PRODUCT METAPHOR GENERATION:
MAPPING STRAGIES OF DESIGNERS

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ABSTRACT

When generating product metaphors, designers select an entity to associate with the product they intend to design and transfer certain feature(s) of this entity to the product. This transfer, called *mapping*, can be realized by following different strategies (e.g. implicit-literal, explicit-literal, implicit-abstract and explicit-abstract. In this paper, we investigate the strengths and weaknesses of these four mapping strategies regarding the identifiability of the metaphor, the aesthetics of the end product, and the ease of mapping for the designer. To do so, we conducted a study with design students who were asked to generate metaphors by using four different mapping strategies. The results are discussed in the light of metaphor theories and contribution to the design practice.

Keywords: product metaphors, metaphor generation, mapping, mapping strategies, metaphor quality.

INTRODUCTION

On the Nanimarquina's website, the Flying Carpet is defined as: "(…) a plain and relaxing topography, a domestic oasis." (see Figure 1) Here, an ordinary rug is associated with lawn where the designer intends to bring the experience of sitting and relaxing in a park to one's living room and evoke the pleasant emotions related to this experience. This carpet is a nice illustration of metaphor use in the design domain; it brings a comfortable mode to sit on a rug and introduces a novel way for relaxation in the house. By this way, the lawn metaphor provides the users a fun, yet functional interaction with the product; eventually leading to pleasurable user experiences.

As a matter of fact, this is what product metaphors are used for. By associating two distinct entities, metaphors create original ideas, perspectives and features. Designers employ them as a means of communication with users to express particular meanings and evoke particular emotions. To do so, designers go through a process in which they take several strategic decisions concerning the comprehensibility and the quality of the metaphor. Our focus in this paper is on the influence of the decisions taken in this generation process on the end product.

In technical terms, the entities that are associated in a metaphor are called *target* and *source*. The target is the product that is designed to convey meaning, whereas the source is the entity that modifies the target to convey that particular meaning. This modification is provided by projecting some features of the source to compatible features of the target. This process, called *mapping*, builds the metaphorical link between target and source, and physically integrates these two domains with each other. In the Flying

Figure 1. A product metaphor example (Flying Carpet by Nanimarquina, 2006).

Carpet example, the features of green color, uneven surface and soft texture of the source “lawn” are explicitly *mapped to* the target “rug”. In this way, the user immediately identifies the reference to grass and lawn, and interacts with the rug in the same way as s/he would behave on the lawn. Therefore, the target gains new features, meanings and connotations by means of mapping.

Products are multimodal entities allowing for various metaphorical mappings between different sensorial modes: the form, color, material, texture, movement, usage, sound and even smell of the source can be transferred to the target. For the comprehensibility and quality of a product metaphor, which of these features are mapped is highly important. Obviously, these features need to be salient for the source in order for the metaphor to work. If one wants to make a metaphorical reference to a cloud when designing a chair for instance, just making it white would not be good enough. For the meaning of a cloud to be unambiguously communicated by the chair, one (also) need to map some other more typical aspects of a cloud such as its fluffiness.

Related to which features to map, a designer should also decide on “how” to do this mapping. First of all, s/he has to decide on the degree of subtlety of the reference to the source by choosing to explicitly display the features that are transferred from source to target or make an implicit reference to the source’s physical features. Secondly, s/he should consider the extent to which the features of the source will be abstracted while transferring them to the target. S/he can map these features literally without making any changes on the form or through their simplification.

Mapping is a subject that has not been adequately investigated in the literature. This is because the majority of the works related to metaphors come from linguistics and cognitive psychology domains, which focus on verbal metaphors. However, product metaphor generation is different from generating verbal metaphors, especially in terms of mapping. While a poet may simply say, “my home is my nest”, without indicating how and in what way, designers have to make a “physical” mapping from source to target. For this reason, the decisions taken in relation to the mapping are apparent to users in the end product, whereas in verbal metaphors, the recipient has to find out the mapped properties between target and source domains (Forceville, 2008). In this respect, the task of the product metaphor recipient (i.e., user) is easier since designers make the mapped qualities visible in product metaphors by the nature of the task (Cila, Hekkert & Visch, in press). For this reason, mapping becomes one of the crucial steps of the product metaphor generation process that transforms the metaphorical idea into a concrete physical entity.

While generating metaphors, one aims to obtain understandable and aesthetically pleasing metaphors (Glucksberg & Keysar, 1990). A designer has similar concerns related to the design process and the end result when creating metaphorical products. The way the mapping is done has profound effects on these qualities. For this reason, designers employ certain strategies according to their concerns. In this paper, we focused on: (1) the identifiability of the source/metaphor, (2) aesthetics of the product, and (3) the ease of transferring the features. Our aim is to investigate the effect of different mapping strategies on these concerns, and find out their strengths and weaknesses in relation to metaphor generation. Before presenting the results of the study, we will further elaborate on the product metaphor generation process and mapping strategies.

METAPHOR GENERATION AND MAPPING

When generating a metaphor, a designer first defines the meaning that s/he intends to convey through the product. This meaning can be an abstract character to attribute to the product (e.g. *“I want to make my product appear fast and agile”*) or a concrete functional intention (e.g. “*I want to express that my product is used for listening to music”*). Based on this intended meaning, the designer then comes up with a source to realize this intention. For instance, for the former example, the designer may select sources like a bullet, jet plane, mouse, etc. for expressing speed; or associate things like a record player, turntable or music notes with the target product, in order to emphasize the intended function in the latter. After selecting the source, the designer then needs to consider how s/he will communicate this source to the users. In this mapping stage, the designer physically

implements the metaphor by transferring some features of the source to reshape the target product. S/he firstly decides on which features to map, and then which mapping strategies to follow. Concerning the second issue, the designer faces two kinds of complementary dilemmas: (a) whether to make the source of inspiration apparent in the form of the final product, and (b) whether or not to make an abstraction of the features that are mapped from this source. The first decision involves the subtlety of mapping, while the latter one is concerned with its abstractness, which will be presented in the coming sections in detail.

SUBTLETY OF MAPPING

When implementing the metaphor in the product, designers can reference the source's physical features on the final design in varying degrees. In one extreme, they can make an implicit mapping by which they hint the origin of the association in a subtle way and give users freedom to interpret it. In the other extreme, they can make an explicit mapping, in which they somewhat force the users to perceive and understand the metaphor by clearly presenting visible cues for the identification of the source. This approach is governed by the intended identifiability of the metaphor.

To elaborate this with an example, two product metaphors that use "nun" as a source can be seen in Figure 2. The reference to the nun is rather perceivable in (2a) as the coif and cross necklace can be easily identified in the appearance of the lamp. However, in (2b), the implication of the nun is so subtle that it is almost impossible to identify the association without the help of the name of the product (i.e., White Nun). In the former example, the features that are transferred from a nun are explicitly drawn to the user's attention. This kind of a mapping is closer to the lower end of the subtlety continuum, and correspondingly, we entitle this kind of mapping as an explicit mapping. Whereas in the latter example, the user is expected to draw his or her own interpretations of the metaphor (if s/he can ever). This mapping is at the higher end of the continuum, which is why we call it implicit mapping. As can be understood from these examples, a designer can adjust the identifiability of the metaphorical association by employing different levels of subtlety while mapping features from source to target.

Figure 2a. Explicit mapping (i.e., unsubtle mapping) (Sister Lamp by Jose Manuel Ferrero, 2004)

Figure 2b. Implicit mapping (White Nun by Bram Boo, 2006)

ABSTRACTNESS OF MAPPED FEATURES

Another consideration in relation to mapping concerns the abstraction of the features that are mapped from source to target. Designers may transfer features of a source directly to the target without making any changes in its physical features, or they may make an abstraction of these features by simplifying them. In the design context, abstractions include the structure of geometric, topological, temporal, causal, and functional relations among design elements (Goel, 1997).

To illustrate this, we will present two garlic presses that refer to the "garlic" form (Figure 3). In (3a), the appearance of garlic is entirely transferred to the form

of the product. The garlic press looks like a plastic imitation of actual garlic with the same shape, color and texture. Again, this is one extreme of the abstractness continuum; the properties of the source are “literally” copied to the target without any abstraction. That is why we entitle this kind of mapping as “literal mapping”. On the other hand, in (3b) the form of the garlic is transformed to match the form of a garlic press: the bulb is simplified to a vase-like shape that is made out of glass, and the form of the leaves is used for shaping the metal part. We refer to this kind of mapping as “abstract mapping” since the essence of the form of the source is extracted and reshaped according to the requirements of the target.

Figure 3a. Literal mapping (i.e., non-abstracted mapping) (The Garlic Chop by Koopeh Designers).

Figure 3b. Abstract mapping (Eva Solo by Jensen).

THE NATURE OF MAPPING STRATEGIES

The considerations mentioned so far have different characteristics that make them preferable for certain situations. For instance, as aforementioned, the subtlety level of the mapping influences the identifiability of the metaphor. This is an issue that is also studied in the Human-Computer Interaction (HCI) literature. It is argued that explicit metaphors used in software and interfaces are instructional since they help the user to be able to discover the functions and learn to use the program easier (Carroll, Mack & Kellogg, 1988). Correspondingly, if designers aim to make the users identify the source and comprehend the metaphor, they explicitly map the feature(s) of the source to the target. However, when they want to keep the association between target and source understated, they make the transfer in an implicit way.

Furthermore, we maintain that the abstractness of the mapping has an effect on the aesthetics and elegance of the metaphor. As the features of the source are simplified and adapted to the target in abstract mapping, it requires the designer’s skill and ability to analyze and extract the core of the source’s form, function, movement, etc. Conversely in literal mapping, these features are directly transferred to the target without making major changes. This also makes literal mapping relatively easier than the abstract one. Correspondingly, to go back to Figure 3, the garlic press in (3a) looks somewhat “cheap” when compared to the example in (3b) because it is a plastic copy of the garlic shape, which is not reshaped according to the formal requirements of a garlic press.

A similar discussion is also made within the scope of the biomimetic design literature. Biomimetic design refers to solving design and engineering problems by building associations between the problem and biological phenomena (Mak & Shu, 2004). The literature contains various case studies (see Helms, Vattam & Goel, 2009 for a review). One of the most famous cases is, for instance, the invention of Velcro, which was inspired by George de Mestral’s observation of burdock root attaching themselves to his dog’s fur by the help of its burrs, which are shaped like tiny hooks (Holyoak & Thagard, 1995). He produced the same effect artificially, so that many objects can be fastened using small hooks. In this example, only the attachment mechanism of the plant is taken out and mapped to the Velcro, rather than its form, smell, context, etc. In general, successful

biological transfer is featured to removing as many structural and environmental constraints as possible, focusing on underlying mechanisms and functions, extracting the useful principles and applying these to the design without transferring the biological forms (Helms et al., 2009; Mak & Shu, 2004). Similarly, we can also propose that the abstraction of the source will lead to more sophisticated metaphors since it requires a different way of thinking and making several decisions, eventually making this kind of mapping more intricate compared to literal mapping.

To summarize, we can state that the level of subtlety and abstractness of the mapping influence the quality of the mapping process and the end product. If we consider these two continuums as axes (level of subtlety and level of abstractness), we can define four different types of "mapping strategies". In Figure 4, Strategy A refers to explicit and literal mapping (i.e., Exp-Lit), that is, the designer literally maps the feature(s) of the source and these features become explicit to the user. Oppositely, Strategy D refers to implicit and abstract mapping (i.e., Imp-Abs), in which the designer abstracts the mapped attributes and chooses to present these to the user in an implicit way. Strategy B and Strategy C refer to implicit and literal mapping (i.e., Imp-Lit) and explicit and abstract mapping (i.e., Exp-Abs), respectively.

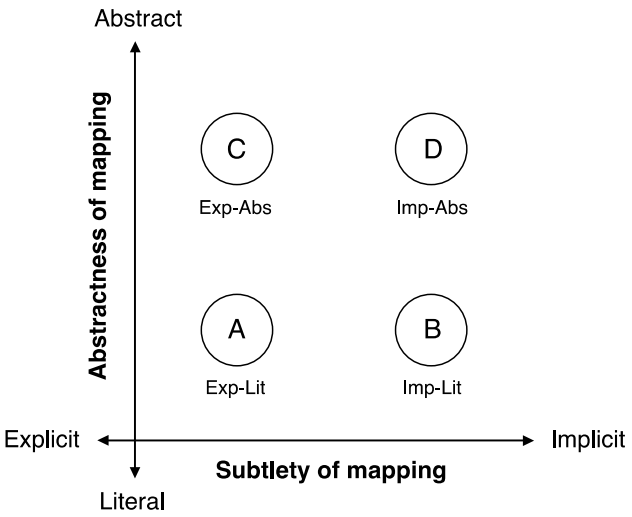

Figure 4. Four mapping strategies

It must be noted that these groupings do not represent a clear-cut division. The mapping strategies should be evaluated according to their relative position with each other. For instance, in Figure 2, besides their difference in level of subtlety, the mapping in the Sister Lamp (2a) is also less abstract than the mapping in the White Nun chair (2b). However, we would not name this mapping as literal; the designer simplifies the nun image with using the coif and cross necklace rather than using the whole body or clothes. There is an abstraction in this example as well, albeit in a lower extent in comparison to the chair. For this reason, we should address these axes as scales rather than definitive categories. We argue that these strategies may have different strengths and weaknesses according to the considerations of designers. We investigated these with a study that is presented in the following section.

METHOD

The aim of this study is to investigate the effect of subtlety and abstractness of the mapping on the quality of the metaphor and the metaphor generation process. To do so, we asked designers to re-design a product by using all of the four mapping strategies (i.e. Imp-Lit, Exp-Lit, Imp-Abs, Exp-Abs). The quality of the metaphor and the generation process was tested by using the following constructs: the identifiability of the metaphor, the aesthetics of the product, and the ease of mapping.

SET-UP

Eighteen MSc. students (8 female – 10 male) from the Industrial Design Department of Delft University of Technology took part in this study. All of them received course credits for their participation.

The experimental task given to the participants was to design an "adventurous teapot" by using a metaphor. The character 'adventurous' was chosen as a meaning to convey because it is an abstract concept previously experienced by certain objects and events in emotional contexts. Therefore, it allows designers to explore a wide network of semantic associations. Teapot was chosen because it is a familiar object in terms of form and usage, and also has distinct product parts (e.g. container, spout, handle) that allow for design manipulations. This product–meaning combination was considered to have a good potential for exploring various metaphor ideas focusing on different aspects of teapots.

At the beginning of the session, the participants were given a 15 minutes introduction on metaphor use in design, mapping process and mapping strategies. Then, they were given the design brief. They first explored the adventurous concept by remembering their relevant experiences, listing the objects/events and their features that make an entity adventurous. Based on this exploration, they made mind-maps to find a source for mapping. Afterwards, they mapped the features of the same selected source to the teapot by using the four aforementioned strategies. Eventually, each participant provided four different products. At the end of the session, the participants presented their concepts and filled in a questionnaire in which they were asked to select the most and the least aesthetic product, the most and the least identifiable metaphor, and the easiest and the most difficult mapping strategy among the four alternatives. Their choices and sketches are used as a basis for the analysis in the next section.

RESULTS

The selection means and standard deviations of implicit, explicit, abstract and literal mappings for each construct can be seen in Table 1. The means for the four mapping strategies are presented in Figure 5.

	Mapping	M	SD
Most aesthetic	Implicit	.33	.478
	Explicit	.17	.378
	Abstract	.42	.500
	Literal	.08	.280
Least aesthetic	Implicit	.17	.378
	Explicit	.33	.478
	Abstract	.08	.280
	Literal	.42	.500
Most identifiable	Implicit	.00	.000
	Explicit	.50	.507
	Abstract	.03	.167
	Literal	.47	.506
Least identifiable	Implicit	.47	.506
	Explicit	.03	.167
	Abstract	.47	.506
	Literal	.03	.167
Easiest	Implicit	.03	.167
	Explicit	.47	.506
	Abstract	.08	.280
	Literal	.42	.500
Most difficult	Implicit	.44	.504
	Explicit	.06	.232
	Abstract	.11	.319
	Literal	.39	.494

Table 1. The means (M) and standard deviations (SD) of implicit, explicit, abstract and literal mappings according to each construct

To determine which main mapping strategies contributed to the concerns, we employed three separate one-way independent ANOVAs as explicit, implicit, abstract and literal as within-subjects factors. The choices for the most/the least aesthetic metaphor, the most/the least identifiable metaphor and the easiest/the most difficult mapping selections were used as the dependent variables.

Subtlety level of mapping

Consistent with our predictions, there was a significant main effect of subtlety of mapping on identifiability of the metaphor and ease of mapping (*the most identifiable:* $F(1,70) = 35.00$, $p < .001$, *the least identifiable:* $F(1,70) = 25.02$, $p < .001$, *the easiest:* $F(1,70) = 25.02$, $p < .001$, and *the most difficult:* $F(1,70) = 17.68$, $p < .001$). Combined with the means for choice, these results indicate that explicit mappings make the metaphor more identifiable and they are easier for the designer, whereas implicit mappings lead to less identifiable metaphors and they are more difficult to carry out. The effect of subtlety was not significant for aesthetics of the metaphor, thus demonstrating that making an explicit or an implicit mapping does not influence the metaphor being beautiful or not.

Abstractness level of mapping

The abstractness of the mapped features had a significant effect on all constructs (for *the most aesthetic, the least aesthetic* and *the easiest:* $F(1,70) = 12.17$, $p < .001$; for *the most identifiable* and *the least identifiable:* $F(1,70) = 25.02$, $p < .001$; and for *the most difficult:* $F(1,70) = 8.02$, $p < .005$). These findings demonstrate that abstract mappings lead to more aesthetic and less identifiable metaphors; whereas literal mappings lead to less aesthetic and most identifiable metaphors. In terms of the ease of mapping, literal mappings were considered as both the easiest and the most difficult.

Mapping strategies

There was a significant effect of the type of strategy on all constructs (for *the most aesthetic:* $F(3,68) = 5.72$; *the least aesthetic:* $F(3,68) = 7.59$; *the most identifiable:* $F(3,68) = 139.33$; *the least identifiable:* $F(3,68) = 60.78$; *the easiest:* $F(3,68) = 35.92$; and *the most difficult:* $F(3,68) = 23.23$, all p's $< .001$).

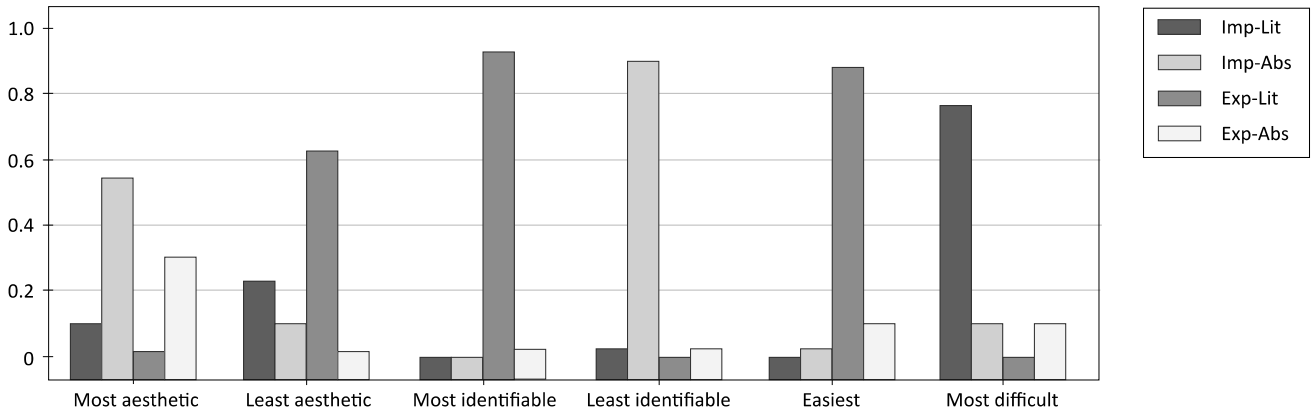

Figure 5. The selection means of each mapping strategy according to designer considerations

In order to obtain differences between specific strategies, Games-Howell *post hoc* test was conducted. Only, the significant results are presented below:

(1) For the most aesthetic metaphor condition, Imp-Abs combination was selected significantly more than the Imp-Lit and Exp-Lit combinations, $MD = 0.44$, $p < .05$, and $MD = 0.5$, $p < .005$, respectively.

(2) For the least aesthetic metaphor condition, Exp-Lit combination was selected significantly more than the Imp-Abs and Exp-Abs combinations, $MD = 0.5$, $p < .01$, and $MD = 0.55$, $p < .001$, respectively.

(3) For the most identifiable metaphor condition, Exp-Lit combination was selected significantly more than the rest, Imp-Lit and Imp-Abs: $MD = 0.944$, $p < .001$, Exp-Abs: $MD = 0.889$, $p < .001$.

(4) For the least identifiable metaphor condition, Imp-Abs combination was selected significantly more than the rest, Imp-Lit and Exp-Abs: $MD = 0.833$, $p < .001$, Exp-Lit: $MD = 0.889$, $p < .001$

(5) For the easiest mapping condition, Exp-Lit combination was selected significantly more than the rest, Imp-Lit: $MD = 0.833$, $p < .001$, Imp-Abs: $MD = 0.778$, $p < .001$, and Exp-Abs: $MD = 0.722$, $p < .001$.

(6) For the most difficult mapping condition, Imp-Lit combination was selected significantly more than the rest, Imp-Abs and Exp-Abs: $MD = 0.667$, $p < .001$, and Exp-Lit: $MD = 0.778$, $p < .001$.

DISCUSSION AND CONCLUSIONS

First of all, the results of the present study indicated that subtlety level of the mapping has an effect on (1) the identifiability of the metaphor, and (2) the ease of mapping. Considering (1), implicit mappings lead to less identifiable metaphors, whereas explicit mappings produced more identifiable metaphors. This is an expected result because with implicit mapping, the physical properties of the target refer less to the features of the source. Thus, the identifiability of the metaphor depends on the user's ability to do so.

In relation to (2), explicit mappings were considered to be easier to carry out than the implicit mappings. Again, this finding is in line with our expectations. In explicit mappings, a designer applies explicit source-related cues on the appearance of the target without the necessity to "hide" or blend them with the features of the target. For this reason, this approach might be easier for the designers. This does not mean that explicit mappings are inferior to implicit mappings. Here, the designer may have different concerns such as making the target-source association apparent or helping the users to identify the source with ease. This is supported with the finding that the subtlety of the mapping did not have an effect on the aesthetics of the product. Both explicit and implicit mappings may lead to aesthetically pleasing metaphors/products as long as the designers pay attention to the degree of abstractness in mapping.

Again in terms of the identifiability of the metaphor and the aesthetics of the product, the results indicated that abstract mappings lead to less identifiable and

more aesthetic metaphors than literal mappings, and vice versa. As the designer almost directly copies the features of the source to the target in literal mapping, the reference to the source becomes more apparent in the final product form. This is why literal mappings lead to more identifiable metaphors than the abstract ones. However, this direct transfer of features may sometimes contradict the usage, form and/or character of the target. As an example, one of the students in our study chose “Superman” as a source to convey adventurousness and made the teapot look like the Superman by transferring the muscled male body form, red cape and logo on the chest. This a quite literal mapping, which makes the end design unrecognizable as a teapot, inefficient to use because of the form and somewhat kitschy as it looks like a gadget rather than a teapot. This might also be the reason why literal mappings lead to less aesthetic products when compared to the abstract ones. As mentioned before, in abstract mappings, the features of the source are simplified while transferring them to the target in order to match requirements of target that are related to form, usage, function, context, etc. The student who used Superman as a reference in her teapot designs, extracted his muscular posture for the abstracted mapping and transferred this feature to the teapot, which resulted with an angular teapot design. This would be a more convenient approach that does not violate the requirements of a regular teapot while bringing in new features regarding the form and use.

In terms of the ease of mapping, the picture is more complex. Literal mapping was rated as the easiest and the most difficult mapping at the same time. This result should be interpreted according to the degree of subtlety that it is combined with. In order to discuss this issue, we should have a look at the effect of four mapping strategies. The results indicated that when literal mapping was combined with explicit mapping (Exp-Lit), it was rather easy to conduct since the designer directly transferred the relevant source features to the target without making elaborate considerations. On the other hand, when it was combined with implicit mapping (Imp-Lit), it became the most difficult strategy to employ. While literally transferring the features of the source but still keeping them subtle/unidentifiable was considered as a challenge by most of our participants. For this reason, we can state that some of the strategies are more conflicting to come together as in this case, whereas some others like Exp-Lit or Sub-Abs are more natural combinations as they are usually found together.

To continue with the effect of four mapping strategies on the remaining concerns, Imp-Abs mappings produced the most aesthetic products while Exp-Lit mappings lead to the least aesthetic ones. This result illustrated that the more subtle the reference to source is and the more it is adapted to meet the target’s requirements, the more aesthetic the product becomes. However, this approach leads to less identifiable metaphors since the results showed that Imp-Abs mapping strategy produced less identifiable metaphors than Exp-Lit mapping. As can be understood from these findings, each of the mapping strategies has certain strengths and weaknesses. A summary of these can be seen in Figure 6. For increasing the identifiability of a metaphor for instance, the designer should try to follow a strategy that is closer to the bottom-left corner of the chart, or for increasing the aesthetics of the product s/he should go for the strategies that are closer to the top-right corner. Furthermore, as s/he follows strategies that are closer to the bottom-left, the mapping becomes easier. It should be noted that these aspects do not indicate one strategy’s superiority than the other. Based on the abilities of the designer, limitations of the design brief or the requirements of the design context (e.g. time, money, target group, product category, brand identity, mechanism inside the product, etc.), different strategies may be employed. One may sometimes aim for making the metaphor easily understood in order to communicate its function/meaning to the users efficiently. For example, the first e-books looked like a real book with a leather cover imitating an actual book cover. Making an explicit reference to a book and literally transferring its usage communicated the users the function of this novel product that it is for “reading”. Similarly, a designer may also give importance to the aesthetics of the final look or s/he may aim to finish to design phase as soon as possible. For each of these concerns, different strategies play a role.

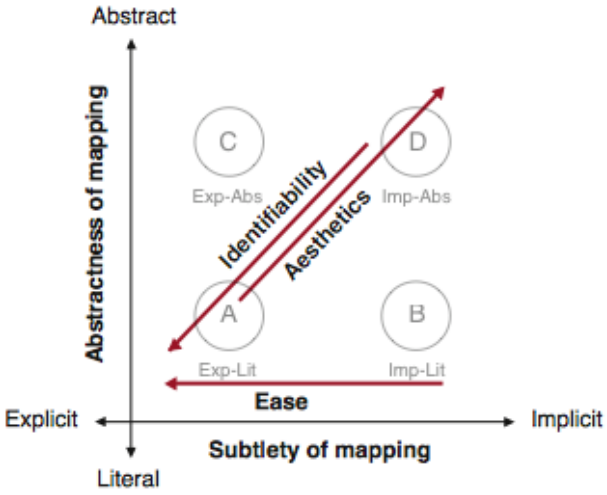

Figure 6. The strengths and weaknesses of each mapping strategy

IMPLICATIONS FOR DESIGNERS

It is also worth to discuss how these strategies are implemented. Let us compare two adventurous teapots that are designed by our participants. The first metaphor employs a “tent” as a source (a), while the second one refers to a “bomb” (b). As can be seen from these examples, the approach taken for Exp-Lit was rather direct: the participants made the teapots explicitly look like a tent or a bomb. However, we argue that there are also degrees for this kind of mapping. Especially the tent teapot is a rather crude example when compared to the bomb. As the bomb’s rounded form fits better with the form of a stereotypical teapot, it becomes a better source to associate with this target. With Exp-Lit mappings, there is always the risk to end up with kitschy products; therefore, this mapping strategy should be followed with caution.

For the Imp-Abs mapping, the students extracted a certain feature of the source to transfer to the teapots. This feature was the “self-assembly” of a tent, and for the bomb it was the blinking red light indicating the tea is ready. Again, these examples show the possible degrees for Imp-Abs mapping. The tent metaphor would be placed in a far top-right in the chart in Figure 4, whereas the bomb teapot would be closer to the center because the bomb is still identifiable to some extent in the appearance of the teapot. Also, the feature transferred from the bomb, again fits better to the context of a teapot (giving feedback about the state of the product). On the other hand, being self-assembled is a feature that is not quite relevant to the teapots, therefore one might have difficulty to figure out the intention of the designer. Therefore, in order to improve the target product and bringing novel functions, analyzing the target and extracting the relevant features from the source is necessary in this strategy.

The feature extraction is also used in the Exp-Abs strategy, but this time participants tried to emphasize the reference to the original source when transferring these to the target. In the tent metaphor, the participant explicitly transferred the angular and cornered form of a tent, while in the bomb metaphor, the transferred feature was the visualization of the effect bomb makes.

Figure 7. Two examples of the teapots designed by participants following the four strategies.

Finally, for the Imp-Lit strategy, the students followed the approach to map a non-salient feature of the source. This helped them to literally transfer the relevant attributes but still keeping the reference to the source subtle. In this case, the tent example is more appropriate since the participant literally transferred the stitches used in a tent as a surface ornament in the teapot, however it is rather difficult to identify this connection as a user. On the other hand, the bomb is still explicitly displayed. As mentioned before, this was the strategy that the participants declared to have the most difficulty when employing.

To summarize, we can state that the mapping is a major phase in product metaphor generation that make the product concrete and tangible, which influences the aesthetics of the end product, the identifiability of the metaphor and the ease of designing. There are different strategies that the designers may follow in order to attain these different concerns.

FUTURE STUDIES

In this paper, we focused on how the mapping strategies affect the end product and the process. However, it is also important to study which features of a source are mapped to target. A future study should be conducted in which designers are asked to reveal how they analyze the features of the source for mapping purposes. For example, designers could use a mind-mapping technique that unravels the features of the source systematically and makes these features hierarchically (and conceptually) connected. Then, it would be interesting to see whether basic level features would be used more often for Exp-Lit mappings, higher-level features for Imp-Abs and lower-level for Imp-Lit and Exp-Abs mappings.

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