapping strategy was selected significantly more than the other strategies as the one

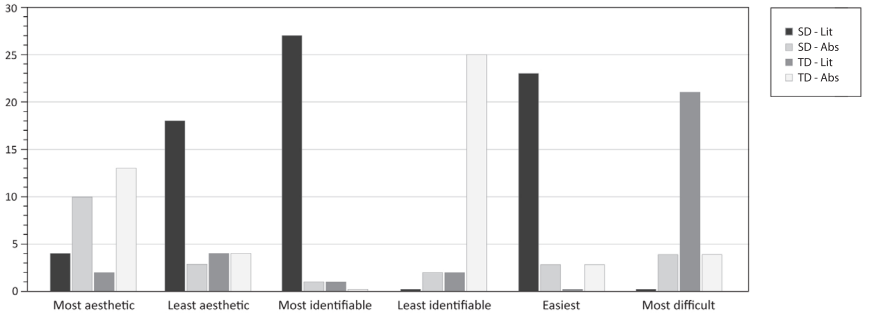


FIGURE 05.5. The selection frequency of each mapping strategy for the aesthetics, identifiability and ease condition

that generated the most identifiable metaphors, and conversely, TD–Abs strategy was considered to lead to the least identifiable ones. Finally, in regards to ease of mapping, the SD–Lit strategy was indicated as the easiest, significantly more so than the other strategies, whereas TD–Lit was selected as the most difficult strategy to employ. The remaining comparisons were non-significant.

On the basis of these results, we can conclude that the overall picture for metaphor identifiability and mapping ease is clear, as one of the four strategies was preferred (or avoided) among the others: SD–Lit was understood to lead to metaphors with the most identifiable sources and as the easiest strategy to employ, TD–Abs was understood to lead to metaphors with the least identifiable sources, and TD–Lit was perceived as the most difficult strategy to follow. However, the findings are more complex when it comes to product aesthetics. Although SD–Lit mapping was indicated as leading to the least aesthetic product concepts, we only found a partial difference among the preferences that led to the most aesthetic ones. The reasons for these selections will be discussed in the next section.

TABLE 05.1. The results of the McNemar's test showing the p values of pair-wise comparisons of the mapping strategies (Significance level: $p < .0083$).

	p values					
	SD - Lit SD - Abs	SD - Lit TD - Lit	SD - Lit TD - Abs	SD - Abs TD - Lit	SD - Abs TD - Abs	TD - Lit TD - Abs
Most aesthetic	.180	.687	.049	.039	.678	.007*
Least aesthetic	.001*	.004*	.004*	1.00	1.00	1.00
Most identifiable	.00*	.00*	.00*	1.00	1.00	1.00
Least identifiable	.50	.50	.00*	1.00	.00*	.00*
Easiest	.00*	.00*	.00*	.25	1.00	.25
Most difficult	.125	.00*	.125	.001*	1.00	.001*

The results from the study indicate that designers appraise particular mapping strategies as more appropriate for particular design goals. From the six hypotheses put forward, the ones regarding source identifiability (H1 and H2) and ease of mapping (H5 and H6) were confirmed; and one hypothesis (H4) in relation to the aesthetics of the product was supported. To discuss these results, we will present and compare two teapots that were generated by participants, of which the first was not a very successful application of the intended metaphor, and the second was a particularly successful one (see Figure 05.6). In the first metaphor, a "tent" was employed as a source, while the second referenced a "tiger".

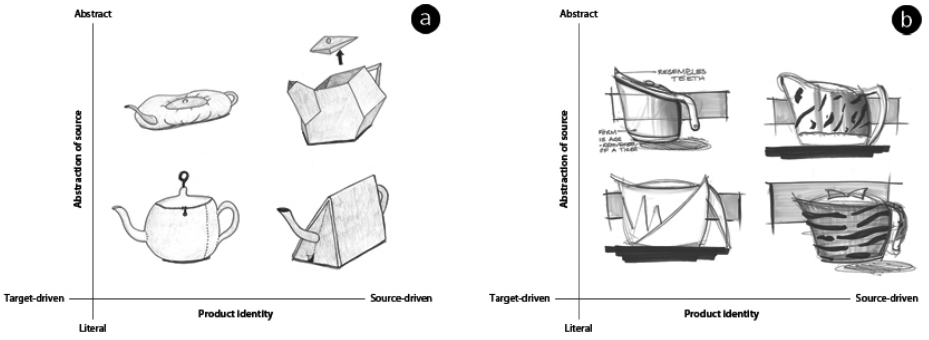


FIGURE 05.6. Two teapots generated by participants according to the strategies.

To begin with identifiability, the results showed that SD–Lit mappings were considered conducive to producing metaphors with the most identifiable sources, while TD–Abs mappings were considered as producing the least identifiable ones, as expected. This means that SD–Lit mapping provides for more fluent communication between the designer and the user. SD–Lit mappings strongly suggest that a metaphoric interpretation is necessary; therefore designers can clearly convey their intentions related to the function, use, and character of a product by following this strategy. A look at the teapots reveals why this strategy was regarded as such.

The approach taken in Figure 05.6a was rather direct: A spout and a handle are attached to a body shaped like a tent; even the stitches and the curled edge of the fabric are replicated. It is impossible to mistake the reference. We believe, however, there are limits to being literal and source-driven. Although the main focus is on the source when using this mapping strategy, a designer should still pay attention to the inherent properties of a teapot to some extent, such as how a teapot looks or is weighted, what kind of standard components it has, how it is lifted and poured, and so forth. Since the designer of the teapot shown in Figure 05.6a failed to take these properties into consideration, the mapped properties that were chosen turned the metaphor application into a gimmick, rather than improving the functionality or enhancing the meaning of the product. By contrast, the design of the teapot shown in Figure 05.6b follows the SD–Lit mapping strategy more appropriately. The de-

signer has carefully matched the source properties with the properties inherent to a teapot, yet the source is still highly identifiable as he directly transferred the tiger's teeth, tail, and fur pattern.

When it comes to TD–Abs mappings, metaphor identifiability relies on a person's ability to detect the source. Prior knowledge, cultural background, and cognitive abilities influence how far one will go in deciding on the mapped properties (Forceville, 2004). Using this mapping strategy carries with it the risk that people may miss the metaphorical reference, or fail to recognize the designer's metaphoric intentions. For instance, the designer of the metaphor in Figure 05.6a mapped a tent's property of "disassembly" to the teapot, and created a product that mimics the appearance of a disassembled tent. Here, the mapped property has inhibited the source's identifiability. In order to make a metaphor identifiable, the properties that are mapped from source to target need to be salient—functionally significant and/or perceptually characteristic—for the source (Glucksberg & Keysar, 1979; Jones & Estes, 2006; Ortony et al., 1985). If one aims to make a metaphorical reference to a cloud when designing a chair for instance, just colouring the chair white would not be good enough. To communicate the reference unambiguously, a designer (also) needs to map other typical properties of a cloud, such as its fluffiness. The designer should always map a source's salient properties in order to keep the reference to that source identifiable. It is for this reason that the tent reference is completely lost here.

In Figure 05.6b, the designer mapped the sharp tooth of a tiger to the teapot, which has relatively greater salience for a tiger than the disassembly feature does for a tent. However, identifying the source as a "tiger" remains challenging, as sharp teeth are not specific to tigers but are a feature of any carnivorous animal. Nevertheless, we do believe this reference assigns a dynamic, assertive character to the teapot, as intended by the designer. Accordingly, the tiger-inspired design is more sensually appealing than the tent-inspired one, especially if identifying the source specifically as a tiger is not critical to the outcome, and the designer's intent is to merely convey a sense of danger and power. Should this lack of immediate identifiability cause misuse and confusion regarding the product, designers should avoid using TD–Abs mappings. However, in some design contexts it is not especially problematic to miss the reference made to a source. For instance, one can still value the functionality and form of the Innosense baby bottle (see Figure 05.3a) without catching the reference to an ergonomically designed, disposable coffee cup. Moreover, uncovering the reference, or learning of the designer's metaphorical intentions afterwards can enhance a person's experience of a product. Implicit mappings, of which TD–Abs mapping is an example, suggest that a metaphoric interpretation is possible but not necessary (Forceville, 1999). Giving users the freedom to identify the source or not is of course a riskier, albeit rewarding, approach. Hence depending on design goals and context, designers should decide how clearly they have to convey the intended metaphor to users, and follow a SD–Lit mapping strategy to facilitate unambiguous communication, or a TD–Abs mapping strategy if the metaphor recognition is not the main priority.

Our third hypothesis predicted the TD–Abs mapping strategy would stand out as the strategy leading to the most aesthetic product metaphors. Although this strategy

was chosen more times in total in this regard, the results indicated that it was only significantly different from the TD–Lit strategy in terms of generating more aesthetic metaphors. No significant statistical difference between the remaining strategies was found. We believe the reason behind this (lack of) finding may be twofold: First, the participants may have considered "aesthetic" to be a complex criterion affected by factors other than degree of abstraction and preserving product identity. Hekkert (2006) defined four principles of aesthetic pleasure—maximum effect for minimum means, unity in variety, most advanced yet acceptable, optimal match—which the participants may have had difficulty applying during such a short design session. The failure to apply one or more of these principles may have interfered with design concepts, and prevented participants from assessing the strategies in terms of an outcome's degree of abstraction and identity.

Secondly, as shown in Figure 05.5, SD–Abs mappings were also selected for their aesthetic quality considerably more than SD–Lit and TD–Lit mappings. This distribution of selection frequency may imply that the target-driven versus source-driven differentiation may not have an effect on aesthetics as much as its abstractness level does, because abstract mappings were chosen more often in general regardless of being coupled with TD or SD mappings. Mapping abstractness is of importance for a metaphor's aesthetics since it matches the physical properties of a source with the inherent properties of a target through simplification. In the SD–Abs mapping seen in Figure 05.6a for example, the physical aspect of a tent was nicely abstracted into an angular form, and this form was used to shape the teapot. Similarly, in Figure 05.6b, the general outlook of a tiger was simplified through a stylization of the fur pattern and the handle's integration into the curve outlining the teapot's body, rather than added on. In both of these approaches, a meaningful property taken from each source (i.e., the tent's angularity and the tiger's fur pattern) was extracted, and this property was blended with stereotypical teapot properties while maintaining the reference's visibility. We consider both outcomes to be appropriate applications of their corresponding metaphors, as did the designers themselves. For this reason, preserving or compromising product identity may not have an impact on aesthetics, contrary to what we expected. The fact that a metaphor is source-driven or target-driven may not hinder the abstraction and integration of source properties, which is apparently the main concern for obtaining an aesthetically pleasing metaphor. This argument appears to be supported by the number of times a certain strategy was designated as leading to an aesthetic metaphor; however, this support should be treated with caution since we only found a partial difference between them that is statistically significant.

Although the abstract mapping of source properties to a target is found aesthetically more pleasing, here the role of source identifiability must be emphasized. As explained earlier, the attractiveness of a metaphor is triggered by the solving of a perceptual puzzle. Here, the words "solving" and "puzzle" are critical: The metaphor should provide a mental exercise that the viewer can ponder, but this exercise should end with a resolution about its meaning. Therefore, the aesthetic pleasantness of a metaphor is also grounded in this balance—the joint influence of subtlety and identifiability of the reference to a source (Cila, Borsboom & Hekkert, in press). In order to create attractive metaphors, designers should conceal the source to some extent

in order to provide an intriguing visual puzzle to solve, but still make the source's appearance emerge in the target to make sure this puzzle is solvable. As the focus is on communicating the source in SD–Abs mappings, the identifiability of the metaphors that are produced by this kind of mapping is higher, despite the abstraction of source properties. In TD–Abs mappings, however, identifiability is low, as also indicated by the findings of the study. Since designer's main concern is maintaining a target's identity and simplifying the source, there is a risk that the metaphor may go unnoticed. In other words, there are also limits to a target-driven and abstract approach. Therefore, it is imperative that designers pay attention to the identifiability of a metaphor when making an abstraction of source properties.

Concerning the least aesthetic metaphors, the results are very clear: SD–Lit mappings were chosen as a major cause, as expected. In this kind of mapping, the designer leaves highly visible source-reminding cues on the target, without necessarily integrating these into the target's physical properties. This may cause the reference to interfere with the context, form or use of target, as well as create a product that looks very much like the source instead of one whose identity has been maintained. This mapping strategy also does not provide the aforementioned puzzle-solving pleasure to users; the crude reference to a source limits any mental exercise. The direct and obvious reference to a tent and a tiger used in Figure 05.6 points to why this strategy may be regarded as limiting. To obtain aesthetically more pleasing metaphors, care must be taken to match source properties with the inherent target properties; otherwise, there is always the risk of ending up with kitschy products. For these same reasons, this strategy was also considered the easiest strategy to carry out. This result is also in line with our hypothesis, since a direct transfer of source properties without considering the target is easier than essence extraction and appropriate blending with the target. In a design process, a designer may be required to address a variety of concerns related to time or budget, and under these conditions SD–Lit mappings could be useful.

As for the most difficult strategy to carry out, TD–Lit was selected by the majority of the participants, as predicted. Transferring the properties of a source directly to a target, yet keeping this transfer hidden at the same time was considered difficult to accomplish. Some strategies present more natural combinations, e.g., TD–Abs and SD–Lit, whereas trying to protect product identity while "literally" mapping source properties onto it is more challenging. Still the participants found ways to manage this. In Figure 05.6a, a different, non-salient property of the source was mapped to the teapot; this time, it is the stitching holding the tent together. This transferred a source property directly, yet made the reference unclear, since it is a property that does not define and represent that source. The mapped property became a surface decoration rather than a structural component of the form, and made no contribution to the product's use and functioning. In Figure 05.6b, the form of a tiger tooth was again used to shape the product, but this time more literally: the form and colour of a set of teeth was used directly. This caused the end product to become too aggressive, which one may not expect to find in relation to a teapot. Although both approaches appear to fit the requirements of the strategy, meeting these requirements and obtaining an appealing product at the same time may be difficult for the designers.

Conclusions

Creating mappings is one of the major components of product metaphor generation; they directly influence not only the quality of the final product but the process itself. In this paper, we identified four distinct mapping strategies, and investigated their impact on perceived source identifiability, final product aesthetics, and the degree of ease each imparted to the design process. The first two concerns pertain to how conveniently users may understand and appreciate the product, while the third affects how much effort will be required of the designer. We maintain that designers strive to juggle all three of these concerns simultaneously—to the best of their abilities—during the metaphor generation process. We found that a SD–Lit mapping strategy leads to metaphors with the most identifiable sources and is the easiest strategy to follow; while following a TD–Abs mapping strategy leads to metaphors with the least identifiable sources. We also found that creating a TD–Lit mapping is the most difficult strategy to conduct. As regards the aesthetics of the product, the findings gave no special prominence to one strategy over another, although SD–Lit mappings were designated as leading to the least aesthetic products. The possible reasons for this lack of difference have been discussed, yet further research needs to be conducted in relation to factors affecting metaphor aesthetics in order to obtain a clearer understanding of the designerly decisions that may lead to aesthetically pleasing metaphors.

This study focused on the evaluation of the strategies from a designers' perspective. We asked them to employ all four strategies in order for them to be able to compare their strengths and weaknesses experientially. It would be interesting to see, however, how users would evaluate the products generated using different mapping strategies, and if these assessments are in line with the designers' evaluations. Another promising area of future research concerns which properties of a source are selected as part of the mapping to the target, in order to gain a thorough understanding of this process. The present study focused on "how" a designer creates a mapping when generating a metaphor, but future study should be conducted within which designers are asked to reveal how they analyse the properties of the source for mapping purposes. Product design is a field where metaphors abound, yet the inclusion of metaphor as a research subject in the literature is limited. Each step taken in extending the discussion of metaphors to the world of design provides an opportunity to enhance our understanding of the process designers go through when generating products, so that we might develop strategies to improve the performance of designers. Revealing how to take meaningful and creative decisions in this respect can help designers to achieve more interesting, appropriate, and pleasant metaphors, and eventually improve communication with users. The findings reported in this paper may provide designers with insight into effective ways of using metaphors in their design process. The results also have potential for design educators. The setting of the study can be used as an exercise that will provide students with hands-on experience with aesthetics and the communicative value of metaphors, at the same time that opportunities for generating good metaphors can be explored.

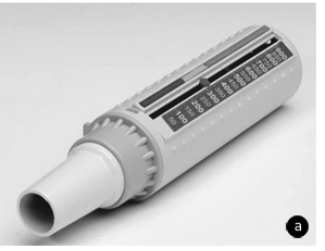
/06
PRODUCT METAPHOR AESTHETICS

So far, we have addressed the decisions that designers need to consider while coming up with a metaphorical association and applying this association to physical form. In this chapter, we shift our attention to the "goodness" of these decisions and investigate four factors that contribute to the aesthetic pleasantness of a product metaphor.

This chapter has been submitted as:

Cila, N., Borsboom, F. & Hekkert, P. (submitted). Determinants of aesthetic preference for product metaphors. Manuscript submitted to Empirical Studies of the Arts.

FIGURE 06.1. (a) A regular peak flow meter, (b) "Kus" peak flow meter (designed by Esin Arsan).



A peak flow meter is a simple monitoring device for people with asthma, which provides numerical feedback on how constricted airways are based on the force of a breath as it is exhaled (see Figure 06.1a). The device has a medical appearance, and its use is generally not very intuitive, especially not for children, who need to consult their parents or doctors when assessing their score. We see another peak flow meter in Figure 06.1b, where the designer has introduced a novel way to measure airflow by associating the use of the device with the familiar blowout party favour. Color-coding is used to give feedback on exhalation force; when the blower unrolls fully, a playful sound is heard, indicating that airways are not constricted. Observing this relationship is not only appealing, it was also proven to help children assume the primary role in their treatment by providing them a more playful and less intimidating tool that is very intuitive, friendly and fun (Arsan, 2011).

This kind of *product metaphor* is created by designers to communicate what a product does, how it should be used or operated, and/or to impart an expressive or symbolic quality. By designing a product (the *target* of the metaphor, e.g., the peak flow meter) so as to elicit the experience of a different entity (the *source* of the metaphor, e.g., a party blowout), designers employ metaphors as aesthetically pleasing stylistic devices because they fulfill these communicative purposes economically (Hekkert, 2006; Ramachandran & Hirstein, 1999). Despite this aesthetic quality of a metaphor, some product metaphors are clearly more appealing than others. The present paper addresses the question of what makes for a "beautiful", or aesthetically attractive, product metaphor.

A product metaphor has two components: like a verbal metaphor, there is a metaphorical *association* between a target and a source; in addition, there is a

physical *application* of this association. To illustrate these two components further, consider a product metaphor that resulted from an association between a pencil sharpener (target) and a beaver (source; see Figure 06.2). Beavers are known for skillfully and diligently gnawing wood using their front teeth, which is why they are an appropriate source for a pencil sharpener design. The designer of the product intended to playfully transfer the precise and skilled wood-gnawing qualities of a beaver to the pencil sharpener he created, and these become the underlying associations in the metaphor. A metaphorical association involves building a conceptual correspondence between a source and a target: identifying the reason(s) a pencil sharpener can be associated with a beaver, and which properties of a beaver are transferrable to a pencil sharpener.

After finding an association, the designer needs to transform this idea into a concrete physical entity. This is the application stage of metaphor generation, where a designer merges the target and source by incorporating certain relevant physical properties of the source onto (compatible properties of) the target. In our example, the metaphor was embodied by shaping the pencil sharpener in such a way that its form reminds us of a beaver. The reference is subtle enough that it does not interfere with our understanding of the product; rather, it enhances what the product has to offer.

In this paper, we propose that both components of product metaphors, i.e., association and application, influence the aesthetic preference for metaphors. We predict that for both components the designer needs to strike a balance between *clarity*—the association must be understandable and, as regards the application, the source must be identifiable—and *interestingness*—the association should also be novel and the application subtle. We begin this article with an overview of these four factors and their relevance to aesthetic preference. Next, we present two studies investigating our hypotheses, followed by a discussion of our findings in light of aesthetic theories. Finally, recommendations for generating aesthetically pleasing product metaphors are discussed.

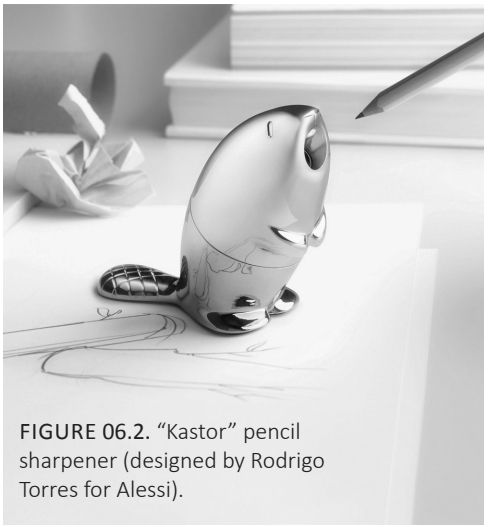


FIGURE 06.2. "Kastor" pencil sharpener (designed by Rodrigo Torres for Alessi).

Metaphors and aesthetics

Much of the existing work on metaphors belongs to the domain of cognitive linguistics and psychology. Here, various scholars have investigated the factors that affect the quality of a verbal metaphor, such as the semantic distance between target and source (Clevenger & Edwards, 1988; Katz, 1989; Malgady & Johnson, 1976; Marschark et al., 1983; Tourangeau & Sternberg, 1982), the salience of the features shared by target and source (Katz, 1989; Ortony, 1979; Tourangeau & Rips, 1991), a

metaphor's appropriateness (Glucksberg & Keysar, 1979; Jones & Estes, 2006), imageability (Fainsilber & Kogan, 1984; Paivio & Walsh, 1979), novelty (Bowdle & Gentner, 2005; Fainsilber & Kogan, 1984), and integration in its context (McCabe, 1983), and finally, a source's concreteness (Katz, 1989; Paivio & Walsh, 1979), conventionality (Marschark et al., 1983; Pierce & Chiappe, 2009) and unambiguity (Glucksberg et al., 1997). As these studies deal with verbal metaphors, all the factors mentioned only concern the quality of the metaphorical association in terms of its comprehensibility or originality. We maintain that product metaphors have an additional component of physical application that, for obvious reasons, has not been addressed in the literature. Furthermore, whether these factors relate to the understanding and appreciation of metaphors found in the product design domain, and how they do so, remains unclear. For these reasons, design research needs an empirical investigation of the factors affecting aesthetic preference for product metaphors. As regards the aesthetic experience of artworks, Gombrich (1984) asserted, "the most basic fact of aesthetic experience is the fact that delight lies somewhere between boredom and confusion" (p. 7). As a matter of fact, this is a common standpoint shared by many scholars working in the domain of aesthetics. For something to be considered aesthetically pleasing, there should be a balance between the extent to which it presents something of interest and the extent to which it makes sense (Berlyne, 1971, 1974; Coates, 2003; Crilly, Moultrie & Clarkson, 2004; Eysenck, 1942).

More recently, Hekkert (in press) adapted this balance to the domain of product design and argued that this dichotomy reflects a fundamental conflict between our needs for safety and accomplishment. Safety needs, on the one hand, drive us towards familiarity, order and clarity, and lead to our approaching things that do not make much demand on our processing capacity. Accomplishment needs, on the other hand, propel us towards originality, novelty and exploration, and make us take risks and extend our capabilities, eventually demand more resources. The aesthetic pleasure we derive from any kind of artefact peaks when we strike a balance between our needs for safety and accomplishment at perceptual, cognitive, and social levels of processing. At the cognitive level, for example, Hekkert, Snelders and van Wieringen (2003) empirically demonstrated that products are preferred when they are perceived as simultaneously maximizing typicality and novelty. Here we propose that this "battle of impulses", or trade-off between needs, also underlies people's aesthetic preference for product metaphors. Regarding the association underlying a metaphor, striking this balance then involves maximizing understandability and novelty, and as for metaphor application, the balance must be sought between source identifiability and subtlety of execution. Below, we will discuss each of these four factors in detail.

Associations underlying the metaphor

A metaphorical expression is considered to involve a "tension" between target and source, as these are normally disparate entities and their similarities and differences create an incongruity to solve (Richards, 1965). This incongruity induces arousal, which is reduced via a conceptual resolution when entities are blended appropriately (Anderson, 1964). Once a metaphorical idea is understood and the hidden similarities between a target and a source are identified, the negative tension in the meta-

phor is relieved. This is why resolving a metaphor is found aesthetically pleasurable (Ramachandran & Hirstein, 1999; Sopory & Dillard, 2002).

In order to create this arousal, the association of a particular target and source needs to be perceived as unfamiliar, unexpected, and novel by the metaphor's recipient. Novelty provides a conceptual challenge to overcome; it is therefore one of the key factors that influence the overall attractiveness of a product metaphor. We believe associating a beaver with a pencil sharpener is a novel idea: The designer has made a break with the expected appearance of a pencil sharpener by building a clever relationship between the wood/lead sharpening function and the gnawing behaviour of a beaver. Moreover, the mundane and pragmatic pencil sharpener usually does not come with metaphorical references. For these reasons, we appreciate the novelty underlying this association.

Now, let us imagine a different pencil sharpener that also mimics an animal, such as a dolphin. This association would be uncommon and novel as well, yet it would not be considered appropriate. It does not make sense because a dolphin does not have any obvious relationship with gnawing wood, let alone sharpening pencils. This is why we cannot define metaphoric quality strictly in terms of novelty. The visual appeal of a product is also influenced by the extent to which it makes sense to the viewer (Crilly et al., 2004). In order to grasp the meaning of a metaphor, users need to understand what the designer intended by bringing together a particular source and target. By building a meaningful and logical relationship between a target and a source, this understanding is secured. Several studies have found that metaphoric quality is closely related to metaphoric comprehension (Blasko, 1999; Malgady & Johnson, 1976; Tourangeau & Sternberg, 1981). In sum, for a metaphorical association to be aesthetically appealing, it has to be both novel and understandable. This is also in parallel with how creativity is typically defined: The quality of creative products is a function of both novelty and appropriateness (Finke, 1990; Runco & Charles, 1993; Sternberg & Lubart, 1999).

Novelty and understandability are not independent. Overly optimizing one of the factors may easily be to the detriment of the other: Highly novel metaphors may lack understandability and risk absurdity, whilst exceedingly obvious metaphors often lose their interestingness, and thus their power to surprise. Our first hypothesis therefore holds that aesthetic preference for product metaphors will be determined by the joint influence of novelty and understandability. Since novelty and understandability will most likely be negatively correlated, our hypothesis implies:

H1: Novelty and understandability will be positively related to aesthetic preference when the counteracting influence of the other factor is controlled for.

Application of the metaphor

When a designer blends a particular source with a target, s/he creates a product that makes a (visual or otherwise) reference to another entity, the source. This reference provides a playful puzzle for our brain to solve. Paradoxically, discovering a

property after a struggle is considered more pleasing than encountering one that is instantly obvious (Ramachandran & Hirstein, 1999). As Armstrong and Detweiler-Bedell (2008) state, "Immediately recognizing an object tends to be mildly pleasant, whereas sensing the prospect of successfully representing a complex object can be exhilarating" (p. 305).

When applying a metaphor, any reference to a source should be subtle enough that it presents the observer with a visual puzzle. This means that a designer needs to keep the properties that are mapped from source to target at a minimum, and tailor these properties to blend with the product rather than "forcing" them onto the target too coarsely and explicitly. Incorporating the source properties into a target in a literal and unsubtle fashion makes the product lose its identity by interfering with the product's common form, context and use, and eventually generate an unattractive product (Cila, Özcan & Hekkert, in press).

In the pencil sharpener example, we consider that an appropriate level of subtlety has been achieved in the application of the metaphor. The product includes typical beaver properties such as a body, tail, and front teeth, but these properties were abstracted and incorporated in such a way that they became an essential part of the form of the pencil sharpener. In other words, the physical form of the beaver was suitably adapted to the form and use requirements of a pencil sharpener; the irrelevant properties of a beaver's physical aspect (e.g. claws, fur, ears) were left out. Consequently, the sharpener makes a rather subtle visual reference to a beaver, and acquired a coherent organic shape that is pleasurable to look at. Still, missing the reference would be difficult, since the source has been noticeably drawn to users' attention through the visual composition of the product (and the name, "Kastor"). This is why the visual puzzle suggested by this product is aesthetic: The reference is hidden but can still be identified.

Designers are required to leave visible cues for users to identify the source, or else users would miss the reference and the whole metaphor. Metaphorical associations are always inferred from target–source couplings, and source identification is therefore the first step in understanding and appreciating a designer's intentions (Cila et al., in press-b). In order to create the most effective and aesthetic metaphors, designers should keep the reference to a source subtle but to some extent apparent, i.e., strike a balance between subtlety and identifiability. If identifiability outweighs subtlety, the product might be too straightforward and kitsch (Cila, Özcan & Hekkert, in press). Alternatively, if subtlety outweighs identifiability, the metaphor could be missed entirely. We hypothesize that only when these factors are in balance, and the product is both subtle and identifiable, will it be considered aesthetically pleasing. Similar to the trade-off between novelty and understandability at the association level, we predict subtlety and identifiability to be negatively correlated. For this reason, the second hypothesis also entails:

H2: Subtlety and identifiability will be positively related to aesthetic preference when the counter-influence of the other factor is controlled for.

The Present Studies

We conducted two studies to investigate our hypotheses regarding the relationship between the underlying association and application of a product metaphor and aesthetic preference. Study 1 tested whether the novelty and understandability of a metaphorical association, and the subtlety and identifiability of its application positively affect the perceived aesthetic appraisal of existing product metaphors. We collected various examples of product metaphors and asked participants to rate them in terms of these four constructs, and on aesthetic preference. In Study 2, we specifically focused on metaphor application and generated series of products that systematically varied on the dimensions of subtlety and identifiability. Below, these studies will be presented in detail.

Study 1

Method

Participants

A total of 60 participants (mean age = 22.02, *SD* = 3.24, 36 female), were recruited via a flyer from the student population of 18 different universities in the Netherlands. All participants received a cinema ticket that was worth 10 Euros for their contribution.

Procedure

To assess participants' aesthetic preference, we collected 70 product metaphors from various design books and websites. These products were selected to represent variation along the scales of novelty/understandability and subtlety/identifiability. Pictures of the products were printed on cards, and two external judges with a background in industrial design assessed whether all degrees of the four variables were covered equitably, by ranking them on two separate 3 x 3 (High, Medium, Low) grids for novelty–understandability and subtlety–identifiability. After this evaluation, 60 product metaphors were selected for use in the study (see Appendix A).

Pictures of these products were put in an online questionnaire. At the beginning of each session, participants were given an introduction to what a product metaphor is via a detailed discussion of an example. Each product metaphor was then presented on a separate page in the questionnaire, together with a description of what the product is and what it refers to, as in "A pencil sharpener that refers to a beaver". Participants rated the metaphors in random order on the following 7-point rating scales: (1) "The association between the target and the source is ("target" and "source" were replaced with the target and source of that particular metaphor in all questions): Common–Novel, Not understandable–Understandable", (2) "The reference to the source is: Obvious–Subtle, Unidentifiable–Identifiable", (3) "The product metaphor is: Not beautiful–Beautiful", and (4) "I don't like the product–I like the product". The last two scales, beauty and liking, were used to operationalize

aesthetic preference (Berlyne, 1974; Leder, 2001). All scales had to be filled in before a participant could proceed to the next question. Completing the questionnaire for all 60 products took about one hour.

Results

For each product, participants' mean ratings for novelty, understandability, subtlety, identifiability, beauty, and liking were calculated (see Table 06.1). Mean ratings of beauty and liking showed a very high positive correlation, $r = .95$, $p < .001$, and were averaged to obtain one measure for aesthetic preference.

	M	*SD*	*SE*
Novelty	5.06	.95	.12
Understandability	4.24	1.15	.14
Subtlety	3.45	1.11	.14
Identifiability	4.90	1.19	.15
Beauty	4.01	.83	.10
Liking	4.10	.83	.10

TABLE 06.1. The mean scores, standard deviations and standard errors of the variables.

Simple Pearson product-moment correlations were computed within each pair of variables and with aesthetic preference. As expected, the mean novelty and understandability ratings, $r = –.76$, and the mean subtlety and identifiability ratings, $r = –.96$ (both p's $< .001$), showed a high negative correlation. As regards the correlations with the mean ratings of aesthetic preference, mean understandability, $r = .56$, and identifiability, $r = .49$ (both p's $< .001$), ratings showed a moderate correlation with aesthetic preference, whereas the mean novelty, $r = –.13$, *ns*, and mean subtlety, $r = –.32$, $p < .05$, ratings showed weak and negative correlations with aesthetic preference.

Given the high negative correlations between novelty and understandability and between subtlety and identifiability, either of these variables may have functioned as a suppressor variable with respect to the relation between the opposing variable and aesthetic preference. We performed partial correlations in order to check whether this was the case. With novelty held constant, the correlation between understandability and aesthetic preference increased, $r = .72$, $p < .001$, and with understandability held constant, the mean novelty scores began to show a significant positive correlation with the mean aesthetic scores, $r = .55$, $p < .001$. Similarly, when subtlety was held constant, the correlation between identifiability and preference remained highly significant, $r = .72$, $p < .001$, while the mean subtlety scores were now also positively correlated with the mean aesthetic scores, $r = .65$, $p < .001$, when corrected for identifiability.

In order to assess how much variance in the ratings of aesthetic preference can be explained by the four predictor variables together, a multiple regression analysis was performed. This analysis indicated that 69% of the aesthetic preference variance

could be accounted for by these four variables (R^2 = .69, $F(4, 59)$ = 31.48, p < .001). The regression weights of the variables revealed the relative importance of each factor in predicting aesthetic preference: novelty, b = 0.40, SE = .11, β = 0.46, understandability, b = 0.50, SE = .10, β = 0.70, subtlety, b = 1.17, SE = .22, β = 1.57, and identifiability, b = 1.22, SE = .22, β = 1.76 (all p's < .001). These results indicate that all variables contributed to explaining aesthetic preference for product metaphors, but the higher beta weights of identifiability and subtlety showed these application factors were relatively more important.

Discussion

In this study we demonstrated that the aesthetic preference for product metaphors is determined by the joint effect of novelty and understandability of a metaphorical association, and the subtlety and source identifiability in a metaphor's application. A closer look at the correlation coefficients and regression weights indicates that for each pair of variables, i.e., novelty vs. understandability and subtlety vs. identifiability, both variables are almost equally important in explaining aesthetic preference, with participants displaying a tendency to place a bit more weight on the "safety" variables of understandability and identifiability. These two factors primarily serve to highlight that a metaphor has been embodied in a product, and support users' efforts to reason why the metaphor has been employed. In other words, when these conditions are not met, we cannot talk about a metaphor experience in the first place. After the source and the metaphor have been recognized, users (un)wittingly examine if the idea behind the metaphor is interesting, exciting or novel, and whether it has been applied with a subtle, "designerly" touch, i.e., one that is not too straightforward and obvious. To the degree that all these conditions are met a complete aesthetic experience can be enjoyed.

The results also indicated that the application of a metaphor had more effect on aesthetic preference than the underlying association: Both factors indicating the application component, i.e., subtlety and identifiability, had considerably larger beta weights in the overall regression analysis. This finding suggests that our aesthetic preference is directed more towards how a metaphor is embodied in a product rather than the metaphorical association as such. Considering the dominance of (visual) appearance in our aesthetic appreciation of objects (Postrel, 2003), this may not come as a surprise. Perhaps it is more striking that the two factors representing the quality of the association played such a prominent role in the aesthetic preference judgments. This could instigate further research into attributes of an underlying idea and their contribution to the aesthetic quality of a designed object.

In a further study we continue investigating product metaphor beauty by looking more closely at the more dominant application factors. Finding a sound novel association may involve some luck or talent, but the embodiment of a metaphor is an activity that designers are trained in extensively. A better understanding of this embodiment stage may therefore inform and support this training.

In the first study, we used existing product metaphors as stimuli. The effects we found, however, could have been influenced by the selection of these stimuli. That

is, identifiability and subtlety varied across the range of products selected, and these products also vary across many other dimensions than these two factors (e.g. product category, form, function, colour, and so on). To put the predicted and observed trade-off between subtlety and identifiability to a more rigorous test, we need a "within product" variation of these factors under careful experimental control. In Study 2, we put our second hypothesis to the test by systematically manipulating subtlety and identifiability for two newly designed product metaphors. Again, we hypothesize that among metaphors generated by designers, the ones that are at the same time high in identifiability and high in subtlety will be found the most aesthetically pleasing, whereas the ones that are low across both dimensions will be found the least pleasing.

Study 2

Method

Participants

A total of 79 participants (mean age = 22.5, *SD* = 2.91, 34 female) were included in Study 2. These participants were recruited from the Department of Industrial Design Engineering from Delft University of Technology because of their training in visual qualities of products, which we considered would guide them to notice subtle differences between the designs we generated and more importantly appreciate the difference these subtle changes make on the overall effect of a product. All participants volunteered to contribute to the study and received no compensation.

Stimuli

We selected two products to create the metaphor for—a USB flash drive and a mug—since these are familiar, everyday products with a simple, iconic form that can be easily manipulated. A trained designer with a BSc and MSc in Industrial Design created a metaphor for each of these products. For the first metaphor, a USB flash drive was associated with a tower. The guiding idea behind this association was the desire to emphasize that the data stored on the flash drive would be "fortified" and could not easily be "conquered". For the second metaphor, a mug was associated with a koala to convey warmth and comfort, which is enhanced by the way the koala "hugs" one's hand while drinking coffee. Designs for the USB flash drive and the mug were digitally altered by systematically manipulating their degrees of subtlety and identifiability to create the intended metaphors. Uniform colouring, background, shadowing, and presentation angle was maintained across all images.

We used three levels of subtlety and identifiability (High, Medium, Low), which resulted in nine combinations for each product metaphor (see Figure 06.3). Identifiability of the metaphor was manipulated by varying the "number" of properties that were mapped from source to target product, where identifiability was expected to increase with the number of properties. Subtlety was manipulated by varying the level of "detail" in these mapped properties, where less detail was considered to be

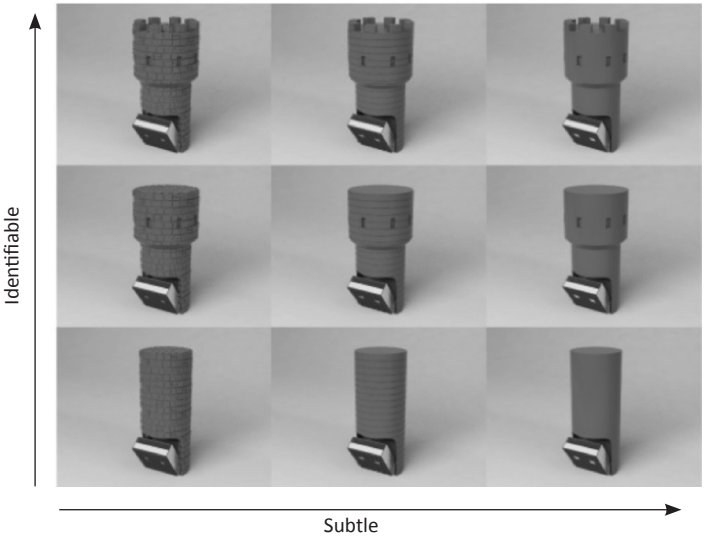
more subtle. In a pre-test, six experts teaching at Industrial Design department of Delft University of Technology rated the level of subtlety and identifiability of the generated stimuli on a 9-point scale, with three experts rating each product (mean age = 33.5, *SD* = 7.2, 4 female). The inter-rater reliability coefficients showed a strong agreement between the ratings: for the tower USB flash drive, identification level, ICC = .96 (95% confidence interval 0.89–0.99) and subtlety level, ICC = .73 (0.12–0.93); for the koala mug, identification level, ICC = .79 (0.37–0.95) and subtlety level, ICC = .84 (0.54–0.96). These results indicated that our manipulations of subtlety and identifiability were effective, and we therefore proceeded with these stimuli to address aesthetic preference.

Procedure

Participants were asked to fill out a questionnaire that consisted of a double-sided A4 sheet (one sheet per metaphor set). The first side included a brief description of what a product metaphor is, similar to the one used in Study 1. Participants were told that in an effort to determine which product version had the "best" appearance, they would be shown several versions and asked to rate how they felt each version looked. We only used the beauty scale from 1 (not beautiful) to 7 (very beautiful) in this study because the results of Study 1 showed it correlated highly with liking. Participants were shown both metaphor sets in random order, and the order of the products in these sets was also randomized. They were also asked to write down what they think the product referred to in order to check if they identified the source correctly. Completing each questionnaire took around 2 minutes.

Results

The responses of the participants who were not able to identify the source correctly were eliminated (3 for USB flash drive, 18 for mug). These misidentifications in-



cluded a turret, “chess” and a banana for the USB flash drive; and a mouse, a bear, a doll, an elephant, a wallaby, a cup, a toothbrush holder, “friendly”, and “cuddling” for the mug. The mean ratings on aesthetic preference for each product version are presented in Figure 06.4.

We performed a 2 x 3 x 3 (Product: USB flash drive x Mug; Identifiability: High x Medium x Low; Subtlety: High x Medium x Low) repeated-measures ANOVA with aesthetic preference as dependent variable. Mauchly’s test indicated that the assumption of sphericity had been violated for the main effect of identifiability, $\chi^2(2) = 22.51$, $p < .001$, and subtlety, $\chi^2(2) = 8.61$, $p < .05$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .72$ for the main effect of identifiability and .85 for the main effect of subtlety). The results showed that, as predicted, the aesthetic preference of product metaphors was significantly affected by the degree of identifiability, $F(1.44, 69.53) = 12.46$, $\varepsilon^2 = .2$, $p < .001$, and the degree of subtlety of the reference to a source, $F(1.71, 82.22) = 6.44$, $\varepsilon^2 = .11$, $p < .01$. We did not find a main effect for product type, $F(1, 48) = 2.32$, *ns*.

Contrasts revealed that metaphors with high identifiability were considered more beautiful than metaphors with medium, $F(1, 48) = 28.1$, $\varepsilon^2 = .36$, $p < .001$, and low identifiability, $F(1, 48) = 8.5$, $\varepsilon^2 = .15$, $p < .01$. There was no significant difference in preference ratings for metaphors with medium and low identifiability. For subtlety, contrasts revealed a significant difference in aesthetic preference for metaphors with high subtlety over the ones of low subtlety, $F(1, 48) = 6.56$, $\varepsilon^2 = .12$, $p < .05$, and metaphors with medium subtlety over low subtlety, $F(1, 48) = 11.74$, $\varepsilon^2 = .19$, $p < .001$. Beauty ratings for metaphors with high or medium subtlety did not differ.

Finally, there was a significant interaction effect between the degree of identifiability and the degree of subtlety of metaphor application, $F(3.05, 146.39) = 5.17$, $\varepsilon^2 = .09$, $p < .01$ (see Figure 06.5). Looking at Figure 06.5, this effect shows that at the highest

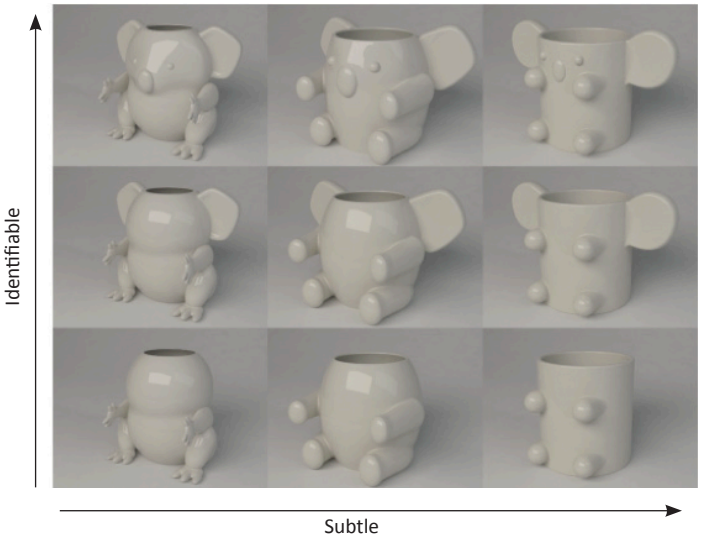


FIGURE 06.3. Stimuli used in the study.

level of identifiability, aesthetic preference did not increase with increasing subtlety, whereas it did at low and medium levels of identifiability (albeit subtlety from low to medium). Apparently, at low and medium identifiability levels, where only one or a few properties are mapped, literally incorporating properties is not considered aesthetically pleasing. All other 2- and 3-way interaction effects were non-significant.

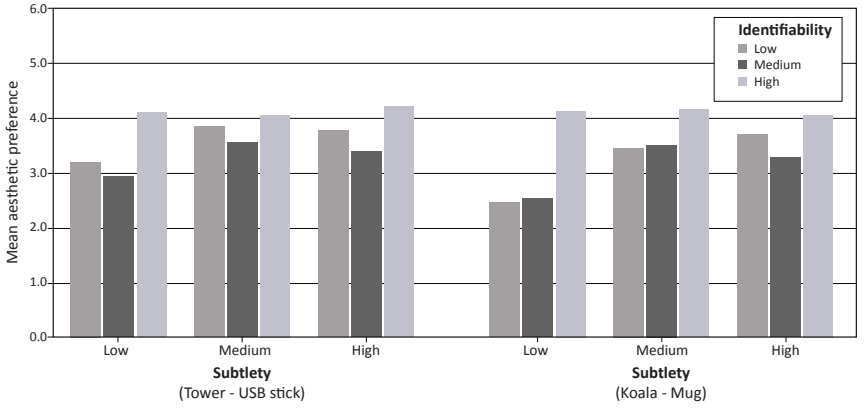


FIGURE 06.4. Mean aesthetic preference scores for each stimulus.

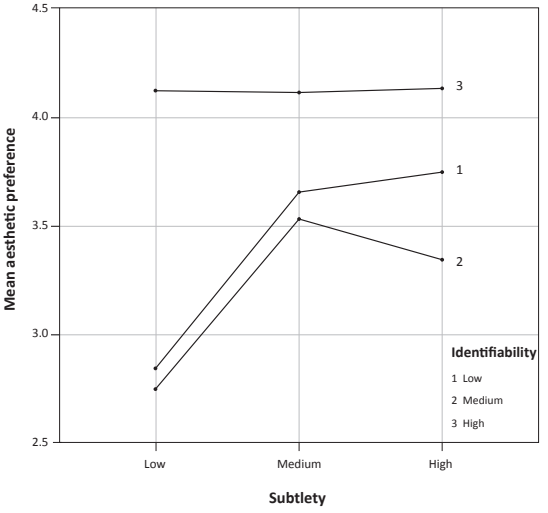


FIGURE 06.5. The combined means of aesthetic preference for stimulus with different levels of identifiability and subtlety.

Discussion

The findings of this study provide further support for the joint effect of subtlety and identifiability in explaining aesthetic preference for product metaphors. Main effects for both identifiability and subtlety indicate that, as predicted, maximizing the two factors leads to the highest aesthetic preference and minimizing them leads to the least aesthetically preferred metaphors. Yet, this finding should be treated with some caution, as the interaction effect showed that subtlety of application mattered when its identifiability was low or moderate, but not when identifiability was high.

In other words, the study confirms the joint effect of subtlety and identifiability on aesthetic preference, but the effect of subtlety is relatively small.

The surprising result here is that the low subtlety–high identifiability variant scored as high as the high subtlety–high identifiability variant. The reason for this may be that the direct mimicking of the source in this variant may have had an advantage that we did not foresee. Regarding the koala mug for instance, a koala is an animal that already has a visually pleasing form. As the form properties of a koala have been directly transferred to a mug in this variant, participants may have unintentionally evaluated the general koala form, instead of considering the product as a "mug" that refers to a koala and evaluating it as a "koala mug". In other words, they may have regarded the product as a porcelain koala, or a toy, rather than as an everyday mug, which may have resulted in their having other use contexts in mind than drinking coffee (e.g., displaying, playing with) and rating the product accordingly.

The score difference of this high identifiability variant from the remaining alternatives with lower levels of identifiability is easier to explain. Again, participants may have preferred a product that completely mimics a source to a product that obviously makes reference to something, but where it is not clear what this reference is, as is the case with the mugs featuring detailed arms and legs or big ears but lacking a defined face. If we look at the lower left product variants, especially as regards the koala, we tend to see a mutilated animal. As we operationalized identifiability with the number of properties transferred from source to target, and subtlety with their amount of detail, these variants included a few (non-identifying) properties of a koala, which were very detailed nevertheless. This might have confused or even horrified participants, and made them rate their preference for these alternatives lower. This is also supported by the interaction effect, shown in Figure 06.5, which indicated that preference dropped drastically when identifiability decreased in the low and medium subtlety conditions.

A second explanation for a larger identifiability than subtlety effect may be that we unintentionally manipulated identifiability more proficiently than we did subtlety when generating the stimuli. Although the pre-test did not indicate so, our detail simplification to manipulate subtlety may not have been dramatic enough to enable participants to assess the differences between them, especially because the assessment experts made may not have matched the assessments made by the participants, who were mainly design students. Experts are generally recognized for their ability to make finer discriminations in their domain of expertise (Weisberg, 2006). For these reasons, we intend to conduct further studies to more fully understand the trade-off between subtlety and identifiability in explaining aesthetic preference.

General Discussion

When do people experience product metaphors as aesthetically pleasing? The studies we have conducted to address the factors that affect aesthetic preference revealed that the extent to which a metaphor is recognizable and comprehensible must be

weighed against the extent to which it presents a challenge to the perceiver in terms of novelty and subtlety. In Study 1, we focused on analyzing existing product metaphors. We found that a definition of metaphoric quality as the interplay between the novelty and understandability of a metaphorical association on the one hand, and the subtlety and identifiability of metaphor application on the other, can serve as an index of aesthetic preference for metaphors. Since the factors in these couples negatively correlate with one another to a large extent, each suppresses the positive effect of the other. When the effect of the pairing factor is statistically controlled for, both factors are in a positive and linear way related to aesthetic preference for product metaphors.

The results of this study also clearly indicate that metaphor application has a bigger impact on aesthetic preference than the underlying association. For this and other reasons, we continued our study of metaphor application in Study 2, testing how subtlety and identifiability jointly influence aesthetic preference for metaphors by systematically and separately manipulating these factors. The results indicated that preference was again determined by a combined effect of these two factors: Increasing both subtlety and identifiability leads to increased aesthetic preference, whereas decreasing them deteriorates aesthetic preference. It was also found that identifiability had a bigger effect on preference than subtlety. This may have been caused by the importance of identifying and making sense of an object before being able to appreciate a metaphor and/or the way subtlety and identifiability were manipulated. A systematic manipulation of the factors provided a more controlled analysis of their effect on metaphor quality, yet it also brings with it new problems that should be tackled in further studies.

The fact that the effect of all four factors was observed independent of product type in both studies suggests that these factors are applicable across a diverse range of products. A designer can come up with novel metaphorical associations for any kind of product by making a break with the expected look, function, context or meaning of the product and choosing a "hidden quality" of it to highlight through the metaphor (Cila et al., in press-b). On the basis of the quality s/he intends to emphasize s/he should then select a source for which this is a salient quality in order to employ it in the metaphor (Cila et al., in press-a). In this way, the designer ensures that the association s/he builds between a particular target and source is novel, as it emphasizes an uncommon quality of the target, yet understandable, as this quality is shared by both of them.

In the application of a source, subtlety can be achieved by abstracting the essence of the source, eliminating all parts irrelevant to the context of a product, and blending its properties thoroughly with the target (Cila, Özcan & Hekkert, in press). By transferring only this essence to a target, a designer keeps the reference subtle—as many details of the source have been eliminated—yet identifiable, as the most prominent properties have been used. When these approaches are followed as regards finding a metaphorical association and applying it, it is most likely that people will find the metaphor aesthetically pleasing. The results of the regression analysis in Study 1 indicated that these four factors explained almost 70% of aesthetic preference. Other variables that could be added to such an analysis to increase this level

of explained variance have been proposed by Hekkert (in press). Along the lines of the "conflicting needs" model, he has argued that similar trade-offs between "safe" and "challenging" variables operate at perceptual (i.e., unity vs. variety), cognitive (i.e., typicality vs. novelty), and social (i.e., connectedness vs. uniqueness) levels of processing. Such variables may very well explain most of the remaining variance.

Generating successful metaphors means facilitating a "leap of imagination" (Brown, 1976, p. 176). Currently, there is no empirical knowledge regarding the factors that can contribute to this leap. The studies reported in this paper were intended to constitute a first step toward understanding the relationship between aesthetic preference and the qualities ascribed to a product metaphor. Although more work is needed, the findings regarding aesthetic preference reported here can not only offer insight and inspiration to design practitioners seeking to generate successful product metaphors, they will also provide researchers working in the product aesthetics field with a solid foundation upon which to develop a comprehensive theory for product metaphor aesthetics.

/07
GENERAL DISCUSSION

In 1979, Max Black said that metaphorical thought was "a neglected topic of major importance" (Black, 1979, p. 31). More than four decades later, we can assuredly state that this picture has been changed regarding verbal metaphors. There are many excellent studies, which have tended to reveal its semantic structure and the peculiar type of thought process that generates it (Bredin, 1992). As regards metaphors used in the design domain, however, Black's statement still holds. Although designers frequently resort to metaphors to achieve cognitive and affective effects through products, there is still a fundamental need for incorporating them in design research.

The studies described in this thesis aimed at this primary goal. In this final chapter, the general findings of these studies will be summarized with a detailed metaphoric communication model and discussed in a broader context of metaphor research and design research. Parallel with developing a model, we also formulated a set of practical recommendations for designers to create successful metaphors. These recommendations will be presented at the end of this chapter, together with directions for future studies.

Summary of the findings

Throughout the thesis, we looked into the characteristics of product metaphors and the decisions designers take when generating them. Starting out with a basic communication model, we gradually explored the specifics of the metaphor experience and metaphor generation processes in the subsequent chapters.

In Chapter 1, the properties of a product metaphor were summarized including its structure and the characteristics of a metaphorical association and mapping. These properties are essentially the means that designers manipulate when generating a metaphor. For this reason, in Chapter 2 we turned our attention from a product-oriented perspective on product metaphors (Chapter 1) to a process-oriented one, and described the main phases of metaphorical communication between a designer and a user. At the end of the chapter, we validated the metaphor generation process we envisioned through an explorative workshop.

In Chapter 3, we focused on the "metaphorical association" that brings together a particular target and source, and addressed the key factors that play a role in finding an appropriate source to associate with the product (Study 1). We found that the sources that have the designer's intended meaning as a salient property and are highly related to the target are preferred over medium or low salient/related alternatives. Furthermore, the results also indicated that being novel, having application potential, and providing a complete and meaningful design concept are also considered as source selection criteria by designers.

In Chapter 4, we focused on the meaning that prompts the metaphorical association. We termed the extent to which the highlighted quality through the metaphor is salient for a target as "metaphor depth" and hypothesized that metaphor depth is influenced both by the effect of the expertise level of the designer (novice or expert) and different types of intention (pragmatic or experiential; Study 2). We found that having a pragmatic intention or being a novice designer led to the generation of surface metaphors, whereas having experiential intentions or being an expert facilitated the generation of deeper metaphors. In the study, there was also an indirect examination of the time spent on the task and the number of relevant attributional dimensions of product type (i.e., target) on metaphor depth, which did not prove to have a significant effect.

The two studies mentioned so far were intended to tackle the first two research questions—'What is a product metaphor?' and 'How is a product metaphor generated?'. The last research question—which decisions a designer takes during the generation process lead to better product metaphors?—was addressed in Chapter 5 (Study 3) and Chapter 6 (Study 4).

In Chapter 5, we shifted our attention from metaphorical association to its application. We defined four types of mapping strategies (TD–Lit, TD–Abs, SD–Lit, SD–Abs) and investigated their strengths and weaknesses regarding the identifiability of metaphor, the aesthetics of the product, and the ease of mapping (Study 3). It should be noted that "designers" were asked to rate these three

goals, which puts the focus of this study on designers' conception of the experience they intended to evoke in users. The results indicated that the SD–Lit mapping strategy was chosen to lead to the most identifiable metaphors, cause the least aesthetic products, and be the easiest strategy to follow; TD–Abs mapping strategy was chosen to lead to the least identifiable metaphors, and TD–Lit mapping strategy was chosen to be the most difficult strategy to follow. Regarding the most aesthetic metaphors, TD–Abs mapping strategy was chosen over TD–Lit strategy for generating more aesthetic metaphors, yet the remaining comparisons were non-significant. In Chapter 6, we approached metaphor aesthetics from the users' perspective. We studied metaphorical association and application together this time, and investigated how the interplay between novelty and understandability of a metaphorical association, and subtlety and identifiability of metaphor application affect aesthetic preference for product metaphors via two complementary studies. In combination, these studies demonstrated that the aesthetic quality of product metaphors results from simultaneously maximizing clarity (the metaphor is understandable and identifiable) and interestingness (the metaphor is novel and its application subtle) at the association and application level.

It was interesting to see that when designers were asked to evaluate their own outcome in terms of its aesthetics (Study 3), their ratings did not indicate the subtlety–identifiability balance that was addressed in Study 4. The reason might be that they were slightly biased to evaluate the identifiability of their metaphors, as they were the ones who created them and therefore knew what the metaphor referred to. In any case, these two studies also implicitly proved that users might not always evaluate the metaphors designers created as they were intended.

These last two studies addressed metaphor quality "directly", but the former studies also presented some indirect insights regarding this issue, although their aim was to indicate the significant decisions that are taken during metaphor generation. This is because designers intuitively and automatically try to take "good" decisions regarding the comprehensibility and aesthetic pleasantness of a metaphor. For instance in Study 1, the reason that designers considered a particular source to employ in a metaphor implies that they thought that it would be understood and appreciated by users, or in Study 2, the reason that experts generated deeper metaphors in general implies that deep metaphors are more original and aesthetic than surface metaphors. These studies also helped us to infer a more comprehensive understanding of metaphoric quality. Therefore, all the studies conducted within the scope of this thesis directly or indirectly served the purpose of comprehending which decisions taken in the metaphor generation process lead to more successful metaphors.

Overview of metaphoric communication

To address what makes for a product metaphor, we illustrated a final overview of metaphoric communication on the basis of the knowledge we collected throughout this thesis (see Figure 07.1). We first started from the extended model that was presented at the end of Chapter 2: A product metaphor mediates between the experience process of a user and the generation process of a designer. A user goes

through the stages of perceiving that a metaphor has been employed in a product, recognizing its target and source, comprehending why these particular entities are brought together, and appreciating (or not) this association. A designer has a particular intention to attain through the target and comes up with a meaning to convey accordingly, finds a source that can assign this meaning to the product, and creates a mapping from this source to the target. These processes are also influenced by the background characteristics and capabilities of both parties, how they envision each other, and external factors of the context.

In the overview, first the product metaphor characteristics that were presented in Chapter 1 were matched with the corresponding decisions taken in the metaphor generation process, which was presented in Chapter 2. Then, some of the findings of the studies were included in their corresponding places. Each study conducted within the scope of this thesis tackled some relationships found between particular components of the metaphoric communication (see Figure 07.2)[8].

As can be seen in Figure 07.1, the intention of designers to employ a metaphor may be for pragmatic or experiential reasons. When unearthing a meaning to convey on the basis of this intention, they can either focus on more obvious meanings (i.e., surface metaphor) or hidden and unrevealed ones (i.e., deep metaphor). This meaning can also be based on our universal, innate knowledge (i.e., embodied metaphor) or on the knowledge we acquire through our life experiences (i.e., cultural metaphor). Designers are then required to come up with a source that can assign this meaning to the target they design throu¬¬gh their association. For effective communication, this source needs to have the intended meaning as a salient property, be highly related to the target yet belong to another categorical domain, be novel yet understandable, have application potential, and finally, have the potential of creating a complete, functional product. After finding a source, designers then turn this metaphorical idea into a physical reality via mapping. For this, they need to consider which properties of a source to project onto the product (e.g., form, interaction, material, sound, movement, smell, name, graphics) and how to conduct the mapping (e.g., literal or abstract, target-driven or source-driven).

Having brought together the knowledge gathered through previous chapters, in the remainder of this final chapter we will first discuss some meta-issues we want to emphasize in order to provide a broader understanding of our findings, which will be followed by the most prominent implications of the findings.

Some remarks on the findings

In this thesis, we have seen metaphor at work in the design of products. Our aim has been to reveal how numerous aspects of the use of metaphor can be understood from

[8] There are also some factors in Figure 07.1 that were presented in Chapter 1 as a product metaphor characteristic, yet were not investigated by any study (e.g., mapped properties, types of meaning). We will address them in the 'further studies' section of this chapter.

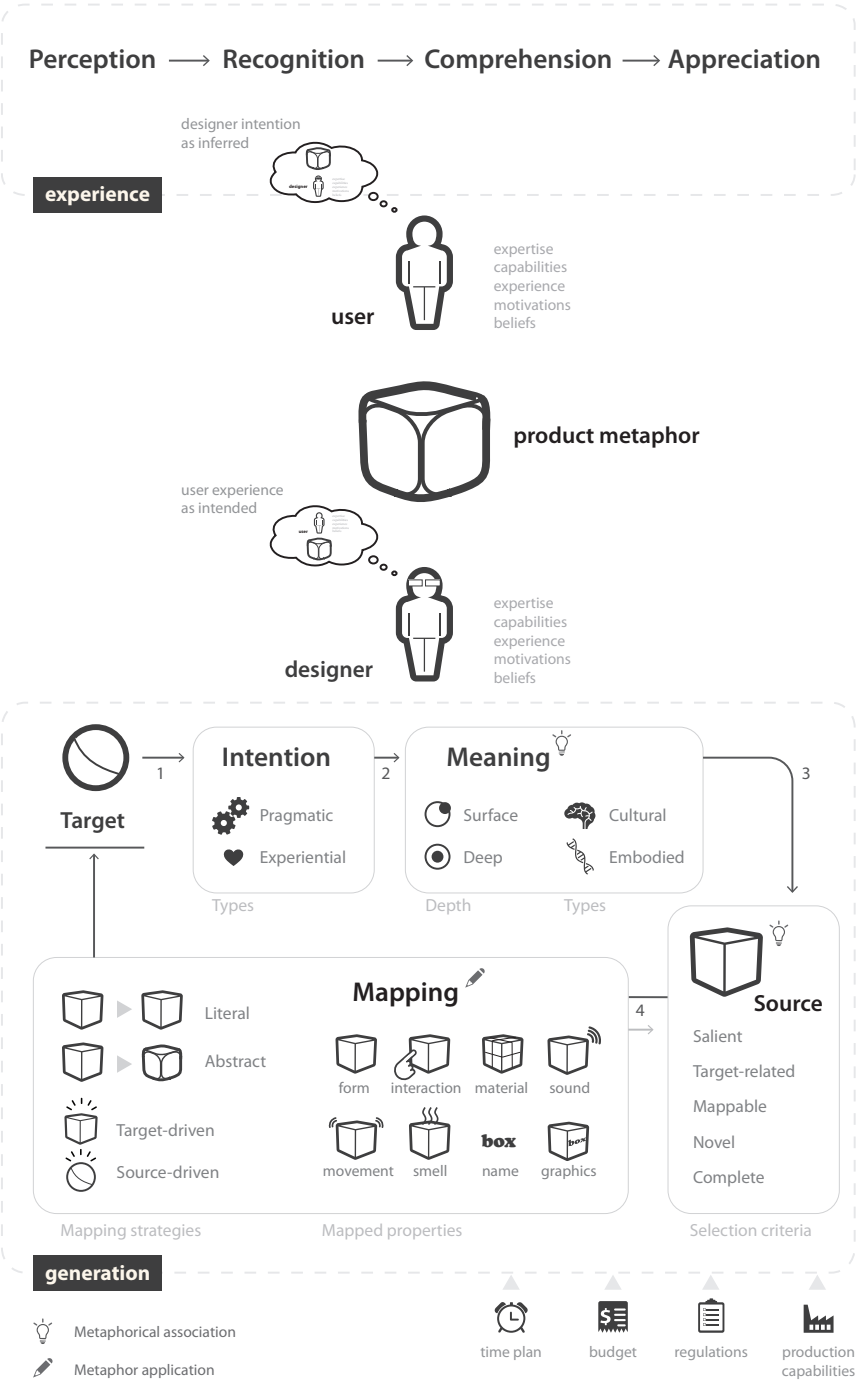


FIGURE 07.1. The overview of metaphoric communication developed through the findings of the studies conducted in the thesis.

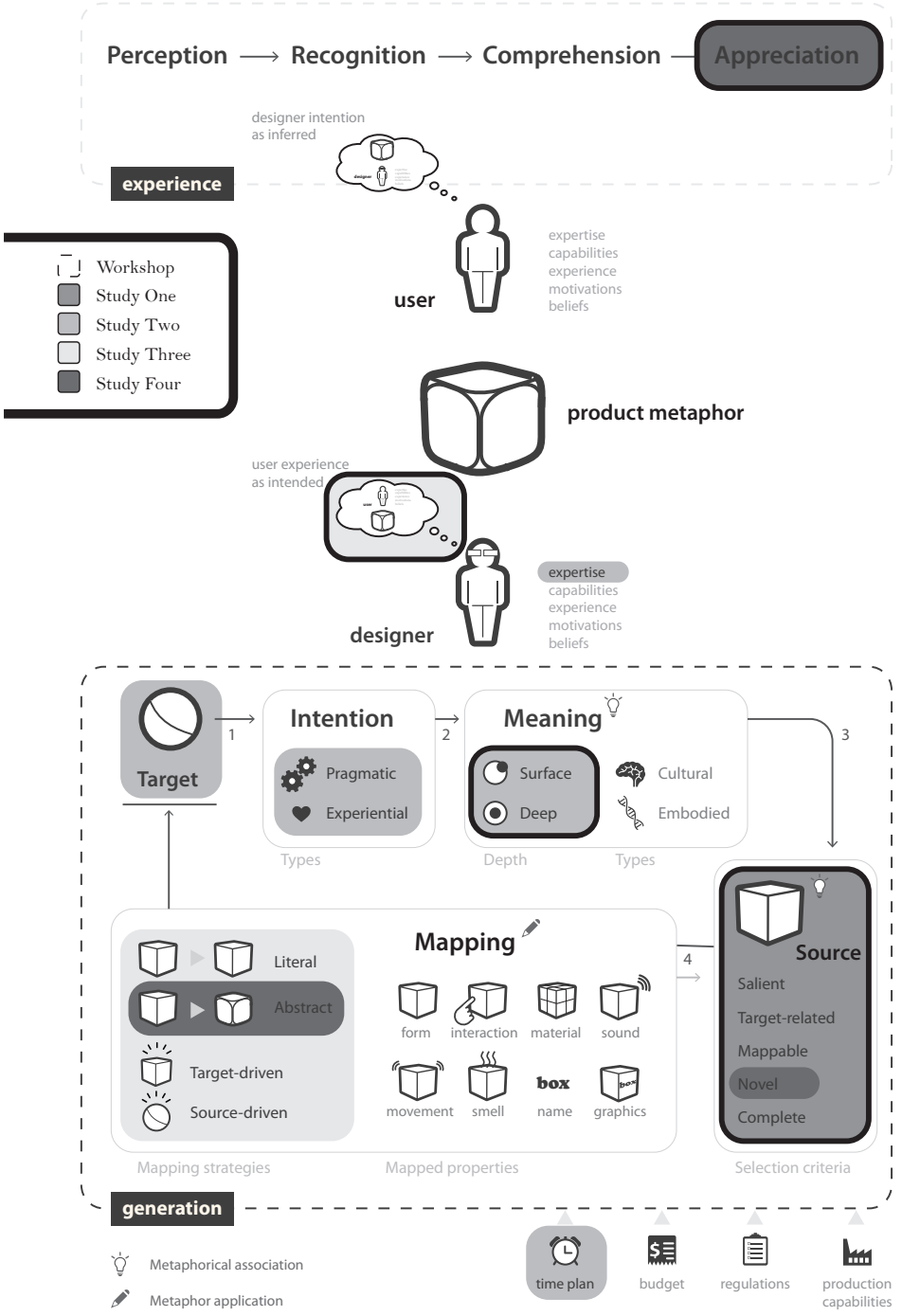


FIGURE 07.2. The components of the metaphoric communication that were investigated via the studies (The colored boxes with black outlines are the dependent variables, the ones without outlines are independent variables of each study).

the perspective of design research. We hope that we were able to provide a compelling overview to the reader regarding this aim, yet some issues related to the findings still need further attention. The research setting and its findings raised some questions (i.e., methodological limitations), and below we will speculate about these.

Metaphoricity of the products

These issues pertain, first, to the definition of metaphoricity. In Chapter 1, we presented the three questions that Forceville (1996, 2002) listed for something to be considered as a metaphor: (1) Which are the two terms of the metaphor, and how do we know? (2) Which is the metaphor's target domain and which the metaphor's source domain, and how do we know? (3) Which features can/should be mapped from the source domain to the target domain, and how is their selection decided upon? Some metaphorical products, however, render the first two questions difficult to answer precisely.

For instance, in Figure 07.3 we see a product that clearly references the ultimate Stone Age tool, a simple rock (source). However, it is not as easy to "name" the target in this example. This product can be used for many different purposes, such as sharpening knives, grating garlic, grinding spices, cracking nuts, tenderizing meet, and so on. Thus, it is unclear if the target here is a sharpening stone, a garlic-chopper, a grinder, or a nutcracker.

It may well be that a combination of all these products is the target. Being unable to identify the target is especially the case with new product categories. In these products, as in Homo Sapiens (Figure 07.3), the source constitutes the whole product. An example can again be the "e-book" concept that was mentioned in Chapter 1. The product's physical similarity to an actual book facilitates the source to be identified as a book; yet how to name the target is problematic because it is a product category that did not exist before (it recently formed its own product type, however). Similarly, the desktop icons in the computer are highly identifiable as a trashcan, folders, documents, and so on; but again how to name the intangible "things" they stand for is a challenging question.

FIGURE 07.3. "Homo sapiens" multi-purpose kitchen tool.

As it is possible to have difficulty in naming the target, in some metaphors naming the source can be tricky. This is the case with embodied metaphors. Let us go back to the NS camera example given in Chapter 1. As the reader may remember, this product appeals to our innate reactions towards infant-like features such as large head, large eyes, round and softer body features. Yet, it is not easy to label the source: The designer did not explicitly refer to a "particular" cute thing like a baby, a doll, or a puppy. Like the target of the Homo Sapiens may be a combination of different kitchen utensils, the source of the NS camera may well be the general category of "all the cute things".

In the examples given so far, we can clearly see or feel the association between a source and a target, yet it is difficult to 'name' precisely what they stand for. In some products, however, we can clearly name these parties but it is not clear which one of them is the target and which is the source. For instance, in Figure 07.4 we see a product that is a hybrid of a tie and a USB stick. This (slightly awkward) product was intended for rendering data sharing quick and easy in a business environment. But, is it a tie that references a USB stick or a USB stick that references a tie? We would not be sure. Correspondingly, the hanger/chair in Figure 07.5 offers a similar challenge: How do we know which one is the target and it is not the other way around.

All the examples given hinder giving a satisfactory answer to the first two of the three questions judged essential for using the label metaphor. Still, we have the feeling that they are metaphors, even though it is difficult to differentiate the domains. As a matter of fact, "when is a product metaphor?" can sometimes be a tricky question to answer. In this thesis, we intended to offer a broad and flexible definition for this reason. As long as one (either a designer or a user) feels that two entities are associated/combined with a meaningful purpose, we considered the product as a product metaphor. We even excluded intentionality from the definition because designers may use metaphors without realizing it, as mentioned in Chapter 4.

FIGURE 07.4. "Business class" by dialog05.

FIGURE 07.5. "Hanger chair" by Philippe Malouin.

However, our loose definition may have caused other tropes to be considered as metaphors in this thesis. Although Lakoff and Johnson (1980) maintained that metaphor also holds for other rhetorical figures of speech such as metonymy, paradox, paronomasia, and irony, scholars who are fond of a more fine-grained analysis may not find some of the outcomes of the studies metaphoric. For instance, the tiger teapot examples given in Chapter 5 can also be considered as metonymic (specifically a "synecdoche") because the whole tiger was represented by its body parts (e.g., fur pattern, teeth); still in our analysis we considered it as an apt metaphor. The same broadness can also be seen in the work of Kennedy (1982) and Jones (1984), who collected numerous examples of visual manifestations of figures of speech (e.g., allegory, euphemism, hyperbole, oxymoron, etc.) with using the word metaphor virtually synonymous with the word "trope" itself (Forceville, 1996). In this thesis, we continuously aimed to find plausible correspondences between linguistic and product metaphors but not in a mechanical manner. For the adaptation of the relevant terms and the processes, we mainly adopted the stance of a design researcher instead of a meticulous semiotician, which may caused us to miss some nuances with other types of tropes[9]. Still, we consider that all the examples given and the outcomes of the studies are able to provide answers to the three questions Forceville raised, which is appropriate for measuring their metaphoricity.

Generation of product metaphors

During the studies, we observed that every designer is capable of generating metaphors when asked to do so, without the need of any detailed information, guidance or systematic method. This process is evidently something that designers intuitively 'know' how to go through. Being employed even by 2nd year students without much effort shows that metaphor use is not something explicitly taught during design education, but it is a way of thinking. Metaphor's being a fundamental part of our communicative practices is apparently at play in the design domain as well. What Beck (2004, in Aveling, 2005) pertinently put forward, "The question is not whether you will think metaphorically or not. The question is whether you will become aware of your metaphors and choose them consciously" is also valid for product metaphors. Metaphor generation is an embodied process that designers naturally and intuitively follow.

Designers use metaphors for conveying any kind of meaning through the product but they can surely solve most design problems without resorting to a metaphor. Almost in all cases, metaphor is an added value in terms of contributing to the effectiveness and pleasantness of a product. If we go back to the Hourglass coffee maker example given in Chapter 1 for instance (Figure 01.3), instead of using the hourglass form to indicate the machine should be flipped, designers could have produced a regular looking coffee maker and conveyed the message to users with printing instructive icons on the product. That way, the product would still be efficient, yet it would have lost a considerable part of its intuitiveness and originality. When giving tips to designers for creating pleasurable products, Djajadiningrat and his colleagues advised to avoid using metaphors because "metaphors suck" (Djajadinin-

[9] Whether all tropes have a counterpart in product design is another issue to address in itself.

grat, Overbeeke & Wensveen, 2000, p. 132). They consider that it may be necessary to rely on metaphor when trying to describe a design in absence of the thing itself but otherwise designers should keep away from metaphors and create products that have an identity of their own. We consider their approach as an extreme one. Although the misuse or overuse of metaphors can create rather kitschy and unaesthetic products as we have shown in Study 3 and Study 4, their successful use enhances the whole product experience drastically. Metaphors are not simple stylistic devices of designers that are used for ornamenting a product, but quite the contrary, they are essential for communicating with users effectively. Throughout the thesis, we have shown that metaphorical thinking is fundamental to reasoning and concept formation, and designers turn to metaphors frequently to strengthen their messages through the product.

When they resort to metaphors, however, is an interesting question. In Chapter 1, we identified five reasons to employ metaphors (i.e., intentions), but this list involved a meta-analysis of the products found in the market. In Study 2, we showed that designers are able to design for particular intentions (pragmatic versus experiential) separately, but this was an experimental condition. Perhaps the most apparent limitation of the studies conducted in this thesis concerns the research setting: The generation of metaphor was researched in isolation within an experimental context. This experimental setting enabled us to investigate and control various factors designers consider when generating metaphors in a systematic manner, yet it brought some drawbacks. Participants were required to "use a metaphor" in all the studies according to the briefing we gave to them, which is obviously an artificial situation. This brings the question of to what extent designers in real practice deliberately seek solving their problems with metaphors.

We consider that designers rarely sit at their desk with the explicit intention of using a metaphor, except when they look for an overarching marketing strategy or an advertising campaign that would shape all the designerly actions within a company (Nonaka, 2007). Instead, the metaphor would come to them spontaneously when considering various other solutions. We can speculate, however, having pragmatic intentions would steer a designer towards a more deliberate strategy to look for a metaphor than experiential intentions do. Going back to the Pepelkus cigarette receptacle shown in Chapter 1 for instance (Figure 01.2), we can say that its designers were deliberately trying to emphasize that the alleged trash bin was solely for cigarette disposal (i.e., intention of identification). What else can be a good source than a cigarette? But in some products, it is apparent that the meaning and the source emerged at the same time in a rather spontaneous way. An example can be the Surveillance chandelier (Figure 01.6), in which it is difficult to imagine that its designer started with a meaning to convey. It is more plausible to think that the designer thought, "What if I transform these cameras into a chandelier? Which meaning would come out of it?" Of course, this is all guesswork and we would never be sure about their thinking process without interviewing the designers. One thing for sure is that the process we addressed throughout this thesis is one of the ways metaphors are generated, which is also the most convenient for experimental purposes. Furthermore, most of the findings (especially the ones that determine metaphoric quality) are sufficiently general to be applicable to other ways of using metaphors.

In actual metaphoric communication, the phases of metaphor generation may not be as clear and distinct as we modeled in Figure 07.1; they were differentiated to make our investigation of the subject easy. As we mentioned earlier, designers intuitively know how to generate a metaphor, yet it would be unrealistic to expect them to be able to spell out the particular decisions they consider during the process. Moreover, the phases may not follow each other in a systematic order. For instance, as mentioned before, mapping and source selection are intertwined decisions to some extent.

Still, although the conditions to generate metaphors were slightly different in our studies from design practice, we consider that the model we developed is nonetheless capable of capturing the phases of metaphor generation, which apply both to design students and professional designers. In general, we were mainly interested in understanding the decisions designers consider rather than evaluating their outcomes (which is also why users were not included in these studies). Owing to our limited focus, we were able to survey the effects of the manipulations undertaken without the necessity to imitate the real-life conditions of design practice. Personal differences such as expertise and skills, and the specific design brief they are commissioned for may influence the variety of the decisions they consider and the level of metaphoric quality that is reached, but not the described activities and processes in the model itself. For this reason, we consider the model presented at this chapter as a comprehensive overview of all the product metaphor components and possible activities of a metaphor generation process, which is helpful to ponder upon all the relationships present in between.

Goodness of product metaphors

The last research question investigated in this thesis had to do with the decisions taken to obtain better product metaphors. “Better” is a vague term, what it entailed has slightly varied in each study we conducted. Throughout the thesis, we alternately used terms like effective, good, successful, efficient, apt, pleasant, and aesthetically pleasing to address the quality of metaphors. This is because what makes a good metaphor changes according to the context and design brief. In Study 2, we equated quality with depth of meaning, which provided a definition with a focus on aptness and originality of a metaphor. In Study 3, we implicitly defined quality from a perceptual perspective—offering a perceptual puzzle; whereas in Study 4, we addressed a combination of these—offering a novel idea and a perceptual puzzle together, which provided the metaphors to be preferred ‘aesthetically’.

From these studies, it was interesting to find out that when designers were asked to evaluate their own outcome in terms of its aesthetics (Study 3), their ratings did not indicate the subtlety–identifiability balance that was addressed in Study 4. Actually, identifiability of a metaphor is one of the prerequisites for metaphor goodness. If users do not recognize the target and the source of a metaphor, then we cannot talk about a metaphor experience in the first place. The reason of the differences between findings might be that designers were slightly biased to evaluate the identifiability of the metaphors they themselves created; they knew what the metaphor referred to. In other words, these studies aptly pointed out the discrepancies between designers and

users; users may not always evaluate the metaphors designers created as they were intended. Still, users should be able to discern a meaning from a metaphor, whether it is the one intended by the designer or not. In order to be considered as 'good', metaphors should make sense. This is the difference products and artworks in general. It is not unusual to find artworks created to be ambiguous. Even in this field, the "need for commentary" has started to get ahead of considering beauty as the sole criterion of good art (Leder, Belke, Oeberst & Augustin, 2004). Product designers, on the other hand, usually work for eliminating ambiguity. Although there is some work in design research that address the advantages of enhancing ambiguity in products (Gaver et al., 2003; Hung & Chen, 2010), designers generally try to control the users' interpretation of the products, and thus, reduce the products' ambiguity. Similarly, users have the need to solve the incongruity of a product metaphor; they are required to "get" the metaphor in order to enjoy and act on it. As we showed in Study 4, comprehensibility is one of the major components of aesthetic preference. The goodness of a metaphor can be defined along different lines: identification potential, effectiveness in communicating a meaning, originality, elegance of application, and so on. Designers should always seek a delicate balance between all these different, and sometimes contradictory, concerns (Study 3). The best metaphors are the ones that are simultaneously effective, efficient, apt, pleasant, and aesthetically pleasing.

Implications for theory

Contemporary metaphor theories put a great emphasis on situating metaphor studies within broad, comprehensive models of human cognition, communication, and culture (Gibbs, 2008). This understanding paves the way for investigating all kinds of nonverbal manifestations of metaphors, of which the metaphors used in product design are an example. In this thesis, we related some major linguistic theories of metaphor comprehension and generation to the domain of products, while paying attention to the characteristic properties of product metaphors. In this way, we aimed to extend the scope of the metaphor research conducted in contemporary academia.

The studies on metaphor are often conducted from a receivers' point of view. Metaphor generation is a topic that is mostly neglected; most research is directed towards metaphor comprehension and metaphorical thought (Flor & Hadar, 2005; Katz, 1989; Lubart & Getz, 1997; Silvia & Beaty, 2012). This thesis contributes to the literature by explicitly focusing on the producer's side of metaphoric communication. Except for Study 4, all studies were performed using designers as participants in which they were asked to generate metaphors under specific conditions, which helped us to uncover the process they go through. Many of the decisions they consider in this process—e.g., criteria for selecting a source, depth of the metaphor, novelty–understandability balance—can also be applied to the verbal metaphor generation process to describe how and why one comes up with a particular metaphor and explain the success of the created metaphor.

The findings related to the application phase of metaphor generation, however, naturally would not apply to verbal metaphor generation, yet it can provide many insights for other kinds of nonverbal metaphor generation, especially for visual metaphors used in advertisement and graphic design. The creative process and the decisions that are necessary to consider are mostly similar to product design, and therefore, our findings can be used by researchers working within these domains to understand how metaphors are used.

This thesis also provides a theoretical contribution to the aesthetic appraisal of products. Traditionally, the research on aesthetics has its foundations in the arts (Leder et al., 2004) and is often performed by using polygons or abstract patterns (Blijlevens, 2011). Considering the wealth of research coming from this field, the research on aesthetic preference for products is at its infancy. As briefly explained before in Chapter 6, Hekkert (in press) aims to describe aesthetic appraisal of products through a comprehensive model, which suggests a battle of impulses between our safety needs and accomplishment needs. For a product to be found aesthetically pleasing, it should balance these needs at perceptual, cognitive and social levels. We hypothesized and found empirical proof that the same safety–accomplishment balance also underlies the aesthetic preference for product metaphors. This finding extends the scope of this model and directs it to a more comprehensive understanding of product aesthetic appraisal.

Last but not least, this thesis also makes a contribution to design research. Researchers investigating the use and generation of product metaphors may use the metaphoric communication model to frame their studies, illustrate their findings, and share their findings with a broader audience.

Implications for practice

In addition to the theoretical implications, this thesis also contributes to design practice and education. Product experience is defined as "the awareness of the psychological effects elicited by the interaction with a product, including the degree to which all our senses are stimulated, the meanings and values we attach to the product, and the feelings and emotions that are elicited" (Hekkert & Schifferstein, 2008, p. 2). The use of metaphors can affect all these aspects of the experience. They have a direct and substantial influence on the meanings and values we attach to products, and their use leads to rich sensorial and emotional experiences. The findings of this thesis can provide design practitioners with theoretical knowledge concerning this role, functions, and quality of product metaphors. They can get insights about how to communicate their intentions better with users and create more innovative design solutions. From a wellbeing-oriented standpoint, this means that practitioners can use metaphors as a means to create pleasurable and meaningful product experiences, and from a marketing-oriented point of view, they can use them for creating brand personalities that convey the values of a company and make consumers identify themselves with. In the next section, we will give some recommendations on generating "good" metaphors on the basis of the findings of this thesis.

Our findings can also be used for training design students better. We have shown that, although both expert and novice designers have the cognitive capacity to use metaphors in solving design problems, the originality and aptness of the generated metaphor improves with the acquisition of expertise (Study 2). Therefore, the metaphoric communication model may accelerate this process by helping students to get an understanding of the various qualities of a metaphor they can manipulate. The explicit instructions to control and change these different elements, as we did in Study 3, can help them to get a hands-on experience on metaphor generation, compare the strengths and weaknesses of their every action, and come up with their own intuitive way of creating successful metaphors. Training designers to retrieve and apply metaphors may also increase their aptitude for the spontaneous use of metaphors as a strategy in design problem solving (Casakin & Goldschmidt, 2000).

Recommendations to designers

Many of the findings that resulted from the studies described in this thesis may help designers to better understand the complexity of metaphor generation and provide insights that can support them in their work. Below, we will condense the findings to several recommendations to create good metaphors. They are organized according to the three main activities of metaphor generation: finding an idea, finding a source, and applying the metaphor.

Finding an idea

Choose a hidden quality of the target to highlight (Chapter 4).

Product metaphors highlight certain properties of the product and shadow over certain others. Original and clever metaphors typically highlight a hidden quality of a product. In order to find this hidden quality, a designer can try to make a break with the expected function and context of the product by noting metaphors already implicit in the problem description.

Keep in mind your intention to use a metaphor (Chapter 4).

The meanings that can be ascribed to a product can change according to the type of intention a designer has. When s/he has a pragmatic intention, it would be better to focus on a meaning that is on the surface; whereas, an experiential intention may require finding a deeper meaning to emphasize.

Finding an apt source

Use a source that has the meaning you intend to convey as a salient property (Chapter 3).

This is for providing an unambiguous communication to the user. If a source does not convey the meaning effectively and has many other properties that are more salient than the meaning a designer intends to convey, then the metaphor would cause confusion and misunderstanding for the user. Therefore, the essential approach here is to find a source that has the intended meaning as salient property.

Use a source that is optimally related to the target (Chapter 3).

Sources that are easy to relate to the target, yet belong to other conceptual categories lead to more interesting metaphors. Especially a "latent-but-preexistent" (Forceville, 2012) type of relatedness between a target and a source provides the most fruitful metaphors.

Evaluate the applicability of a source (Chapter 2, Chapter 3, Chapter 4, and Chapter 5).

For the functioning of a product, it is important to consider whether the association a designer intends to make with a potential source would fit the inherent constraints present in the product (e.g., align with working mechanisms, support product category identification, sustain the intended product character). For this reason, a designer needs to evaluate the applicability of a source, which would not physically interfere with the use and character of a target.

Choose a source that is novel but understandable (Chapter 3 and Chapter 6).

The aesthetic quality of product metaphors results from simultaneously maximizing novelty of the target–source association and its understandability. In order to create excitement and interest in users, the metaphorical association needs to be perceived as unfamiliar, unexpected and novel, which provides a conceptual challenge to overcome. However, this association should also make sense to the user: Highly novel metaphors may lack understandability and risk absurdity. Therefore, a designer needs to balance the novelty and understandability of a target–source association.

Choose a source that makes a functional contribution to the product (Chapter 3 and Chapter 5).

If the selected source provides a holistic design concept that makes a contribution to the functionality of the product rather than being a mere decoration, the generated metaphor would be considered as more meaningful and appealing.

Applying the metaphor

Keep the reference to the source subtle but identifiable (Chapter 6).

In order to create attractive metaphors, the source needs to be concealed to some extent in order to provide an intriguing visual puzzle to solve. Still, this puzzle needs to be kept solvable by making the source emerge in the appearance of the target. When the source is not hidden, the metaphor would become too straightforward and obvious; whereas, when it is too hidden, the metaphor would not be recognized. Therefore, a designer needs to keep the balance between subtlety and identifiability.

Match the inherent target properties (Chapter 5).

Metaphorical mappings should preserve the structure of the source in a way that is consistent with the inherent structure of the target. This means that designers are required to pay attention to the properties of the target, i.e., how a typical version of that product looks and feels like, what kind of components it has, how it is used, and so on. To obtain aesthetically pleasing metaphors, care must be given to match the

source properties with the target properties; otherwise, the mapped properties may make the application of a metaphor to be seen as a gimmick instead of improving the functionality or enhancing the meaning of the product.

Tailor the source properties to blend with target properties (Chapter 5).

In parallel with the previous recommendation, a designer needs to blend the projected source properties with the target properties rather than forcing them onto the target too coarsely and explicitly.

Always map salient properties of a source (Chapter 1 and Chapter 5).

The properties that are projected from a source needs to be functionally significant and/or perceptually characteristic in order to make the users recognize the source.

Do not necessarily transfer "everything" from a source (Chapter 5 and Chapter 6).

It is a more convenient approach to keep the projected properties from a source onto a target at a minimum. When the properties that are irrelevant in the context of the target are transferred from the source (i.e., skeuomorphism), the product may lose its identity because these properties may interfere with the product's expected form, context and use. In general, a design is considered as more beautiful when a great effect is attained with only a minimum of means (Hekkert, 2006).

Consider all the modalities (Chapter 2 and Chapter 3).

There are eight different means that a designer can manipulate to convey a metaphorical message. To make the metaphor stronger, the means other than appearance can be considered when applying the metaphor.

Remember that there are different ways to apply the metaphor (Chapter 5).

Designers can project source properties onto a target along different dimensions (i.e., literal–abstract, target-driven–source-driven). These approaches all have different effects on the end metaphor. A designer can experiment with them and choose the one that is the most fitting to the design brief s/he has.

Further studies

The metaphoric communication model that was presented (see Figure 07.1) also offers other viable components and relationships that have not been addressed in the scope of this thesis, but can be fruitful to investigate in further studies in order to extend the present work. Below, we will sketch these research opportunities briefly.

Designer and user characteristics

The differences of people with regard to their cognitive capabilities often have theoretical and practical implications on metaphor generation and experience. If a metaphor involves creating a bridge between distinct entities while filtering out unim-

portant qualities and selecting relevant ones, then it requires certain skills from both the designer and the user.

As regards metaphor generation, it has been shown in verbal metaphor literature that people with high fluid intelligence, i.e., a capacity to solve problems in novel situations independent of acquired knowledge ("Fluid and crystallized intelligence", 2013, para. 2.), create metaphors that are more creative than people with low fluid intelligence (Silvia & Beaty, 2012). Correspondingly, Pierce and Chiappe (2009) showed that people's working memory capacity—a mechanism for active processing of information storage—predicted the aptness of the sources employed in metaphors. In this thesis, we only addressed the effect of expertise level of designers on product metaphor generation (Study 2), but other factors such as their fluid intelligence or working memory are also likely to have a significant effect on the products generated. Researching how these factors will moderate the creativity and quality of product metaphors may be a rewarding exercise in the future.

Similarly, scientific evidence has accumulated to show that individual differences of metaphor recipients predicted performance on metaphor comprehension (Gernsbacher, 1990). For instance, Trick and Katz (1986) found that people with high analogic reasoning capabilities rated metaphors with dissimilar domains more highly. Similarly, greater working memory capacity of people predicted the extraction of richer interpretations from metaphors and the enjoyment of more challenging metaphors with more possible interpretations (Blasko, 1999). Future work can address the effect of these factors on metaphor experience.

Factors affecting metaphor aesthetics

In Chapter 5, we addressed four factors that we hypothesized and proved to have an effect on aesthetic preference for product metaphors. The results of the study indicated that these factors explained almost 70% of the variance. We discussed other possible factors that would be theoretically likely to explain the remaining variance (e.g., unity vs. variety, typicality vs. novelty, connectedness vs. uniqueness), and it would be a fruitful direction for future research to confirm their effect.

Mapped properties

As regards metaphor application, we mainly focused on how the mapping strategies influence the end product in this thesis. It is also noteworthy, however, to study which properties of a source are projected onto target in specific design contexts. A future study can be conducted in which designers will be asked to reveal how they analyze the properties of a source for mapping purposes. For instance, designers could use a mind-mapping technique that unravels the properties of a source systematically and makes these properties hierarchically and conceptually connected. Then, it would be interesting to see which properties would be regarded more apt for which type of targets, intentions or mapping strategies, and how many properties are ideally projected under these conditions.

With regard to the role of target's relevant attributional dimensions in the generation of metaphors (Glucksberg et al., 1997), it would be of great interest to see whether there are any correlations between specific sources and specific types of products. Kövecses (2005) entitles the set of sources that are used for metaphorizing a particular target as "the metaphor's range" (p. 70). It would be interesting to investigate the range of metaphors for different product types and chart whether anything systematic can be said about the choice of the source (Forceville, 2002).

Accidental use of metaphors

As mentioned in Chapter 2, metaphors can also be generated in a coincidental way. Rather than deliberately looking for a source according to the meaning she intends to convey, a designer can see an immediate relationship between the product she is designing and a remote entity and incorporate it into her design spontaneously. We consider that many of the decisions taken in a sequential kind of process like we addressed in this thesis also apply to this accidental generation process (e.g., the source selection reasons, mapping, and so on). Still, investigating this process independently by conducting interviews with designers would indicate the generalizability of our findings to any kind of generation process and eventually provide a more comprehensive understanding on metaphor generation.

Metaphors we design by

Even though the field of metaphor studies involves seminal texts, established scholarly debate, publications and an academic history, it is, as we have seen throughout this thesis, a rather diverse subject. Even in many of our daily activities--chatting with friends, browsing through magazines, shopping, zapping through television channels, reading books, and so on—we are surrounded by the magic of metaphor. The existence of metaphor, no matter in what medium, is a constant reminder to us that metaphor is a key instrument in any kind of communication. As metaphorical thinking is an innate capability we as humans all possess, metaphors can be actively experienced, generated, and studied rather than just passively learnt and digested.
In this thesis, we have attempted to provide an overview on the use of metaphors in the product design field. To this end, we raised and proposed provisional answers to the questions of how designers use metaphors and how they can use metaphors in a "better" way. Every product metaphor is a story that a designer intends to tell through the product. We hope that the ideas contained in this thesis will come to be better represented by examples than in writing. The many different ways of generating good metaphors will be best communicated through exemplars and better represented by practice than by theory. In this regard, we hope that this thesis will provide inspiration to design practitioners, who want to tell their own stories.

Summary

Imagine a coffee maker that subtly references the serving gesture of a butler or a car that explicitly mimics the sleek and streamlined form of a jet plane. Such metaphors are frequently used by designers as a means to render the values and meanings they want to assign to a product into a physical form. By their nature, metaphors build meaningful relationships between two distinct entities, which urge us to see things in a new light. For this reason, designers resort to metaphors to exhibit original and aesthetic solutions to design problems.

Still, so far the use of metaphors has not taken up the importance in design academia as it did in design practice. In this thesis, we aimed to propose a structured means to incorporate metaphor in design research by investigating a product metaphor's characteristics and the peculiar type of thought process that generates it. The key questions we intended to answer were, (1) What is a product metaphor? (2) How is a product metaphor generated?, and (3) Which decisions of designers lead to good product metaphors? By providing provisional answers to these questions, we gradually built a framework that accounts for the processes underlying product metaphor generation and examine the success of the decisions taken in this process.

Theoretical background

In Chapter 1, the characteristics of a product metaphor were presented with examples in order to familiarize the reader with the related concepts and terms that were used throughout the thesis. These included the structure of product metaphor (the association between a target and a source, and a mapping in between), the reasons for using metaphors in design (pragmatic versus experiential intentions), types of metaphorical associations (embodied versus learned), designers' means to conduct a mapping (form, interaction, movement, sound, taste/smell, material, name, and graphics), and the differences of product metaphors from their linguistic counterparts (target and source being literally merged, mapping being designer's duty, multimodality, and source concreteness).

In Chapter 2, the specifics of the metaphoric communication between designers and users were presented. We first provided a basic model of communication, elaborated this model by examining the studies and models on linguistic metaphors and then presented our own framework. According to the framework, a product metaphor mediates between the experience process of a user and the generation process of a designer. A user goes through the stages of perceiving that a metaphor has been employed in a product, recognizing its target and source, comprehending why these particular entities are brought together, and appreciating (or not) this association. A designer has a particular intention to attain through the target and comes up with a meaning to convey accordingly, finds a source that can assign this meaning to the product, and creates a mapping from this source to the target. These processes are

also influenced by the background characteristics and capabilities of both parties, how they envision each other, and external factors of the context. We validated this framework through an explorative workshop and used it for framing the studies presented in the coming chapters.

Empirical studies

In Chapter 3, we focused on the "metaphorical association" that brings together a target and a source, and presented the first study, which was aimed to address the key factors that play a role in finding an appropriate source for a product metaphor (Study 1). The results revealed that the sources that have the designer's intended meaning as a highly salient (i.e., prominent, noticeable) property and are highly related to the target are preferred over their medium and low salient/related alternatives. Furthermore, the results also indicated that being novel, having an application potential, and providing a complete and meaningful design concept were also considered as criteria for selecting a source by designers.

In Chapter 4, the meaning that prompts a target–source association was at focus. We termed the extent to which the intended meaning is salient for a target as the "depth" of a metaphor, and investigated how depth is affected by the expertise level of a designer (novice versus expert) and his/her intention to use a metaphor (pragmatic versus experiential; Study 2). The results showed that having a pragmatic intention or being a novice designer led to the generation of less deep metaphors, whereas having experiential intentions or being an expert facilitated the generation of deeper ones.

In Chapter 5, we shifted our attention from metaphorical association to its application. We defined four types of strategies that a designer can map the properties of a source to a target (TD–Lit, TD–Abs, SD–Lit, SD–Abs) and examined their strengths and weaknesses regarding the identifiability of a metaphor, the aesthetics of the end product, and the ease of mapping (Study 3). The results indicated that the SD–Lit mapping strategy was chosen to lead to the most identifiable metaphors, cause the least aesthetic products, and be the easiest strategy to follow; TD–Abs mapping strategy was chosen to lead to the least identifiable metaphors, and TD–Lit mapping strategy was chosen to be the most difficult strategy to follow. Regarding the most aesthetic metaphors, TD–Abs mapping strategy was chosen over TD–Lit strategy for generating more aesthetic metaphors, yet the remaining comparisons were non-significant.

In Chapter 6, we specifically focused on the aesthetics of a product metaphor, and investigated how the interplay between the novelty and comprehensibility of a metaphorical association and the subtlety and identifiability of a metaphor application affect aesthetic preference for product metaphors via two complementary studies (Study 4). In combination, these studies demonstrated that the aesthetic quality of product metaphors results from simultaneously maximizing clarity (the metaphor is understandable and identifiable) and interestingness (the metaphor is novel and its application subtle) at the association and application level.

All these studies directly or indirectly served the purpose of revealing the decisions taken in a metaphor generation process and understanding the success of metaphors. In the final chapter, Chapter 7, the general findings of the studies were brought together in a detailed overview of metaphoric communication and discussed in a broader context of metaphor research and design research. On the basis of the results, we also formulated a set of practical recommendations to designers, which they may use as an inspiration for creating good metaphors.

During the studies, we observed that every designer is capable of generating metaphors when asked to do so, without the need of any detailed information, guidance or systematic method. This process is evidently something that designers intuitively 'know' how to go through. Being employed even by bachelor students without much effort shows that metaphor use is not something explicitly taught during design education, but it is a way of thinking. The process we addressed throughout this thesis is one of the ways metaphors are generated, which is also the most convenient for experimental purposes. Although the conditions to generate metaphors may slightly differ in our studies from design practice, we consider that the model we developed is nonetheless capable of capturing the phases of metaphor generation, which apply both to design students and professional designers. In general, we were mainly interested in understanding the decisions designers consider rather than evaluating their outcomes (which is also why users were not included in these studies). Owing to our limited focus, we were able to survey the effects of the manipulations undertaken without the necessity to imitate the real-life conditions of design practice. Personal differences such as expertise and skills, and the specific design brief they are commissioned for may influence the variety of the decisions they consider and the level of metaphoric quality that is reached, but not the described activities and processes in the model itself. For this reason, we consider the model presented at this chapter as a comprehensive overview of all the product metaphor components and possible activities of a metaphor generation process, which is helpful to ponder upon all the relationships present in between.

Samenvatting

Stel je een koffiezetapparaat voor dat subtiel refereert aan de gebaren van een butler of denk aan een auto die door een expliciete slanke en gestroomlijnde vormgeving lijkt op een straaljager. Dergelijke metaforen worden regelmatig door ontwerpers ingezet als middel om de waarden en betekenissen die ze aan hun product willen toewijzen fysiek vorm te geven. Van nature verbinden metaforen twee afzonderlijke entiteiten op een betekenisvolle manier, wat ons weer aanspoort dingen in een nieuw licht te bekijken. Daarom maken ontwerpers gebruik van metaforen; om originele en esthetische oplossingen te genereren voor ontwerpproblemen.

Toch neemt het gebruik van metaforen in de academische wereld nog niet zo een belangrijke plaats in als in de ontwerppraktijk. In dit proefschrift was ons doel om op basis van het bestuderen van kenmerken van product metaforen en het specifieke bijbehorende denkproces, een gestructureerde manier te beschrijven waarop metaforen ingelijfd kunnen worden in ontwerponderzoek. De hoofdvragen die we beoogd hebben te beantwoorden waren, (1) Wat is een product metafoor? (2) Hoe wordt een product metafoor gegenereerd?, En (3) Welke beslissingen van ontwerpers leiden tot goede product metaforen? Door het geven van antwoorden op deze vragen bouwen we geleidelijk een raamwerk dat de processen die ten grondslag liggen aan het genereren van product metaforen beschrijft en we onderzoeken het succes van de genomen besluiten in dit proces.

Theoretische achtergrond

In hoofdstuk 1 zijn de kenmerken van een product metafoor beschreven met voorbeelden zodat de lezer bekend kan worden met de gerelateerde concepten en termen die gebruikt worden in dit proefschrift. Deze kenmerken bevatten: de structuur van product metaforen (de verbinding tussen een doel – het product - en een bron – datgene waarnaar de metafoor verwijst -, en een projectie van de bron op het doel), de redenen om metaforen te gebruiken in het ontwerpproces (pragmatische versus experimentele intenties), verschillende typen van metaforische associaties (natuurlijk versus aangeleerd), de middelen die de ontwerper tot zijn beschikking heeft om een projectie uit te voeren (vorm, interactie, beweging, geluid, smaak/geur, materiaal, naam en afbeeldingen), en de verschillen van product metaforen ten opzichte van hun taalkundige equivalenten (doel en bron worden letterlijk samengevoegd, projectie als taak van de ontwerper, multimodaliteit en concreetheid van bron).

In hoofdstuk 2 zijn de specifieke kenmerken van de metaforische communicatie tussen ontwerpers en gebruikers gepresenteerd. Als eerste hebben we een basismodel voor deze communicatie gegeven en we hebben dit model uitgebreid door de studies en modellen over taalkundige metaforen te bestuderen, daarna hebben we ons eigen raamwerk gepresenteerd. Volgens dit raamwerk bemiddelt een product metafoor tussen een proces van ervaren door een gebruiker en het proces van genereren van de

designer. Een gebruiker ondergaat de stadia van het waarnemen: dat een metafoor is toegepast in een product, het herkennen van zijn doel en bron, het begrijpen waarom deze specifieke entiteiten bij elkaar worden gebracht, en het waarderen (of niet) van deze associatie. Een ontwerper heeft een bepaalde bedoeling die hij probeert te bereiken door het doel en hij bedenkt een daarbij behorende betekenis. Vervolgens vindt de ontwerper een bron die deze betekenis aan het product kan geven, en creëert een projectie van deze bron op het doel. Deze processen worden ook beïnvloed door de achtergrond en vaardigheden van beide partijen, hoe ze elkaar zien en externe contextfactoren. We hebben dit raamwerk gevalideerd door middel van een verkennende workshop en gebruikten het ook als een raamwerk voor de studies in de volgende hoofdstukken.

Empirische studies

In hoofdstuk 3 hebben we ons gericht op de "metaforische associatie" die een doel en een bron samenbrengt, en we presenteerden de eerste studie, die gericht was op de belangrijkste factoren die een rol spelen bij het vinden van een geschikte bron voor een product metafoor (Studie 1). Uit de resultaten bleek dat de bronnen die de bedoelde betekenis van de ontwerper als een zeer opvallende (prominent, merkbare) eigenschap hebben en in hoge mate gerelateerd zijn aan het doel, de voorkeur hadden boven de gemiddelde en minder opvallende/gerelateerde alternatieven. Bovendien geven de resultaten weer dat nieuwheid, het bezitten van een toepassingsmogelijkheid, en het zorgen voor een volledig en zinvol ontwerpconcept eveneens beschouwd werden als criteria voor het selecteren van een bron door ontwerpers.

In hoofdstuk 4, was de focus op de betekenis die een doel-bron associatie oproept. We hebben de mate waarin de beoogde betekenis duidelijk is voor een doel de "diepte" van een metafoor genoemd, en onderzocht hoe de diepte wordt beïnvloed door het expertise niveau van een ontwerper (beginner versus expert) en zijn/haar voornemen om een metafoor te gebruiken (pragmatisch versus gericht op beleving; Studie 2). De resultaten toonden aan dat een pragmatische intentie of een beginnend ontwerper minder diepe metaforen voorbracht, terwijl een belevingsgerichte aanpak of een ontwerper met veel expertise makkelijker diepere metaforen creëren.
In hoofdstuk 5, verschoven we onze aandacht van metaforische associatie naar de toepassing ervan. We definieerden vier soorten strategieën die een ontwerper kan gebruiken om de eigenschappen van een bron naar een doel in kaart te brengen (TD-Lit, TD-Abs, SD-Lit, SD-Abs) en we onderzochten hun sterke en zwakke punten ten aanzien van de herkenbaarheid van een metafoor, de esthetiek van het eindproduct en het gemak van projectie (Studie 3). De resultaten lieten zien dat de SD-Lit projectie strategie werd gekozen als strategie die tot de meest herkenbare metaforen leidt, resulteert in de minst esthetische producten, en het makkelijkst te volgen is; de TD-Abs projectie strategie werd gekozen als strategie die leidt tot de minst herkenbare metaforen, en de TD-Lit projectie strategie werd de moeilijkst te volgen strategie gevonden. Voor het ontwikkelen van de meest esthetische metaforen werd de TD-Abs projectie strategie verkozen boven de TD-Lit strategie omdat deze tot meer esthetische metaforen leidde, maar de overige verschillen waren niet-significant.

In hoofdstuk 6, hebben we ons specifiek gericht op de esthetiek van een product metafoor, en we onderzochten hoe de wisselwerking tussen de nieuwheid en de begrijpelijkheid van een metaforische associatie en de subtiliteit en herkenbaarheid van een metafoor-toepassing, de esthetische voorkeur voor product metaforen beïnvloed. Deze twee studies samen toonden aan dat de esthetische kwaliteit van product metaforen het resultaat is van gelijktijdig maximaliseren van duidelijkheid (de metafoor is begrijpelijk en herkenbaar) en aantrekkelijkheid (de metafoor is nieuw en de toepassing ervan subtiel) op het associatie- en toepassingsniveau.

Conclusies

Het doel van al deze studies was direct of indirect het in kaart brengen van de genomen besluiten in een metafoor generatie en het begrijpen van het succes van metaforen. In het laatste hoofdstuk, hoofdstuk 7, zijn de algemene bevindingen van de studies in een gedetailleerd overzicht van metaforische communicatie samengebracht en worden de bevindingen besproken in een bredere context van metafooronderzoek en ontwerponderzoek. Op basis van de resultaten hebben we ook een reeks praktische aanbevelingen geformuleerd voor ontwerpers, die ze kunnen gebruiken als inspiratie voor het creëren van goede metaforen.

Tijdens de studies constateerden we dat iedere ontwerper in staat is om metaforen te genereren wanneer dat gevraagd wordt te doen, zonder de noodzaak van gedetailleerde informatie, begeleiding of een systematische methode. Blijkbaar "weten" ontwerpers intuïtief hoe dit proces te doorlopen. Dat zelfs bachelor studenten het proces zonder veel inspanning kunnen doorlopen geeft aan dat het gebruik van metaforen niet iets is wat expliciet onderwezen wordt in het ontwerp onderwijs, maar dat het een manier van denken is. De werkwijze die we in dit proefschrift beschreven hebben is een van de manieren om metaforen te generen, die tevens het meest geschikt is voor experimentele doeleinden. Hoewel de voorwaarden om metaforen te genereren in onze studies iets af kunnen wijken van de ontwerppraktijk, zijn wij van mening dat het model dat we ontwikkelden toch in staat is om de fasen van metafoorgeneratie vast te leggen, die zowel geschikt is voor ontwerpstudenten als voor professionele ontwerpers. Over het algemeen waren we vooral geïnteresseerd in het begrijpen van de beslissingen die ontwerpers overwegen in plaats van in de evaluatie van hun resultaten (dat is ook de reden waarom gebruikers niet werden geraadpleegd in deze studies). Door onze beperkte focus, waren we in staat om de effecten van de uitgevoerde manipulaties te overzien zonder de noodzaak om alle omstandigheden van de ontwerppraktijk na te bootsen. Persoonlijke verschillen zoals kennis en vaardigheden, en de specifieke ontwerpopdracht waarvoor ontwerpers worden ingehuurd, zou van invloed kunnen zijn op de verscheidenheid van beslissingen die zij overwegen en het niveau van de metaforische kwaliteit die wordt bereikt, maar dit beïnvloed niet de beschreven activiteiten en processen in het model zelf. Daarom beschouwen we het gepresenteerde model in dit hoofdstuk als een volledig overzicht van alle product- metafoor componenten en van alle mogelijke activiteiten in een metafoor ontwikkelingsproces, dat nuttig is om alle aanwezige relaties tussen beiden te overdenken.

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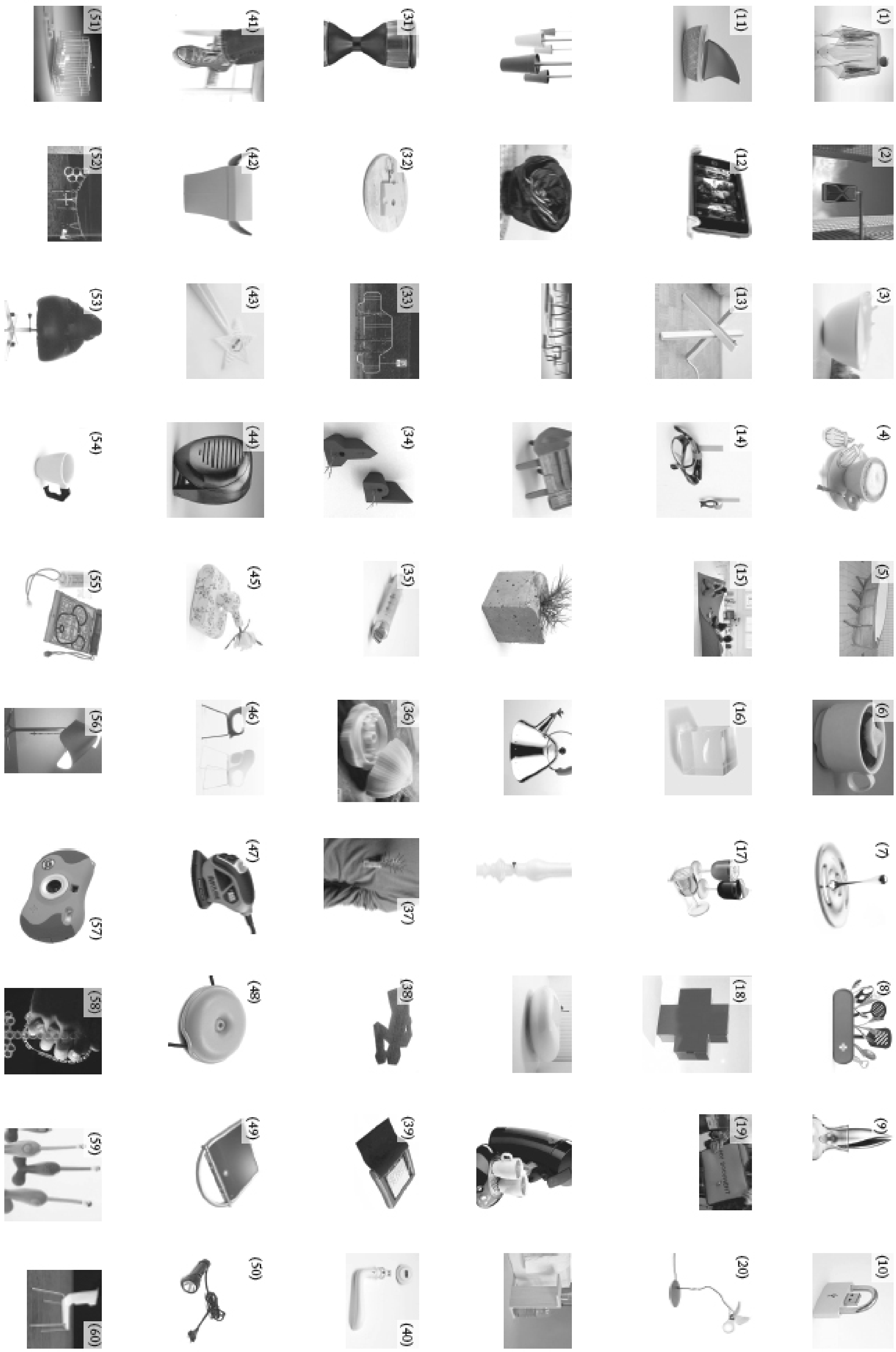

The stimuli used in Study 1 (Chapter 6).

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Nazli Cila was born on June 18th, 1984 in Bursa, Turkey. After obtaining her B.Sc. degree from Department of Industrial Design at Middle East Technical University in Ankara, she continued with her Master's studies at the same university. During this time, she also worked as a teaching assistant, involved in various design courses, and spent five months at Delft University of Technology as an Erasmus exchange student. For her graduation, Nazli was involved in a research project on the experience of fun with consumer products, by which she received her Master of Science degree (high honours) in 2008. Next to her academic activities, she also worked at several commercial usability-testing projects at UTEST Product Usability Testing Unit, Ankara.

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