From teatime cookies to rain-pants: Resolving dilemmas through design using concerns at three abstraction levels

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ABSTRACT

Users often have conflicting concerns (i.e., dilemmas), such as 'embracing change vs. following tradition'. Design can resolve these dilemmas through simultaneously fulfilling conflicting user concerns. This paper proposes three abstraction levels for framing user concerns when formulating dilemmas. In a large-scale industry project, we identified that dilemmas can be formulated and resolved at different abstraction levels. Based on these preliminary findings, we developed a structured way to formulate dilemmas, which involves using three different types of concerns (i.e., product-, activity-, and identity-focused concerns). In this framework, product-focused concerns represent the most concrete concern level and identity-focused concerns represent the most abstract level. Sixty master-level design students were asked to formulate a dilemma evoked by a product of their own choice and to create design ideas to resolve this dilemma. The results showed that dilemmas involving all concern levels can be an input for ideation, with the 'most abstract yet informative' dilemma being the most inspiring. In addition, we found that design can resolve dilemmas in several distinct ways, where each dilemma-resolving strategy comes with opportunities and challenges. Consciously formulating and examining alternative dilemma formulations can create opportunities that might otherwise not be considered as input for ideation.

KEYWORDS: emotion; idea generation; design methodology; problem solving; design synthesis

1. Introduction

Design traditionally aims to increase the quality of life by removing barriers to our efficiency and comfort, and by enhancing our everyday experiences. A potent way to achieve this, is through resolving dilemmas (Ozkaramanli, Desmet, & Ozcan, 2016). Dilemmas can be defined as the realization that one cannot have two desirable alternatives at the same time, such as packing a light suitcase (comfort) vs. packing a variety of outfits (being prepared for unexpected occasions). In this situation, the conflict between comfort and being prepared necessitates a compromise (e.g., I will bring an extra pair of shoes but leave my stylish handbag at home). Design can resolve this compromise by reconciling the conflicting desires. The stylish yet foldable handbag shown in Figure 1 enables one to travel light without having to leave a stylish handbag behind. In this way, design can offer product alternatives that are more user-appropriate and emotionally satisfying than products that necessitate a compromise.

Figure 1. Foldable handbag

Users' conflicting concerns, such as traveling comfortably (i.e., packing light) vs. being well prepared (i.e., packing various outfits), often manifest as dilemmas in everyday life. Identifying these conflicts can be important triggers for design creativity, because they challenge the designer to envision novel scenarios in which the conflict is resolved (Ozkaramanli & Desmet, 2012; see also Benack, Basseches, & Swan, 1989). A well-known design method that demonstrates the creativity-enhancing nature of conflicts is TRIZ developed by Altshuller (1988). TRIZ focuses on formulating, analyzing, and resolving technical conflicts in a system (e.g., the conflict between increasing the weight of an object without increasing the energy required to move it) by applying 40 conflict-eliminating principles (Moehrle, 2005). In addition, Cross (2003) stated that a characteristic of exceptional designers is this ability to utilize conflicts between the features of an object and the user's requirements to come up with creative ideas. Moreover, the ability to tolerate cognitive conflict (i.e., conflicting thoughts) has been suggested as an important characteristic of creative people (Sheldon, 1995). Therefore, dealing with users' conflicting concerns might be a creativity enhancing exercise for designers. Tolerating cognitive conflict can also be compared to tolerating ambiguity in design activities. Ambiguity is a form of uncertainty in the meaning or intentions of an object or a situation (De Jong & Özcan, 2016). As design activities often involve ambiguous situations, mastering this ambiguity, and the cognitive conflict that presumably results from it, can contribute to design creativity (De Jong & Özcan, 2016).

Dilemma-driven design requires an understanding of users' concerns and concern conflicts. This understanding is often achieved through user research. A challenge in researching dilemmas is that people are generally not able to articulate their dilemmas on the level of concerns, because concerns are latent phenomena (e.g., Kleiman & Hassin, 2011). Instead, they tend to express dilemmas in terms of the concrete choice alternatives: Should I go for a morning run or sleep in? Should I buy a new dress or save money for a nice summer holiday? We argue that, despite being informative, these choices only provide a partial understanding of users' dilemmas. An opportunity here is to search beyond these concrete choices to identify the qualities of concerns that underlie each choice. For instance, asking the participant why it is important to go for a morning run might reveal that this choice is driven by a general concern for being energetic, while sleeping in might be driven by the concern for comfort or relaxation (see laddering interview techniques, Reynolds & Gutman, 1988). Actively searching for motivations underlying users' choices enables us to reformulate users' dilemmas at different abstraction levels as input for idea generation.

In this paper, we propose 'three levels of user dilemmas' for examining the nuances among abstract and concrete dilemma formulations that can enable new interpretations of a dilemma, and consequently, creation of new design ideas inspired by these interpretations. Concrete formulations (e.g.,

"*I want to go for a morning run"*) often involve rather tangible references, such as time, location, or physical features, which makes them easy to imagine and describe (Wiemer-Hastings & Xu, 2005). On the other hand, abstract formulations (e.g., "*I want to be energetic*") are intangible in nature and they lack well-defined physical references and persisting existence in a specific context, which makes them harder to imagine and describe (Wiemer-Hastings & Xu, 2005). Ward, Patterson, and Sifonis (2004) suggest that abstract problem formulations (e.g., design an animal that can survive in outer space) allow more originality due to their general nature. Alternatively, concrete formulations (e.g., adapt a cow to enable it to survive in outer space) offer other advantages, such as ease of cognitive processing in ideation or incremental design advances that result in more familiar and acceptable products (Ward, Patterson, and Sifonis, 2004). As both abstract and concrete formulations have their benefits (and limitations), it might be helpful to understand the nuances of these formulations to discover and use alternative dilemma formulations as input for ideation.

This paper consists of four main sections. In the first section, we briefly report a large-scale industry project in the domain of food design. In this project, the design team intuitively explored the nuances between abstract and concrete dilemma formulations and used these formulations as input for developing teatime snack concepts. In the second section, we define the three levels of user dilemmas based on a post-hoc analysis of the findings of the teatime project. The third section reports a study in which sixty master-level design students used the proposed levels for creating dilemma-resolving design ideas. This study addressed two main research questions: (1) What are the prominent abstraction levels that designers use when formulating design-relevant dilemmas? And (2) what kind of design strategies do designers use when generating ideas to resolve dilemmas? The results are discussed in terms of the opportunities and challenges of using the *three levels of user dilemmas* and the *dilemma-resolving design strategies*. We conclude with a general discussion on the contribution of dilemma-driven design to other approaches on creative problem solving.

2. Dilemmas during teatime

The first and second author were involved in a large-scale industry project in which dilemmas experienced during an afternoon tea ritual were taken as a starting point to develop new teatime snack concepts for a specific target group (Ozkaramanli et al, 2013). The occasion and the target group for this project were determined by the company who consulted our research group for an emotion-based understanding of their target users. Sixteen people were visited for three to six hours during their afternoon tea ritual with friends. The research team identified the main concerns and concern conflicts of target users using a protocol called Emotion Capture Card (ECC) procedure (see Ozkaramanli et al, 2013), which is a hybrid method that combines observation, interviewing, and experience sampling.

During the ECC procedure, the participants were asked to explain their emotions, which were captured at pre-defined intervals during teatime, using a laddering type interview technique. This yielded both concrete concerns that were related to teatime (i.e., specific wants and needs of users such as *"I want to serve variety of snacks for my guests*") and abstract concerns in the general context of life (i.e., personal values and aspirations such as "*I want to be a good mother*"). These concerns were compared and contrasted to identify users' dilemmas. Table 1 outlines the identified dilemmas and the descriptions of the resulting dilemma-inspired designs (for images of the designs, see Figure 2).

Some of the dilemmas were specific to the teatime context and had a pragmatic quality. For example, the host wanted to serve self-made food as a sign of her love and respect for her guests. At the

same time, she struggled to offer enough variety to please everybody. This dilemma, which was mainly triggered by limited preparation time, led to the development of packaged snack alternatives that looked (and felt) homemade.

In addition, some dilemmas were embedded in deeply-held personal and cultural values. For example, the researchers repeatedly observed a general tension between the desire to keep up to date with new trends and developments (i.e., being open to change), and the security of following tradition (i.e., maintaining traditional values). This dilemma had implications for teatime: while wanting to try new, international recipes for the occasion, the hosts feared that their guests would appreciate traditional, well-known tastes better. In addition, the same dilemma (i.e., being open to change vs. maintaining traditional values) had implications in other life domains as well, such as educating children (e.g., "*I want my children to develop the skills necessary to succeed in a changing world"* vs. *"I want my children to do things in the traditional way"*). The trans-situational nature of this dilemma indicated that it touched upon the deeply-held values of the target consumers.

Table 1. Summary of dilemmas experienced by target consumers during teatime

Dilemma Title and Explanation	Design Output
Serving self-made food vs. offering variety *I want to serve a variety of snacks, including sweet and savory, but at the same time, I feel that I have to prepare them myself to ensure their quality.*	Packaged food products that look and taste homemade to increase the variety of snacks served. (See Figure 2a)
Being a proud host vs. being a comfortable host *I feel pressure to perform as a host; I don't want to make mistakes and I want to be sure that my guests are happy and have all that they need. At the same time, I want to be relaxed so that my guests can relax as well.*	Brand website that communicates tips and suggestions to prepare for teatime.
Trying new environments vs. maintaining intimacy *I like trying different environments for hosting teatime. However, I also want my guests to feel safe, and I want to have an intimate atmosphere in which we can have intimate conversations. For this openness, I have to rely on the traditional routines.*	Brand website that offers discounts for organizing teatime in local patisseries.
Trying new recipes vs. anxiety to fail *I love trying new recipes and experimenting with my cooking. On the other hand, I don't want to fail the expectations of my guests. Therefore, I often use my familiar recipes.*	Brand website that suggests fail-proof recipes.
Being open to change vs. maintaining tradition *I want to maintain my traditional values and habits, and pass them onto my children. However, I also want to embrace change, especially for my children, since I want them to be self-sufficient*	Packaged food products that combine new, unexpected forms and flavors with traditional ones. (See Figure 2b)

and successful in an ever-changing world.	Brand identity that aligns modern forms, colors and patterns with traditional ones. (See Figure 2c)
Feeling special vs. being a responsible housewife *I want to feel like a special and unique person, but as a mother and wife, I feel that I should always put my family and friends before myself.*	Packaged food products that are flexible so that users can customize them according to their personal taste. (See Figure 2d)

Figure 2. From left to right (a) Imperfectly shaped crackers flavored with spices used in home-cooking, (b) packaged cake combining traditional forms with new flavors, (c) website communicating the brand identity by combining traditional colors and forms in a modern setting, (d) bite-sized, neutral-tasting cups that can be filled in with different ingredients to create unique tastes

In the design process, we experienced that it was fruitful to reformulate a dilemma at various levels of abstraction. In this project, the client chose "being open to change vs. maintaining traditional values" as the main design theme. Within this theme, a variety of design ideas were created, such as new product features, packaging ideas, brand identity, and communication strategies. Exploring abstract formulations (i.e., change vs. tradition) enabled the design team to think beyond the teatime context, which resulted in communication strategies (e.g., a television advertisement that featured the clash between a mother with firm, traditional values and her rebellious daughter-in-law). Alternatively, concrete formulations (i.e., surprising flavors vs. traditional flavors) inspired new snacks that combined surprising, new ingredients with traditional tastes or forms. As a result, consciously examining dilemma formulations at different abstraction levels could stimulate creation of new ideas, each with a distinct focus.

In addition, the design team used different approaches to resolving dilemmas. For instance, the design idea shown in Figure 2b combines sensorial information that embody the abstract concepts of tradition and being open to change. Here, historical forms were used to embody the concept of tradition and unexpected flavors were used to embody the concept of being open to change. Alternatively, to resolve the dilemma between *"I want to feel special"* vs. *"I want to be a responsible housewife"*, the design team developed edible, bite-sized cups (Figure 2d), which could be used to prepare fillings with unique flavors. The personalized nature of these snacks aimed to create a feeling of uniqueness, while their practical preparation could save time for other responsibilities. In summary, the different design approaches adopted in the teatime design case indicate that there might be a variety of design strategies that can be used to resolve dilemmas.

3. Three levels of user dilemmas

Insights derived from the teatime design case inspired developing three levels of user dilemmas that can be used to create alternative representations of dilemmas at three abstraction levels. At the heart of a dilemma is a combination of two concerns that conflict in specific situations (e.g., *"I want to maintain my traditional values and habits"* vs. *"I want to be open to change"*). Because conflicting concerns represent the *raison d'etre* of dilemmas (see Ozkaramanli, Ozcan, & Desmet, 2017), we use the term *dilemmas* and *conflicting concerns* interchangeably and will take the formulation of concerns as a starting point for formulating dilemmas.[1]

Concern is a collective term used to describe the goals, standards and attitudes of target product users (Desmet, 2008). User concerns can be product-, activity-, or identity-focused (Desmet, 2008). By their nature, these concerns appear to represent three different abstraction levels.[2] Product-focused concerns focus on a quality of the product, such as a product attribute or benefit. *"Teatime snacks should have a traditional taste,"* or *"the product should help me to focus"* are examples of product-focused concerns. This is the most concrete level, because the concerns involve perceivable product attributes or are embedded in specific contexts. In contrast, identity-focused concerns express a quality of the person, such as habits, personality traits, values, aspirations, or life goals. Examples are *"I want to maintain my traditional values and habits"* or *"I want to have healthy eating habits"*. Personal qualities are often independent of the context of product use and might be applicable to various domains in the person's life. Therefore, identity-focused concerns are at the most abstract level. Activity-focused concerns are about a quality of the activity in relation to product use, such as an experience or a behavior. *"I should meet the expectations of my guests during teatime"* or *"I want to follow my routine when preparing breakfast"* are examples that describe activities a product might enable. As these concerns refer to the context of use, yet do not involve specific product attributes; they sit at a mid-abstraction level between product- and identity-focused concerns.

It is often possible to formulate a concern at different abstraction levels using a technique called laddering up (i.e., interpretation), and laddering down (i.e., instantiation) (Reynolds & Gutman, 1988). For example, a product-focused (concrete) concern, such as *"I want to serve traditional snacks to my guests,"* might be reformulated to an identity-focused (abstract) concern, such as *"I want to maintain my traditional values and habits."* In this case, laddering up by asking *why* (e.g., why is it important to serve traditional snacks?) helps to identify the abstract concern behind a concrete choice. Similarly, laddering down by asking *how* (or what causes this?) helps to identify a specific product or an activity that can fulfill an abstract concern (see Manyiwa & Crawford, 2002). For example, *"I want to experiment with new recipes for teatime"* might be one instance of *"I want to be open to new experiences"*. Note that the responses to 'why' questions ideally come from users themselves to avoid misinterpretation of their deeper goals and values by the design team. Therefore, this approach always requires a stage in which users' concerns are determined in a way similar to the ECC procedure used in the teatime project.

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[1] The term dilemma refers to the holistic experience of intrapersonal (i.e., within-person) conflict where conflicting concerns are one ingredient, and where mutually exclusive choices (e.g., prepare a traditional dish vs. prepare a new, unfamiliar dish) and anticipated emotions evoked by each choice (e.g., relief and boredom vs. excitement and anxiety) are the other two ingredients. For a complete definition, refer to (Ozkaramanli, Ozcan, & Desmet, 2017).

[2] Note that, although identity-focused concerns tend to be abstract and product-focused concerns tend to be concrete, *the focus of these concerns* and *the abstraction level* are two different dimensions where the former involves discrete categories of content and the latter a gradual range. However, for purposes of this study, we have used these three foci (product, activity, identity) to represent concerns at three abstraction levels.

As it is possible to formulate a concern at three abstraction levels without losing its essence, it becomes possible to formulate conflicting concerns *within* and *across* any of these levels. This yields nine alternative pairs of conflicting concerns (i.e., nine dilemmas). Figure 3 shows three levels of user dilemmas that illustrate how product-, activity-, and identity-focused concerns can be combined in nine different ways to obtain nine alternative dilemma representations. As an example, we used the dilemma *"maintaining traditional values* vs. *being open to change."* In Figure 3, combinations 1.1, 2.2 and 3.3 represent dilemmas formulated within the same abstraction level (i.e., product-product, activity-activity, identity-identity combinations, respectively), and the remaining numbers represent dilemmas formulated across different abstraction levels. Note that there are two representations for each cross-level combination, which are similar in concern type but differ in content. These combinations are product-activity (1.2) or activity-product (2.1); identity-product (3.1) or product-identity (1.3); and identity-activity (3.2) or activity-identity (2.3) combinations.

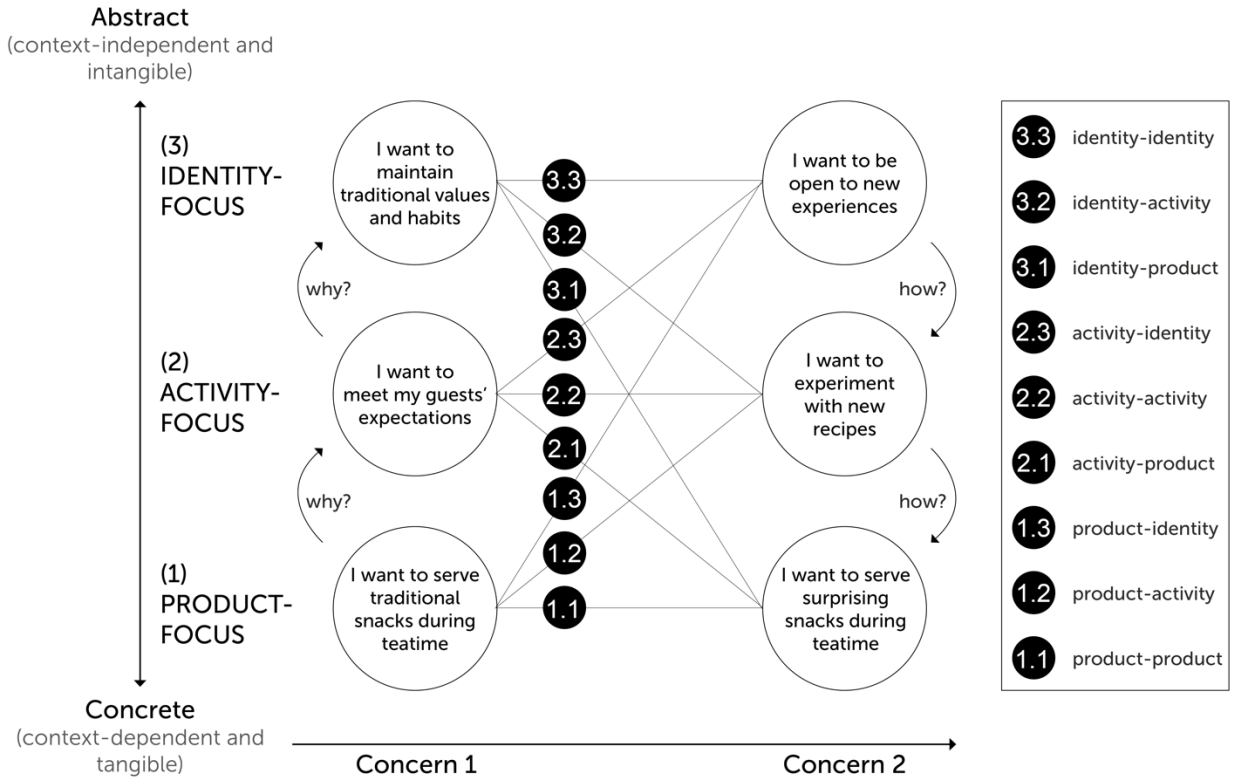

Figure 3. Graphical representation of the three levels of user dilemmas that yields nine alternative dilemma formulations

Explicitly formulating and examining these alternative dilemmas can create problem definitions that might otherwise not be considered as input for ideation. Although some combinations seem similar, one or more combinations might stand out as the most promising for ideation. When resolving dilemmas, this might inspire variety of ideas ranging from very technical solutions (i.e., by using dilemmas that involve product-focused concerns) to very conceptual solutions (i.e., by using dilemmas that involve

abstract concerns). As a result, a design team can choose to create ideas to address dilemmas at multiple abstraction levels, or choose one level as an inspiring starting point for ideation.

4. Implementing the three levels of user dilemmas and introducing design strategies

The design examples in the teatime design case were inspired by dilemmas; however, their design did not involve a structured way of examining conflicting concerns at varying abstraction levels. The design team intuitively formulated dilemmas to best capture the insights they gathered during user research. If the proposed levels of user dilemmas were in fact utilized, it would have been interesting to know, for example, whether the dilemma formulations would be different, and whether some of the nine alternative representations would stand out as more attractive than others. To better understand the contribution of the three levels of user dilemmas to resolving concern conflicts, we implemented these levels in a design project completed by 60 novice designers.

4.1. Method

The main goal of this study was to understand how designers would adopt and adapt the three levels of user dilemmas when redesigning a product to resolve a particular dilemma. Specifically, we focused on the following questions:

(1) Formulating dilemmas: How do designers explore the three abstraction levels? What challenges do they encounter? Are some levels more attractive than others?
(2) Resolving dilemmas: What kind of design strategies do designers use when generating ideas to resolve dilemmas? Are some strategies more useful than others?

Sixty master-level student designers enrolled at Delft University of Technology responded to our design brief as part of a first-year master course focused on product experiences. The designers identified a dilemma that a product they owned could evoke, and they proposed a redesign using the three abstraction levels as input for ideation. The theoretical background and the design brief were explained during a two-hour lecture, and designers had one week to respond to the brief following the lecture. The selected products covered a wide range of product categories such as bicycles, rain-pants, water bottles, or fountain pens. First, the participants mapped the key user concerns that their product (or service) could or could not fulfill. For this, they were asked to imagine themselves as the user of their chosen products. Second, they analyzed the relationships among these concerns and identified a potential concern conflict to resolve. Third, they formulated abstract and concrete representations of this conflict *(i.e., I want ...etc. vs. I want ...etc.)* using the three levels of user dilemmas in Figure 3. In the fourth and final step, they chose the most inspiring formulation to redesign their product in a way that resolves the concern conflict. To gain a better understanding of the design decisions, the participants were encouraged to communicate their design ideas in simple sketches and mind-maps, supported by an explanation of their approach.

4.2. Results

To answer the first research question, we used a frequency analysis method by counting how many times each abstraction level was employed by designers. We checked for the clarity and meaningfulness of each concern formulation. To answer the second research question, we used content analysis to identify the patterns in the written descriptions of the approaches designers used to resolve the dilemma (see Hsieh & Shannon, 2005). These descriptions were supported by the sketches of the design ideas. The main question that led the analysis process was *'what is the design mechanism used to fulfill the conflicting concerns?'* We excluded two responses from our analysis due to incomplete formulations.

Figure 4 shows an example of how the participants followed the steps indicated in the design brief. The product used in this example was a Polaroid Camera. In the first step, the main concerns that a Polaroid Camera could or could not fulfill were mapped out. In the second step, a pair of conflicting concerns was selected and formulated at three abstraction levels. Finally, the activity-focused concerns (i.e., "*I want to take photos with a vintage experience"* vs. "*I want to make digital photos"*) were chosen as a starting point for a redesign that combines the efficiency of a digital camera and the vintage experience of a Polaroid camera.

4.2.1. Three levels (or nine combinations) of user dilemmas

All participants could generate alternative dilemma formulations at all levels. Table 2 presents the frequency of participants' choice for each abstraction level and gives examples of conflicting concerns for each combination in the wording formulated by the participants. The results indicate that, overall, the activity level was used the most frequently (28 times) and the identity level was used the least frequently (11 times). The product level was used 19 times.

Furthermore, within-level and cross-level combinations were analyzed. Within the abstraction levels, activity-activity combination was used the most frequently (18 times) followed by the identity-identity (seven times) and product-product (five times) combinations. Across the abstraction levels, the product-activity combination was used the most frequently (12 times) followed by activity-product (eight times) combinations. The product-identity (or identity-product) and activity-identity (or identity-activity) were the least frequently used cross-level combinations (two times each).

Analyzing the clarity of the concern formulations revealed that, for sixteen responses, the formulations could be interpreted as being at a different abstraction level than those indicated by the designers. For instance, *"I want to show people all the books I have read"* was indicated as an activity-focused concern, whereas it could also be interpreted as an identity-focused concern (e.g., conveying an intellectual personality). In addition, the difference between product-focused and activity-focused concerns was occasionally overlooked. For instance, the concern *"I want to make digital photos"* and *"I want to make photos in a digital way"* are, in fact, both product-focused concerns despite the latter having been indicated as an activity-focused concern. Finally, five participants used negative wording (i.e., I do not want to …) for framing one of the concerns in the dilemma, such as *"I want to monitor my wellbeing but I do not want to feel pressured by the information I receive"* although the proposed framework mainly emphasizes positive wording.

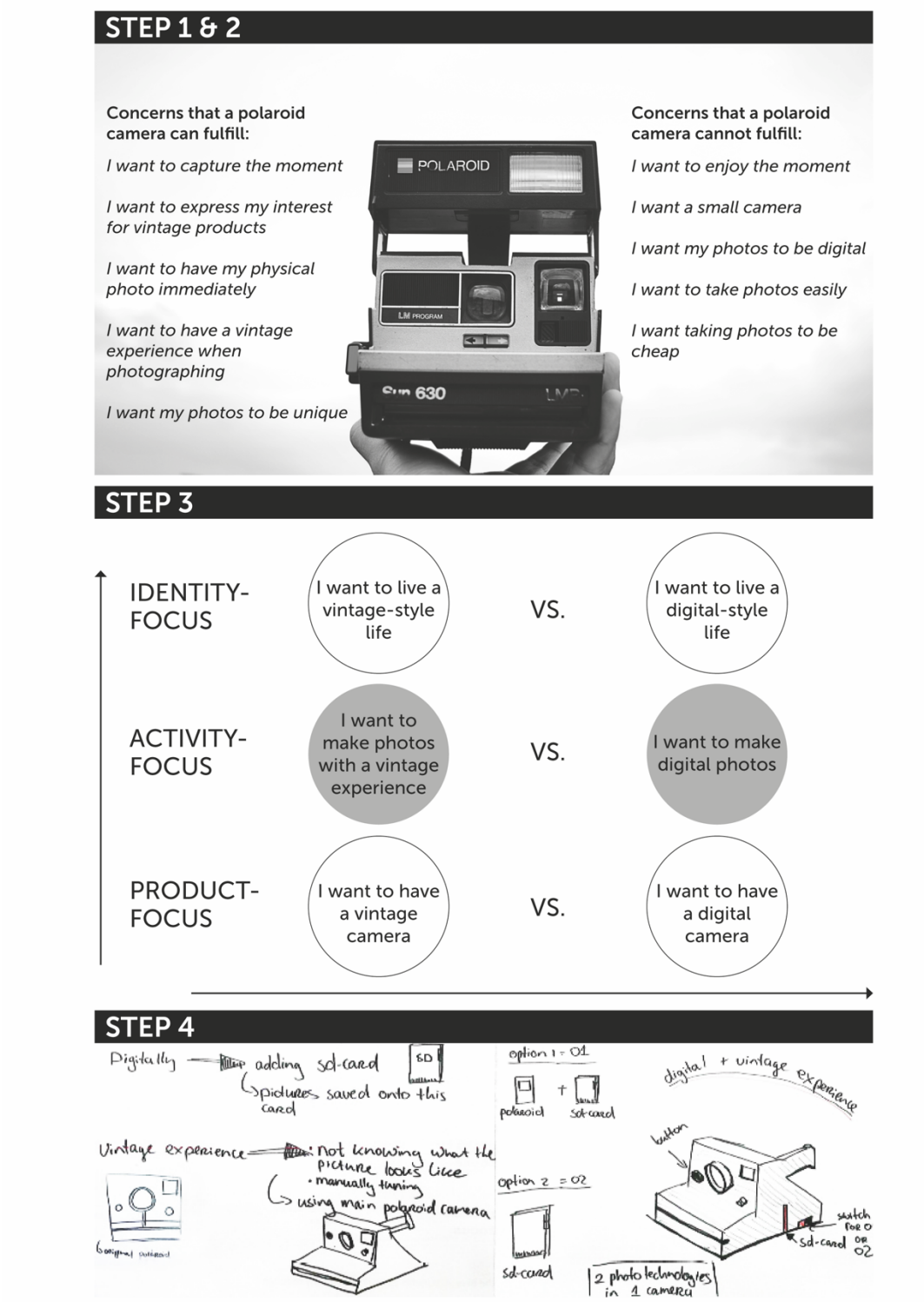

Figure 4. An example response to the given design brief

Table 2. Frequency of selection and example formulations for each concern combination

Level (Figure 3)	Concern combinations	Frequency of use	Dilemma Examples
1.1	**Product-Product**	5	*"I want to have a small bag"* vs. *"I want to have a bag with many compartments"*
1.2	**Product-Activity**	12	*"I want to carry a small and light blanket when camping"* vs. *"I want to sleep next to my boyfriend when camping"*
1.3	**Product-Identity**	2	*"I want to use trendy products"* vs. *"I want to express my own personality through the products I use"*
2.1	**Activity-Product**	8	*"I want to show people all the books I have read (i.e., buy physical books)"* vs. *"I want to read books in a money-conscious way (i.e., read online)"*
2.2	**Activity-Activity**	18	*"I want to shave comfortably"* vs. *"I want to shave efficiently"*
2.3	**Activity-Identity**	2	*"I want to stay dry in the rain (i.e., wear rain-pants)"* vs. *"I want to look fashionable (i.e., wear my own clothes)"*
3.1	**Identity-Product**	2	*"I want to live a healthy life"* vs. *"I want to indulge in sweet snacks"*
3.2	**Identity-Activity**	2	*"I want to be a mobile professional"* vs. *"I want to work comfortably on my computer"*
3.3	**Identity-Identity**	7	*"I want to feel feminine" vs. "I want to look tough"*

4.2.2. Dilemma-resolving design strategies

Based on participants' written reflections, we identified four design strategies used to resolve conflicting concerns. These are: (1) blending, (2) fixing, (3) designing flexibility into the product, and (4) introducing new designs.

(1) Blending: This strategy combines characteristics of two products in a way that can simultaneously fulfill conflicting concerns. Two different products in the same product category (e.g., cameras) might have characteristics that fulfill different concerns, such as "*I want to have a 'vintage' experience when making photos (i.e., use a polaroid camera)"* vs. *"I want to manage my photos easily (i.e., use a digital camera)*" (see Figure 4). A Polaroid-style camera with a digital storage card might resolve this conflict, because it might enable a vintage experience as well as easy management of photos. For this redesign, the designer explained his approach as *"I combined the properties from both cameras that I like to create an optimal design that fulfills both concerns."* We identified seven redesigns that were based on this strategy.

(2) Fixing: Existing products sometimes meet a specific user concern while ignoring or violating another (e.g., rain-pants help staying dry in the rain, but they are often considered unfashionable). In such cases, the product can be redesigned in a way that maintains the fulfillment of the first concern (i.e., staying dry), while also fulfilling another concern relevant for the same situation (i.e., being fashionable). We called this strategy *fixing*. Fixing involved either modifying existing characteristics of a product (e.g., material, form) or adding new characteristics (e.g., new functionalities). For instance, rain-pants that is transparent enable staying dry, and at the same time, reveals the actual clothing of the wearer. In this way, it can maintain the fulfillment of the concern for staying dry, while also fulfilling the concern for being fashionable, (see Figure 5). Thirty redesigns were based on the fixing strategy.

Figure 5. Example of strategy, *fixing*: Transparent rain-pants that resolve the conflict between *"I want to stay dry"* vs. *"I want to look fashionable."*

(3) Designing Flexibility into the Product: When a product characteristic is preferred in some usage situations but not in others, an existing product can be redesigned to allow flexible usage scenarios. For example, the conflict between *"I want to have a small bag"* vs. *"I want to have a bag with many compartments"*, was resolved by creating removable backpack compartments that can be added to the backpack when needed (See Figure 6). This strategy resulted in modular products or products that allow personal customization. Eight redesigns were based on this strategy.

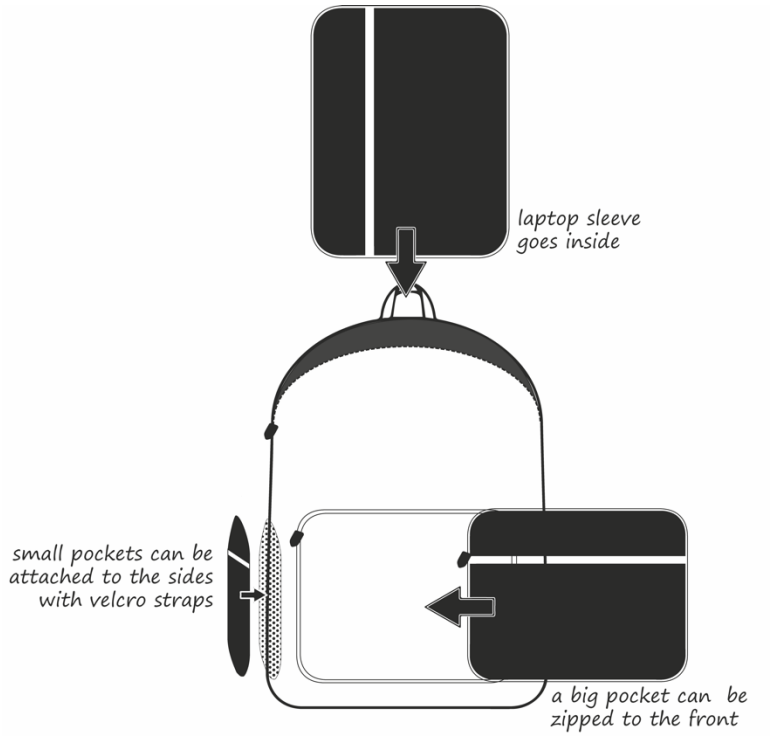

Figure 6. Example of strategy, *designing flexibility into the product*: Backpack with modular components that resolves the conflict between *"I want to have a small bag"* vs. *"I want to have a bag with many compartments."*

(4) Introducing New Designs: This strategy involves designing a product that is in a different yet related category than the product selected for the design brief (instead of redesigning the same product). These new designs involved new packaging (e.g., e-books with a cover to enable physically displaying a book collection without having to buy the physical version of the book), a supporting service (e.g., a direct calling service for internet banking to enable one-to-one communication when needed), or a supporting product (e.g., a card reader that detect the remaining balance on a public transport card to enable efficient monitoring of expenses). For example, for the conflict between *"I want to be a mobile professional"* vs. *"I want to work comfortably on my computer"*, the designer created a laptop bag that can be used to comfortably carry belongings essential for working, instead of redesigning the computer itself (see Figure 7). Eleven new designs were introduced in response to the given design brief.

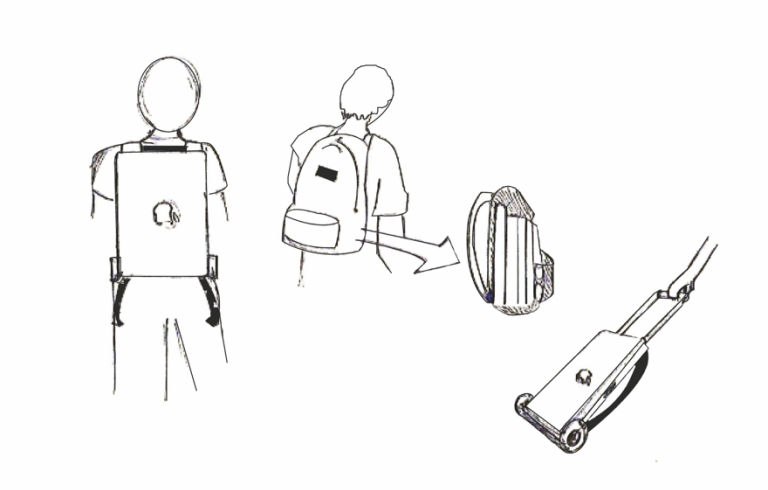

Figure 7. Example of strategy, *introducing a new design*: a laptop bag trolley that resolves the conflict between *"I want to be a mobile professional"* vs. *"I want to work comfortably on my computer."*

4.3. Discussion

4.3.1. Using abstract vs. concrete formulations

The frequency of use for different abstraction levels showed that all levels could be used to formulate dilemmas, where activity-focused concerns were used most frequently. Activity-focused concerns balance the high number of design opportunities offered by abstract concerns with the tangible references offered by concrete concerns. When two abstract formulations (e.g., identity-identity combination) are paired, they might create a large solution space, as there are multiple instances that can fulfill each concern (see Ward, Patterson, & Sifonis, 2004). However, when paired, abstract formulations might not always clearly communicate a conflict. Consider the conflict between the product-focused concerns; *"I want to have a small bag"* vs. *"I want to have a bag with many compartments."* When abstracted, this concern conflict might become *"I want to have a simple life"* vs. *"I want to lead an organized life."* Although the conflict was clear when two product-focused concerns were paired, it becomes less clear when represented as an identity-identity combination, which might render the solution space less actionable.

Alternatively, when two concrete formulations (e.g., product-product combination) are paired, the resulting solution space is informative and actionable, yet restricted to a single product or a context (see Ward, Patterson, & Sifonis, 2004). For instance, resolving the conflict, *"I want to have a small bag"* vs. *"I want to have a bag with many compartments,"* is likely to restrict the potential solutions to the redesign of a bag, whereas, not having a specific product as input might stimulate exploring alternative product categories. This is not to say that all product-product combinations are uninspiring. Product-focused concerns can inspire creative designs even if they restrict the solution space to a single product or context, examples of which are abundant in engineering design. For instance, TRIZ focuses on formulating, analyzing, and resolving technical conflicts in a system, and as such, it thrives on the creativity-enhancing nature of these conflicts (see Moehrle, 2005).

4.3.2. Challenges of implementing the three levels of user dilemmas

The variety of combinations that were adopted indicates that the rationale behind the three levels of user dilemmas could easily be adopted. However, understanding the nuances among different abstraction levels (i.e., product-, activity-, or identity-focused concerns) posed a steep learning curve. Primarily, we observed that making a concern more abstract (e.g., laddering up from product-focus to activity- or identity-focus) requires careful analysis and interpretation of users' concerns, which, to some degree, can be subjective.

In addition, finding appropriate instances of a concern (e.g., laddering down from identity-focus to activity- or product-focus) was a common challenge. Particularly, the subtle yet important difference between activity- and product-focused concerns was not always evident in participants' responses. For instance, *"I want to make photos in a digital way,"* which was indicated as an activity-focused concern, could instead be phrased as *"I want to manage my photos efficiently."* The latter formulation better describes the quality of an activity (i.e., being efficient) rather than the quality of a product involved in the activity (i.e., digital photos).

Finally, we observed that several designers used negative wording when formulating dilemmas, such as *"I want to monitor my wellbeing but I do not want to feel pressured by the information I receive."* Here, the negative formulation of the latter concern helps to communicate the tension among the concerns. However, it does not allow identifying various instances that would fulfill that concern in ideation. Rephrasing this negative formulation as *"I want to feel at ease about my physical wellbeing"* makes it a better-suited formulation for ideation, because it allows exploring solutions that can help 'feeling at ease.' Although it might not always be possible to rephrase a negative formulation in a positive way without changing the meaning of a concern, it is best to avoid negative formulations when possible.

4.3.3. Opportunities and challenges in using the design strategies

By analyzing the approach taken to resolve the formulated dilemmas, we identified four design strategies, namely blending, fixing, designing flexibility into the product, and introducing new designs. Each of the design strategies poses specific opportunities and challenges in ideation. *Blending* is a unique mental exercise for identifying concrete product characteristics that can satisfy abstract concerns (e.g., *"I want to walk comfortably"* vs. *"I want to look elegant"*). However, when meanings of abstract concepts (e.g., comfort, elegance) are not sufficiently explored, their combination might result in an overt hybrid design (e.g., comfortable sneakers with high heels). Therefore, exploring the subtle embodiments of abstract concepts in concrete product features is important when using the blending strategy. Özcan & Sonneveld (2009) suggested that this exploration can involve embodied sketching or role-play. In the context of resolving dilemmas, we suggest that designers should be encouraged to carefully think about the choice of keywords as meaning cues in dilemma formulations (e.g., elegant vs. rough, masculine vs. feminine) and to embody these cues in product conceptualization using techniques such as those suggested by Özcan & Sonneveld (2009).

Fixing strategy can sometimes lead to a design that forces a compromise from the fulfillment of both concerns. For instance, to resolve the dilemma *"I want to store my jewelry securely"* vs. *"I want to show off my jewelry",* a conventional jewelry box was modified into a transparent one. However, this design neither fully fulfills the first concern (i.e., a transparent box might be less reliable than a safe) nor does it fully fulfill the second concern (i.e., a better way to showcase jewelry might be to wear it instead

of keeping it in a box). Here, it is evident that the designer fixated on redesigning the chosen product (i.e., a jewelry box), instead of exploring other product categories or new practices (e.g., redesigning the jewelry itself or the social surroundings where jewelry might be worn). Therefore, critically thinking about the extent to which using the fixing strategy can satisfy conflicting concerns is a crucial step in ideation.

The designs that result from the strategy of *designing flexibility into the product* fulfill conflicting concerns alternately, instead of simultaneously. For instance, to resolve the dilemma between *"I want to have a small bag"* vs. *"I want to have a bag with many compartments,"* a modular backpack design was proposed. This design forces the user to decide whether he would use his backpack with or without compartments at a particular point in time. Providing the option to fulfill concerns alternately, instead of simultaneously, might trigger new dilemmas (e.g., do I need the extra compartments today or not?), which might constitute a new source of user dissatisfaction. Therefore, when designing flexibility into the product, the consequences of using this strategy on the experience evoked by the resulting products should be carefully reflected up on.

When *introducing new designs*, participants explored related product categories, such as new packaging ideas or supporting services to form product-service combinations. Because of this, explicitly considering this strategy might be an eye-opener to consider novel design solutions when redesigning a specific product. However, the resources and demands of a client might constrain the extent to which this strategy may be implemented in real-life design practice.

4.3.4. Limitations

In this specific design brief, the participants did not engage in any user research prior to using the three levels of user dilemmas. Instead, they had to rely on their own experiences as users of the selected products. This meant that they had to use laddering techniques (i.e., sequentially asking 'why' and 'how' questions) to reflect on their own experiences as users. This introspective exercise may have affected the relevance of the generated design ideas for actual users. If the participants were given the opportunity to conduct user research, the dilemma formulations could have been richer in detail and depth, and they would have ensured relevance for users. In addition, the designers had little prior experience with the laddering techniques, which might have also influenced the clarity and consistency of the dilemma formulations.

5. General discussion

The findings of the teatime design case and the second study show that inspiring dilemma formulations can be discovered through consciously examining conflicting concerns within and across three abstraction levels. Abstract formulations have context-independent and intangible characteristics (e.g., stylish handbag), whereas concrete formulations are context-dependent and easier to imagine (e.g., foldable handbag) (see Wiemer-Hastings & Xu, 2005). By the virtue of these differences, using either formulation as input for ideation poses both opportunities and challenges. According to Ward, Patterson, & Sifonis (2004), abstract problem formulations lead to more innovative designs compared to concrete formulations. Alternatively, concrete formulations require less cognitive effort in ideation than abstract formulations (Ward, Patterson, & Sifonis, 2004). Explicitly reformulating dilemmas at varying abstraction levels can facilitate making the best use of concrete dilemmas (which might create actionable

design spaces) and abstract dilemmas (which might stimulate novel thinking). Moreover, the dynamics of cross-level combinations enable balancing the advantages and disadvantages of using either type of formulation. As a result, combining concerns at different abstraction levels can result in a dilemma formulation that is abstract enough to offer opportunities for novel thinking, yet concrete enough to inform design decisions in ideation.

Examining conflicting concerns within and across different abstraction levels can be compared to other sense-making activities in the design process, such as problem framing and problem reframing. Problem framing in design is defined as the mental construction of a situation in the real world, which helps to make sense out of the situation (Jonassen, 2000). Analyzing dilemmas involves distilling the conflicting concerns involved in the dilemma, and as such, might be considered as a way of problem framing. Problem reframing, i.e., changing the problem representation, makes the core of the problem apparent (Simon, 1996). According to Banach and Ryan (2009, p. 107), problem reframing "shifts attention from trying to solve the current problem in the right way to asking whether the right problem is being solved." When resolving dilemmas, explicitly reformulating dilemmas at various abstraction levels leads to realizing the benefits and experiencing the limitations of using these levels when creating design ideas. This defines and refines the reflective dialogue designers have with the design problem at hand, as suggested by Schön's (1991) constructivist theory on reflective design practice.

The dilemma-resolving design strategies provide an overview of abstract solutions that can support using dilemma formulations in ideation. Similar to the way that concerns can be abstracted using laddering techniques to form alternative dilemma formulations, the specific solutions created to resolve dilemmas can be interpreted to form a set of abstract solutions, namely design strategies. Because of this, the dilemma-resolving strategies might be compared to the inventive principles of TRIZ. Moehrle (2005) defines these principles (e.g., giving feedback, changing the color, or thermal expansion) as abstract solutions to abstract problems that guide the ideation process when creating new inventions. The dilemma-resolving strategies work in a similar manner. Specifically, blending guides embodying abstract concerns in concrete product characteristics. Fixing and designing flexibility into the product provide possibilities for multi-functionality (or customization) and modularity, respectively. Introducing new designs prompts for exploring related product categories instead of limiting solutions to a single category. As a result, conceiving a variety of new design ideas becomes possible through examining the appropriateness of each design strategy with respect to different dilemma formulations. This is possible through designers asking themselves questions such as "*would the 'fixing strategy' work for this dilemma formulation? If so, how? If not, is there any formulation for which it could work?*" or "*How would the 'blending strategy' work for this dilemma formulation? Would any other strategy be more fruitful?*".

The design ideas created in the second study indicate that the participants often fixated on the product they chose, whereas the ideas created in the teatime study displayed more variety. This could be because the second study involved novice designers instead of expert designers. According to Cross (2004), comfortably retrieving and storing information cued by abstract concepts is an ability that develops with design expertise. Another reason could be that the design brief for the teatime study did not specify a product, whereas the second study required extracting concern conflicts related to specified product. The study with student designers focused on selecting one abstraction level as input for ideation to pinpoint the most attractive levels. To better understand the relationship between the design output and different abstraction levels, future research can focus on creating design ideas at all (or multiple) abstraction levels instead of choosing one level. This approach can enable comparing designs inspired by different dilemma formulations.

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