clean technologies

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Design-Based Approach to Support Sorting Behavior of Food Packaging

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Abstract: It is widely acknowledged that environmental impacts from packaging waste depend on how consumers sort this waste fraction. In this research, "design for sustainable behavior" (DfSB) strategies are used to improve a cream packaging design that can support proper sorting of packaging waste as a sustainable behavior. The application of three DfSB strategies—"match", "steer", and "force"—was examined through circular interviews and practical experience with two groups of participants in Karlskrona, Sweden. Prototyping was used to provide a more realistic experiment and enhance communication during the interviews. The results show that consumer-packaging interaction during the usage phase is important to enhance proper sorting behavior. The results also show the potential of a user-centered design-based approach to study consumer-packaging interaction and to understand the challenges faced by users when sorting packaging waste. It also shows the possibility of packaging design to script consumer behavior and reveals details that are important when designing packaging that was not known. In this vein, packaging form, color, and haptic attributes are the most influential design attributes that can support packaging functionalities and script consumer sorting behavior.

Keywords: packaging design; packaging waste; sustainable behavior; sorting packaging waste; packaging functionality; emotional factor; haptic attributes

Citation: Nemat, B.; Razzaghi, M.; Bolton, K.; Rousta, K. Design-Based Approach to Support Sorting Behavior of Food Packaging. *Clean Technol.* **2023**, *5*, 297–328. https://doi.org/10.3390/cleantechnol5010017

Academic Editor: Sabino De Gisi

Received: 19 December 2022
Revised: 29 January 2023
Accepted: 1 February 2023
Published: 28 February 2023

1. Introduction

A total of 79.6 million tons of packaging waste was generated in 2019 by countries in the European Union [1]. The COVID-19 pandemic has led to an increase in this amount by 15% due to the rise in e-commerce and the over-protection of food products [2]. Due to its material diversity, handling packaging waste is critical in a sustainable waste management system. It is a potential resource for material recovery and energy production if properly separated and sorted by households/consumers and could be a threat to humans and the environment if it is not sorted [3]. Therefore, waste sorting by residents is an effective behavior for handling packaging waste that involves, among other things, technical and ethical issues [4]. However, the recycling rate of packaging waste, including paper, cardboard, metal, glass, wood, and plastic, is less than 50%, and for the plastic packaging fraction, it is less than 15% [1,5]. Sweden's packaging waste recycling rate is higher than the other European Union (EU) countries due to a well-established waste collection system. Still, packaging waste contributed to about 20% of the total municipal solid waste (MSW) in Sweden in 2020, and it was the fraction that was missorted the most [6].

The reasons for the low rate of sorted packaging are varied. The most common is that sorting packaging waste is perceived as inconvenient by consumers if the sorting process requires effort and time [7–11]. Sorting packaging waste by consumers may require the packaging waste to be empty, clean, folded (sometimes unfolded), separated to a certain extent, and sorted into specific containers. The process, however, is not the same in different countries. For instance, in Sweden, washing food packaging to clean it is not necessary [12,13].

Sorting eco-friendly (e.g., biodegradable) packaging could be even more complex and confusing since this type of packaging should be sorted differently from conventional packaging. For instance, missorting biodegradable material can have the same environmental impact as conventional plastic if it ends up in nature, or it contaminates the recycling stream if not sorted along with other compostable materials [14,15]. Therefore, as shown in a recent investigation, active involvement in waste sorting largely depends on consumer motivation and the perception of convenience (i.e., the easy-to-implement nature of sorting) [16–19].

One way to facilitate the sorting process is to enhance consumer recycling knowledge. Having knowledge of the different parts (materials) of the packaging and to what extent they are recyclable, and how the different parts should be cleaned, separated, and sorted is important. This knowledge can save time and reduce confusion [20,21].

Instructive and visible recycling images, logos, and symbols are used to convey knowledge and facilitate communication between packaging developers, waste management, and consumers. However, it has been seen that consumers can simply ignore this type of communication, e.g., [11,22,23], unless supported by other packaging design elements such as signage or haptic attributes [19,24]. This is due to the fact that waste sorting is habitual (without conscious planning), which can result in a discrepancy between what consumers regard as environmentally and socially important activities and what they do in practice [25–27]. Information that is provided to consumers is a determining factor in eliciting sorting behavior when people are motivated to engage in the first place, suggesting an interaction between knowledge and motivational factors. If motivation is high and the task of waste sorting is simple, recycling rates would increase, and vice versa [28,29]. Hence, the packaging design considered by this research to address either one or both of these aspects.

The assumption is that packaging structural design, such as easy to fold or separate, is intended to facilitate the sorting process. Packaging design also can generate an emotional anchor by showing that packaging waste is a resource that should be sorted. This can be supported by packaging functionalities [19,30,31]. Under these circumstances, packaging can be a platform to offer additional services, including facilitating proper sorting. Consumer satisfaction with the service is an emotional incentive [32] to induce sorting behavior. Emotions have deep roots in motivating consumers to act in specific ways and are thus essential predictors of sorting behavior. Then, packaging, rather than being a passive message-bearer, can actively foster sorting behavior or even direct it, as shown by former studies, such as those by Wever et al. (2010). To exploit this potential, the abilities of packaging to influence sorting behavior need to be studied.

1.1. Problem Statement

Generally, food packaging has primary layers of functions, including containment, protection, communication, and facilitating handling [33]. Facilitating sorting will add a new layer to these primary layers, as illustrated in Figure 1.

This new layer can include a group of functions such as easy to empty, easy to close (re-seal), easy to clean, easy to fold, and easy to separate. These functions are commonly referred to as "waste sorting functions" (WSFs) since they make the sorting process more effortless and convenient [23,34–37].

However, WSFs may promote the perceived value of the packaging if they are usable and aligned with consumer expectations [19]. Not all of the functions act in the same way, so they may interfere with each other and therefore be perceived as problematic for sorting or even compromising the primary packaging functions. For example, a yogurt package with a wide mouth (see Figure 2) was identified as easy to sort since it was easy to open, empty, and fold. Nonetheless, the package's inability to be resealed prevented it from retaining the freshness of its content. Hence, even though the package was fully recyclable, it was sometimes missorted when the contents were rotten [8].

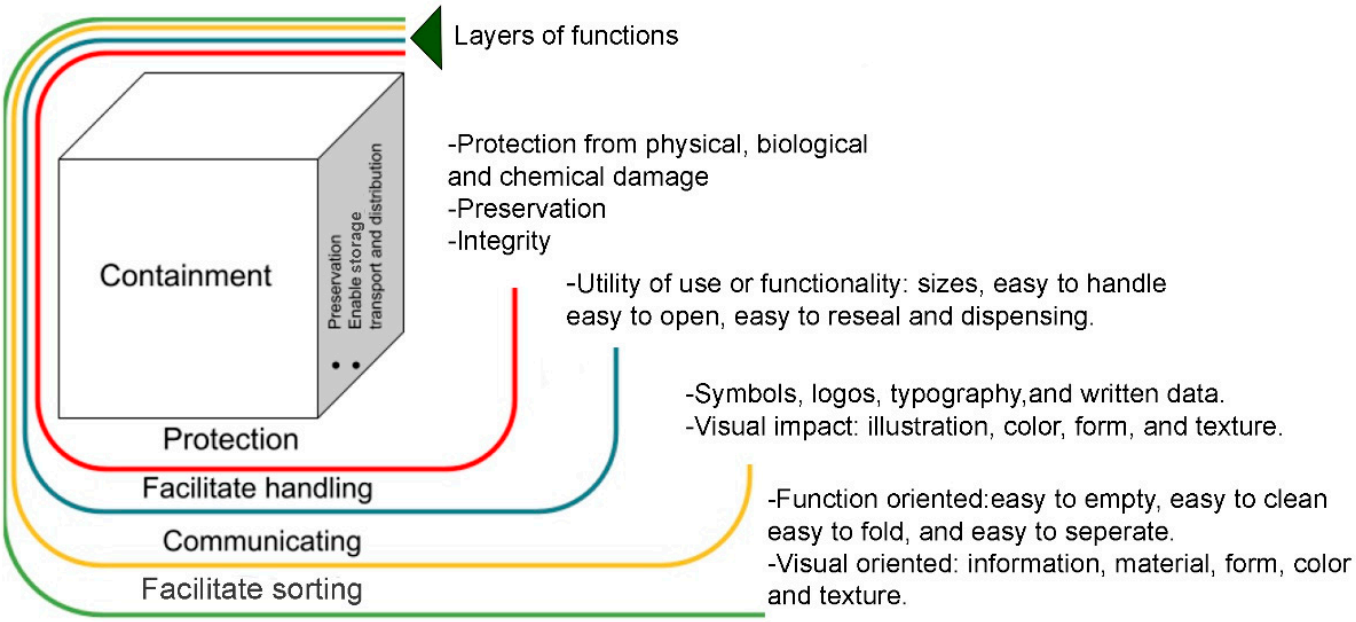


Figure 1. Different layers of functions and their role in food packaging.

Figure 2. A yogurt packaging with a wide mouth.

WSFs can also include visual attributes that can increase the value of perception and can be an incentive for consumers to respond to these design aspects emotionally [38]. The potential effect of the visual elements, however, is not merely about promoting the sense of value but also about supporting the packaging's usability. Each food packaging function communicates with the consumer so that they can engage with the packaging and reflect upon their physical interaction with the package; for example how the package should be empty, clean, or fold. At the same time, to support these functionsthe package should offer a suitable size and grip for the human hand when emptying, cleaning, or folding. Therefore, to enhance the overall usability to foster sorting behavior, a delicate balance in the design is needed between packaging abilities and consumer expectations from the packaging. To fulfill this, it is not sufficient for designers to know the properties of the packaging, they must also understand the user's expectations of, and experiences when handling, the packaging. However, the possible interrelations between WSFs within primary packaging functionalities have not been extensively studied. In addition, the role

of visual attributes in fostering sorting behavior has not been discussed as much as other design aspects, such as packaging materials.

Previous studies typically analyze and critique existing packaging, leading to suggestions of how the packaging should be changed to support sorting behavior (see, for instance [8,22,23,33,35,39,40]. Since these studies do not develop and study new packaging designs according to the suggestions, the research outcomes remain either theoretical suggestions or general statements. The theoretical results are not effective to influence consumer behavior unless they are translated into a practical application and directly applied in a design [41]. This yields a gap in utilizing the potential of food packaging design—as seen in previous research—to support sorting behavior.

Considering the negative environmental impacts of mis-sorting packaging waste and the related advantages of correct sorting behavior, a particular approach, namely, design for sustainable behavior (DfSB), is suggested by this study to utilize packaging design to improve sorting behavior. In this way, packaging design can fulfill an additional service and support sorting behavior as a sustainable behavior.

1.2. Design for Sustainable Behavior

The first step to improving sustainable behavior is to discover which factors act as interventions to develop solutions that trigger certain behaviors. It is then possible to maintain specific consumer behavior and guide consumer actions toward more sustainable habits [42]. It is not enough to see what people practice, but it is necessary to understand what they think and feels to discover effective interventions. However, tracking consumer behavior while sorting waste is not an easy task. Waste sorting at home is usually carried out in a private place (kitchen) and as a habitual task [8,36]. So, consumers may have encountered problematic issues during sorting packaging waste but have difficulty recalling them at the time of sorting. Here, DfSB can discover effective interventions and those factors that bridge the behavior planned by the designer and the actual consumer behavior [43,44]. The approach has been widely used in a variety of research fields to promote sustainable behavior, such as preventing littering [36], sustainable food packaging [39,45], consumption behavior [46], or prevention of marine litter [47]. However, human behavior is not a chain of reactions that occur sequentially, hence applying any behavioral amendment demands various design strategies.

One of the earliest design strategies for inducing an intended behavior is the 'scripting' approach proposed by Jelsma and Knot (2002). They defined scripting as the design of a product layout that guides the user's behavior more or less forcefully [48]. In this case, a product to script consumer behavior should be designed to make the desired behavior easy, while undesired behavior is made difficult or impossible. For instance, perforated lines on a package indicate where the package should be open. Following Jelsma and Knot (2002), other researchers have proposed various strategies in psychology and designing behavior, e.g., [27,36,43,49]. One example in the field of disposal behavior is the study by Wever et al. (2010) to mitigate food packaging waste littering. Wever proposed a typology of several design strategies in addition to the "scripting" strategy, "eco feedback, forced functionality", and "functionality matching". He used eco-feedback in the form of anti-littering labels on disposable coffee cups and scripting in several forms such as "reusability, reclose ability", and "top of mindness" intended to make it less likely for consumers to forget to clean a package [36].

1.3. Purpose of This Study

This study aims to understand how applying a practical approach such as DfSB can improve the packaging design to foster correct sorting behavior. The main objective is to practically enhance the design of a package by collecting user feedback, implementing DfSB strategies, and prototyping. By choosing a pragmatic approach, the study intends to assess the new packaging model's overall impact on consumer sorting behavior that has not been studied before. Considering the research intention, the usability of the new packaging model was critical, whereas creating a model that suits mass production was not part of the research. The outcomes of this study could shed light on the following questions:

(1) How can user-centered design strategies support sorting behavior?

(2) Which aspects of food packaging design are more valuable to encourage proper sorting behavior?

Application of three DfSB strategies was in focus: "match", "steer", and "force". These were chosen since they relate to behavioral control by the product design. The effects of these strategies were studied separately within the second round of interviews.

The "match" strategy was applied to ensure that, regardless of the packaging design improvements, the final model still contains the features that the participants perceive as valuable. The "steer" and "force" strategies aim to script behavior by applying design constraints and enhancing the user's ability to intuitively utilize specific functions. In the context of this study, usability is the packaging sorting-related functions that are easy to discover, understand, and use for everyone.

Two constraints were used to support the "steer" and "force" strategies: (a) Physical constraints and (b) Semantic constraints. The constraints to affect the behavior should be functional and easy to perceive and understand; thus, people react to these constraints without thinking about their actions [50]. In this vein, to improve the new design, the "steer" strategy was applied in the form of recyclable labels, texture, and color/graphical elements of the package. The "force" strategy involved mainly two forms, foldability, and separation, through packaging shape and functionalities.

The study's outcomes can assist packaging developers in utilizing the packaging design as an efficient element to direct consumers' sorting behavior. Consequently, manufacturers can use packaging design to generate appropriate consumer expectations, which will fruitfully affect consumer-packaging waste perception and decisions.

2. Materials and Methods

Five rounds of interviews (detailed in Section 2.1) were used together with sketching and prototyping to explore how applying DfSB strategies in packaging design can direct sorting behavior. Each group's interviews were planned to obtain specific information to fulfill the research intentions and evaluate the design model. Different types of prototypes supported each round. All sessions were recorded, either as images, videos, audio, or notes by having permission from the participants. The repetition of the interview process was limited to five rounds due to time limitations and the research constraints regarding prototyping. As discussed below, these five rounds were sufficient to gain a deep understanding of the respondents' needs concerning packaging design and to design and test prototypes that were aimed to fulfill these needs.

The first four rounds of interviews, which were aimed to obtain the ideal packaging model, were conducted with a small group of participants (n = 10) at the participants' living places. All interviews were recorded and photographed with the participants' permission.

The first round of interviews aimed to identify (as part of user-centered research) design interventions that could improve sorting behavior. The assumption was that improving the design gradually, instead of dramatically, allows the authors to analyze how each packaging design attribute can support correct sorting. This can be done by informing consumers about possible actions for sorting packaging waste. The last round of interviews (the 5th) was conducted with a relatively large group of participants (n = 30) to evaluate the models that were approved by the earlier interview groups. Gradual improvement of the

packaging design in collaboration with the interview group also minimizes possible bias of the researchers and ensures the packaging model's superiority over the original package.

2.1. The Interviews

Unstructured interviews with open-ended questions were conducted to collect data. Unstructured interviews usually have the least number of questions as they lean more towards an exploratory conversation but with an underlying subject. Moreover, the informal nature of unstructured interviews lets the participants clarify their doubts about the research topic and freely voice their reflections. Hence, there are more plausible for designers to learn from the respondents as they typically know more than what they can initially verbalize [51,52].

Interviews were conducted in Karlskrona, Sweden. The following considerations were used when selecting participants: (a) they must be familiar with the package and must have used it before; (b) they must be able to read Swedish to follow the provided information on the porotypes without difficulty; (c) the group must include a variety of ages to test the usability the of prototypes; (d) members of the groups should preferably live with a family, since this is likely to increase the frequency that the selected packaging is used and disposed of; and (e) the group members were willing to have a researcher visit their home. The latter condition was critical considering COVID-19's impact, so everyone who contributed to this study was required to be vaccinated.

Ten respondents in ten households accepted the study invitation, and they all were Swedish. Three of them lived without family and were older than 65. The rest of the participants were between 35 and 55 and lived with their children. Except for two, they lived in houses, so external factors such as waste collection facilities or distance to collection sites were similar. The waste sorting system stipulated that all participants sort their packaging in different fractions such as metal, plastic, or glass. All participants could be classified as upper-middle class and educated at the university level or experts in a particular field (e.g., nursing). Hence, economic backgrounds were similar. These parameters were not studied in this study.

A cream package was chosen for this study since it was identified as being difficult to sort in previous research [8]. Moreover, in the five most popular Swedish grocery retailers (ICA-MAXI, Willys, COOP, City Gross, and Lidl), more than 60% of cream products are supplied with this package, but with different brands. The package's facial appearance, content (i.e., cream 36% fat), and physical features such as volume (5 dL), and size (h = 195 mm, w = 55 mm, d = 55 mm) are identical among the named retailers except for the graphical elements and brand, as shown in Figure 3.

Figure 3. Examples of the cream package are studied here.

To address the research's objectives the combination of free discussion, testing prototypes, and exchanging feedback was used to identifies the user expectations of the package at the time that they sort the packaging waste.

Although the interviews were unstructured, they were based on some questions to keep the discussion aligned with the research objective. Every round of interviews was directed by a different group of questions to address the research purpose and provided separately within the related investigation's stage. The questions were not rigid and were worded differently due to the flexibility in the interview discussions.

3. Results

3.1. Sorting Patterns

The participants were questioned regarding choosing this particular package. A summary of the questions provided at the preliminary interviews is given in Table 1.

Table 1. Summary of the questions for the first round of interviews.

Questions	
Q1	Why did you select this particular product? Is there anything that you like or dislike about the package itself?
Q2	How do you usually sort the packaging waste?
Q3	What is your overall opinion about sorting the packaging waste? Did you find it difficult, easy or . . . ?
Q4	What aspects of the package did you find more problematic when sorting?
Q5	What aspects of the package did you find more accessible when sorting?
Q6	What would you suggest to improve the package waste sorting?

Each participant was also asked to demonstrate the required steps for sorting, as well as explain the necessity of the action and express the perceived difficulties or simplicities involved in each step. A sorting pattern consists of a series of consumer actions to perform the process, often carried out sequentially. The required steps for sorting the packaging waste and participants' statements are summarized in Table 2.

Table 2. The main steps and reasons for sorting the packaging waste.

Main Steps for Preparing the Package	**Reason**
Removing the cap Emptying the package Cleaning the package under running water Folding Reclosing the cap	Preparing for emptying Preparing for cleaning + eating or drinking Preventing food odor Savin space Preventing food odors or any leakage and letting the package remain folded
These Steps Can Take Place Inside or Outside the Residential Area	**Reason**
Separating the cap	Eco-related concerns to sorting the plastic cap and paper body into different containers
Sorting the cap as plastic and the body as a paper packaging	Eco-related concerns

Answering Q1–Q4, participants stated several issues that caused the packaging waste sorting to be somewhat problematic. The main complaint concerned the package's physical constraints, which made folding difficult. The package consists of a paper-based container and a plastic enclosure (neck) with a cap. Most of the participants responded that the package can be folded, but its plastic neck hinders users from folding it fully. Moreover, the package does not remain folded unless the cap is closed. Some participants recalled forgetting to remove the cap before sorting the packaging at the waste collection point, which meant that the plastic cap and paper body were missorted into the same packaging fraction. All needed steps to sort the packaging waste are depicted in Figure 4.

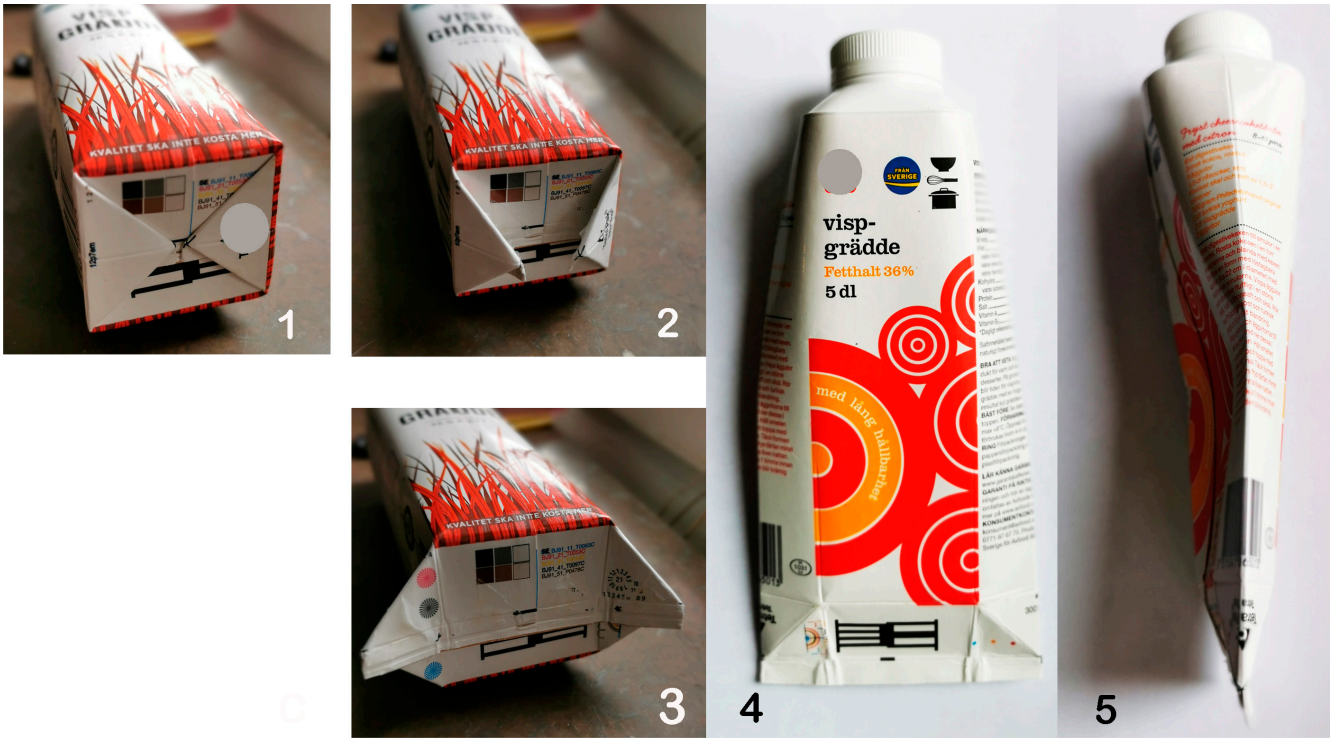


Figure 4. Sequential steps to fold the package: the flaps should be opened completely (left images from 1 to 3), then both sides of the package should be pressed down (images 4–5).

Since the present design affords no ability for users to fold the package some participants stated that they would ignore the process and sort the package unfolded:

> *"This is a relatively small size of the package, and I am a single person not consuming often, so sometimes I prefer to sort it unfolded and do not bother myself to struggle with the package to fold it."*

From a waste management view, folding the packaging waste is an unnecessary action. However, it is a great advantage at the collection points and for the collector trucks, since the amount of waste that is sorted and transported in each container can be maximized. This is especially important for paper-based packaging waste since it occupies a lot of space despite its light weight [53]. Folding the packaging waste is also crucial to saving space in trash bins. Whether consumers live in an apartment or house, they often have to have a separate place to store the generated packaging waste before it is taken to the recycling facility. Larger volumes of waste may result in extra trips between consumers' living areas and recycling facilities. This issue was more important for some participants (those with a bigger family and higher consumption) as they folded the package and rolled it to save more space, as shown in Figure 5. In this vein, fold-ability and roll-ability are advantageous even for this size package, and positively influence consumer attitudes, and thus should be considered by the designers.

Figure 5. Folding and rolling the packaging waste.

Separating the package's components was another issue of concern for the participants. The package's plastic neck is noticeably bigger than the cap, but it is not separable from the paper body. The company's current recommendation is to sort the package's plastic cap as plastic and the body, consisting of the plastic neck and paper body, as paper packaging. Due to the difficulty of separating the neck and the body, participants ignored the recommendation. This went against the participants' sorting desire and caused confusion. Participants who tried to separate the neck discovered it even more dangerous rather than practical or problematic: "*I injured my hand once when I tried to cut the plastic part with scissors.*"

An issue such as this can induce arbitrary sorting behavior and can be a misleading factor, and should be avoided by designers. Another misleading factor was applying the same texture and color (ivory appearance) to the packaging body and its plastic parts, leading to the perception that the whole package was made from plastic. Therefore, some participants sorted it as plastic waste. In summary, the current package design does not induce correct sorting. In fact, in some specific issues, such as folding and separating, its design hinders correct sorting even though consumers are motivated to perform their sorting correctly. These results showed directions in which the design of the package can be further improved to foster proper sorting behavior.

The interviews not only focused on problems, but also on the package's features and abilities that participants considered valuable. The packaging size and its cubic form were identified as the consumers' favorite features since they fitted with the refrigerator space. Participants were also satisfied with how the packaging is easy to use, clean, and empty because of its straight head and wide mouth. Its resale-ability was also an advantage due to the fact the package contains long-life cream: "*It is a kind of packaging designed to help you take the last drop!*".

These specifications enable the consumers to utilize packaging functions and make the right choice. Thus, it can act as a design intervention to influence sorting behavior. Once the interventions and their relationship with consumer behavior are identified, they can be changed to benefit design and scripting user behavior.

3.2. Identification of Subtasks

The sorting pattern ascertains "what" actions were carried out by participants. The subtasks give information on "how" these actions are performed. Focusing on "how" can reveal if packaging design affordance and attributes are important to support the sub-tasks. For instance, the 'removing the cap' step could be broken down into sub-tasks such as grabbing the package, turning the cap counterclockwise, and removing the cap. These actions can be supported by the design of the package to provide specific affordance, namely, grip-ability and reclose ability. Supporting both functions to a great extent depends on the package's visual aspects, texture, and size. From this perspective, tuning each aspect can be carried out more accurately to anticipate user reactions. In addition, the table can show how different packaging parts are able to interchange their roles due to the context

of use and how different layers of tasks can intervene in a specific part of the package. For instance, the package's cap was associated with several steps, including resealing the package, preventing the spread of odors, and maintaining its foldability. So, the cap has an essential role throughout the package life cycle until the packaging waste is sorted.

From a design standpoint, these details are valuable indeed; however, they could be missed in interviews—or might not even come to the respondents' attention—as the entire process is performed habitually (i.e., without conscious decision making). Hence, the recorded images, videos, audio, and notes taken during interviews were used to extract "how" participants performed the stated action. A summary is presented in Table 3. The detailed findings are given in Appendix A, Table A1.

Table 3. The sorting process includes sub-tasks and relevant details.

Sorting Pattern	Sub-Tasks	Affordance	Package's Parts That Support Affordance	Possible Design Attributes That Affect Affordance
Removing the cap	Grabbing the package, Turning the cap anticlockwise.	Grip-ability Reclose ability/easy to reseal	Body Cap	Body texture Cap texture, Cap and Neck form Size
Emptying	Shaking, Turn the package upside down.	Grip-ability Grip-ability	Body, Body, Top open	Body texture Body texture, Packaging form
	and/or		Body, Top-open	Body texture, Packaging form
	Fill it with water; turn the package upside down.	Grip-ability Fillable/easyto empty		
Cleaning	Fill it with water for washing and cleaning Reclose the cap,	Grip-ability Fillable and Reclose ability /easy to clean	Body, Top—open Cap and Neck—Screw	Symbol, verbal attributes Body texture, Packaging form Cap and neck form
	Shaking the package, Removing the cap,	Grip-ability Grip-ability	Body Cap and Neck—Screw Body Top-open	Body texture, Packaging form Cap and neck form Body texture, Packaging form
	Turn the package upside down	Grip-ability		

3.3. Implementing DfSB

The ideas that were identified in the first round of interviews were prototyped for use in the second round of interviews. This reduced possible misunderstandings between the interviewer and the respondents regarding the necessary changes in design. It also provided the participants with a more realistic experience of examining the new packaging model. The prototype shows the idea in a physical format that communicates the idea to participants and allows them to try its usability in practice [54]. Observing the participants' natural reactions to the prototypes provided valuable insight into what design attributes should be altered to improve the package sorting abilities. The prototyping process benefited from a recursive procedure that depends on the complexity of the attribute in focus. Changes in the design were repeated until most of the assumptions are tested and either improved or fixed. For instance, if the effect of the texture was to be investigated, the prototype surfaces were made so that the participants would consider it as a paper texture and not as a printed image of the paper.

The core of the discussions within the interviews was how the prototype design affordance could differ from the original package. Thus, different series of questions were asked. The questions for the second round of interviews are presented in Table 4.

Table 4. Summary of questions discussed in the second round of interviews.

Questions	
Q1	How was your sorting experience compared to the original model?
Q2	How would you describe the overall sorting experience?
Q3	Regarding the new prototype, is there any feature you like or dislike? Why?
Q4	How did you notice the package can be folded in this way?

The participants were not shown the prototypes prior to the interviews. With the delivery of each model, they were asked to show how they would sort the prototype. Immediate attention was paid to how they perceived the model as being easy or difficult to sort and what attributes could contribute to forming this perception. The new model was developed and modified through sketching and based on feedback from each session to test by the subsequent round of interviews (see Figure 6).

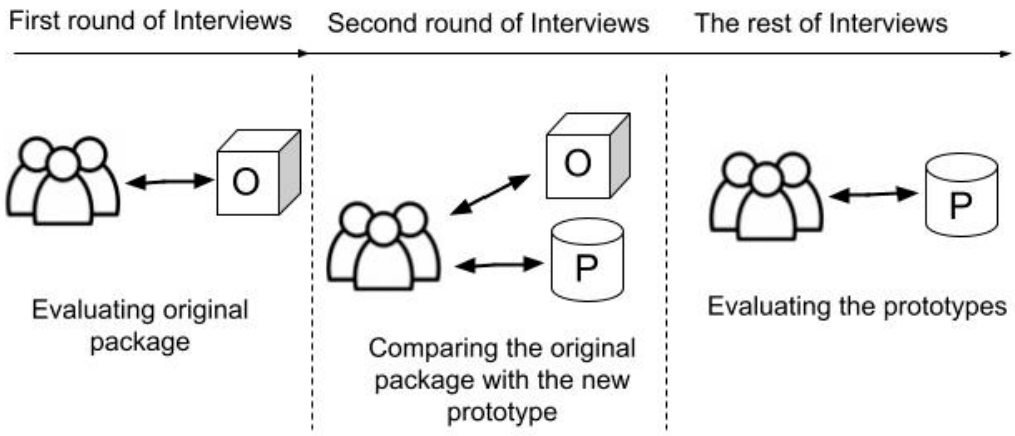


Figure 6. Different stages within the interview process (O = Original package. P = Prototyped package).

The first strategy was "steer", which was implemented by applying different textures, colors, and labels. These attributes were considered as semantic constraints to indicate the package's recyclability and how it should be positioned in the consumers' hands. Five prototypes were prepared, using the original package as the basis for prototyping. Each participant was given these five packages to assess their support to aid in correct sorting behavior in terms of either visual or informative attributes.

The first two prototypes aimed to compare the effect of texture and additional information when both packages are similar to the original sample. As shown in Figure 7 the body of both packages was covered by the same textured cardboard (330 g, brown and grey). Model (A), has the usual recycling-related information based on the manufacturer's recommendation). In contrast, Model (B) has new information that proposes the user sort the package's parts marked with the red dot as plastic and the white dot as paper (see Figure 7).

Figure 7. Prototypes that test the package's texture and sorting information. Model A provides information in regular style and Model B provides information in a new format.

The prototypes revealed that the participant's response to the texture was more definitive and faster than to the visual attributes. All of the participants ignored the conventional recycling information in Model (A). This was attributed to the small size of the written information, which made it difficult for them to read, regardless of their age. The participants readily recognized that the body of the two models was made from paper due to the texture, which was felt by touching.

Regards to Model (B) the new text was legible but confusing. Several participants found that the red color in the legend was very similar to the color used in graphic elements on the package's cover, leaving the participants with the dilemma of how the body should be sorted (the red color is for sorting the plastic but the body of the package is made from paper).

All participants felt that simply modifying the current packaging design with instructions supporting the correct sorting of the package would not "steer" their sorting behavior. The new information will not be noticed if the original format remains. This finding is supported by previous research that shows that users perform waste sorting with little cognitive effort and based on their former experience unless facing a new challenge [23,25,36]. In this case, a clear, concise, and consistent message is more likely to automate sorting behavior [31,55].

Therefore, in the other three models (C–E) shown in Figure 8, the text and icon were at the center of the design to expose the packaging value for recycling.

In Models (C and D) the recycling icon was supported by the text "recyclable paper" and in model (E), the "I'm 100% compostable" icon, informs the users about packaging recyclability. All three models were printed on lighter cardboard (220 g, matt white, and cream). A new graphic design for these prototypes was aimed to distinguish these models from the original package and represented them as new packaging. It was more likely that, in this vein, the participants perceived that they were faced with a new package that had new information.

In Model (E), the message "I'm 100% compostable" is intentionally designed to indicate that the package should be composted. This message was used to ascertain if participants would differentiate the message from the other models. Among these three models, the recyclable message on Model (D) was perceived as highly directive for sorting due to the explicit label view. The reaction was predictable as the label was created following the Gutenberg diagram effect.

Figure 8. Different prototypes with new visual design. Each model (C, D, and E) aims to present the recycling symbol in a new way.

The Gutenberg diagram is established based on how the human eyes move across a surface when reading. Because Americans and Europeans read from left to right, top to bottom, the eye will always start at the top left section of a layout and scan down to the bottom right corner. Research has found that the upper left area is the most valuable region within the packaging design because of this scan pattern. When the user reaches the lower right portion of the page, there is a break in the reading or 'page scan' process, and the user will need to take action [56]. This is the perfect location to insert a call-to-action, such as the model (D).

Comparing the models, the way that the label was communicated in model (D) was preferred over the others. The label content was perceived as being instructive and friendly. These findings are consistent with prior studies that show package typography is one of the essential visual elements of a package because words directly communicate a message to the consumer, unlike images and other decorative elements that the consumer must interpret. Increasing the size and novelty of typefaces often allow the letters to be more visually appealing to consumers and the letter also become images, not merely symbols used for reading. This enables the letter to be more creative and emotionally connected [57,58].

The form of the prototypes used in the second round of interviews (Figure 8) was not changed to keep the interviews' focus mainly on the package texture and visual attributes. An object's shape or exterior appearance can create an initial impression and generate long-lasting inferences, thus affecting the other design attributes [59]. Hence, the main focus in the third round of interviews was on developing the package form by utilizing DfSB. The design was supported by prototyping to see how manipulating the package's shape can afford its functionalities, especially folding and separating.

The interviews revealed that the current design has no "steering" over sorting behavior, and thus the balance of control is more weighted on the side of the users. The current

design does not give the impression that the package could be folded, and it was not easy when trying to fold the packaging. The plastic neck was also inseparable. Thus, the form of the prototype should be improved to "steer" participants to fold the package since it is perceived that this is the only way to treat the packaging waste.

Similarly, the new form was intended to "steer" or "force" participants to separate different packaging components. It was also ensured that other attributes of the original package were maintained in the new prototypes to support the matching of consumer needs and designers' objectives. The finding from the first group of prototypes also was taken into account. For instance, previously accepted graphical items were partially replicated on all prototypes, such as the legend location at the front of the package. In addition, the prototypes' visual images were expanded further, corresponding to the form evolution.

Several design solutions could have been implemented to improve the package's target functionalities. One suggested approach is to generate a wide range of prototypes as a base to start the selection process. This requires a sufficient number of models that differ from each other so that the set of models covers the space of possible designs. This idea-generation process benefits from considering as many different models as possible [60,61]. To prevent replication (several models with similar features), the identification of the different models was limited to design specifications that had been perceived as values by interviewees, such as the straight head, wide-open mouth, easy-to-empty, clean, and reseal. Logically, the package's functionalities will ultimately be matched with the participants' sorting demands (the design process is detailed in Appendix B).

Three possible forms were generated from the original packaging, all were similar in size and form, and prototyped for the interviews. Model A-1 is identical to the original packaging, with the exception that the corners are sharp. Model B-1 has a triangular shape, and model C-1 has a polygonal shape (see Figure 9).

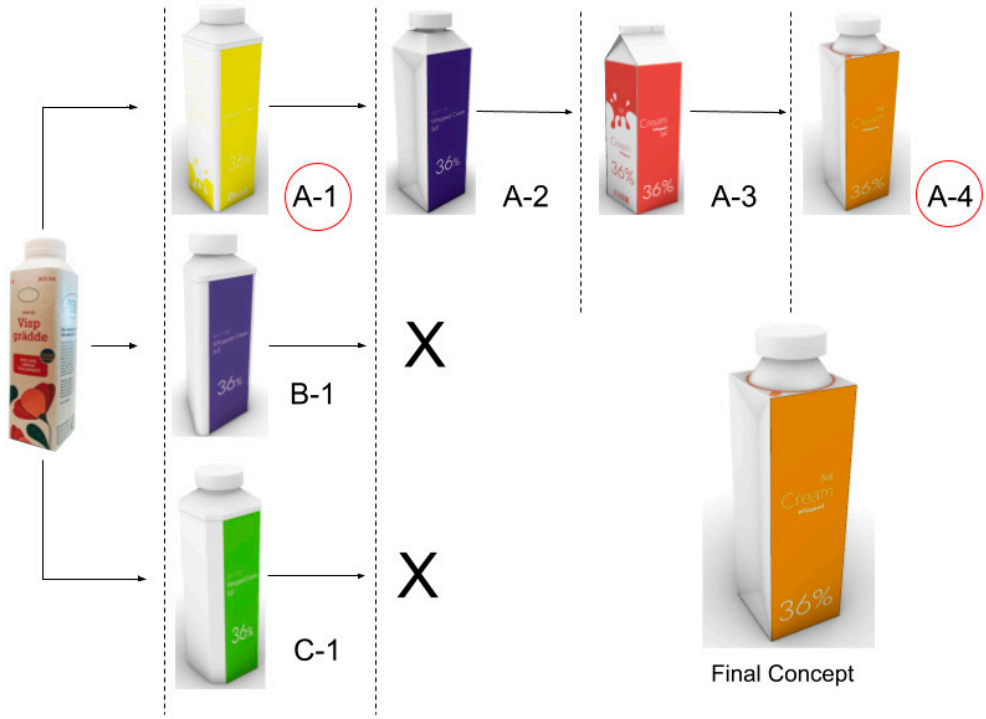


Figure 9. The models used in the design evolution led to the final model.

All models compared with each other in specific items are shown in Appendix C. The collected feedback was compared, summarized, and interpreted into design elements. The conclusion manifested itself as a new model, and this evolution process led to the discovery of the final models (see Figure 9).

In all three basic models (A-1, B-1, and C-1), the plastic neck was designed to be removed automatically to facilitate separating the neck from the body. In round four of the interviews, each of these three models was evaluated in comparison to the original package and by itself, respectively, based on the capabilities its design afforded with respect to how easy it is to fold and separate the plastic cap and neck from the paper body. The interviewer was merely an observer during the interviews and collected feedback. Figure 10 shows Model (A-1) when sorted by one of the participants.

Figure 10. Sorting Model (A-1).

Although the solution seemed to facilitate the separation of the neck from the body, the design of the body for Models (B-1) and (C-1) hindered foldability. The triangular shape may appear to be simple to fold due to fewer sides, but in actual practice it causes difficulty. One of the participants noted that:

> *"This is rather than confusing to fold. The only logical way is to put the package on the ground and crush it with my foot!"*

On the contrary, Model (C-1) had more sides than the other models, which meant that the package could not be folded and flatted completely. Therefore, both Models (B-1) and (C-1) were rejected by the participants due to difficulties encountered when folding. Of the three models, A-1 was perceived as easy to fold due to the sharp corners, even though its oblong shape does not, in theory, afford this function. Moreover, separating the plastic neck from the body was perceived as being effortless and performed unintentionally. However, the new design left new concerns, such as the risk that the neck will separate unintentionally from the body during daily operations, and also, why could the entire package not be made from paper.

New prototypes were created to address these two issues. In Model (A-3), the plastic neck was removed entirely and replaced with a new way to re-seal the package (see Figure 11). On paper, the model meets all the participants' requirements. However, in practice, the way that the package should be re-sealed created an impression that the system is not safe enough to preserve the content and not easy to use. Hence, the package was rejected by most participants.

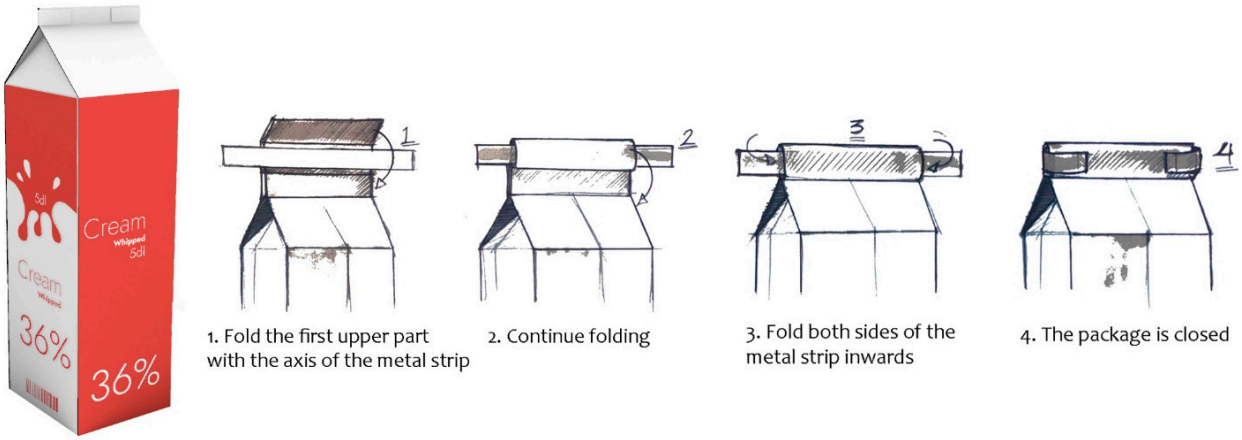


Figure 11. Model (A-3) folding process.

The decision to remove Model (A3) from the possible prototypes went against the participants' preference to have a package made entirely from paper. Debates around Model (C-1) resulted in creating a new model to keep the balance between participants' ultimate desire (complete paper package) and actual practice. Model (A-4) was designed to fill this gap (see Figure 12). This model had flaps at both ends of the package (left image in Figure 12) that should be opened prior to folding the package. Based on participant feedback, these flaps were further modified (right images in Figure 12) to facilitate folding.

Figure 12. The final model (the left one with flaps and the right one without flaps).

This prototype, which was the final model, was aligned with many of the participants' preferences. The model is mostly made of paper and has a plastic neck that is relatively smaller in size than the original packaging. The neck is surrounded by a colorful ring that can act as a strap to pull out the plastic part when the packaging content is finished, and consumers want to separate it from the paper body. The final model functions and the entire sorting process are depicted in Figure 13.

Although the participants thought that the final model was a significant improvement over the original packaging, it was a risk that the model shortcomings would be overlooked due to the fact that the participants had contributed to developing the new model. This could be a research bias. Hence, the last (fifth) round of interviews aimed to evaluate the final model using a completely different group of users, and also on a larger scale.

It was decided that the interviews would take place in a public area—a public library—to save time and to include typical consumers in the final target group.

The respondents compared the final model with the original package, with a focus on criteria related to sorting the packaging waste. The aim was to understand how the differences in the packaging attributes between the final model and the original package were perceived by the respondents and how these differences would affect their sorting behavior. This, in turn, would identify which of the two packages was preferred.

Figure 13. The final model sorting functionalities.

Considering the research boundaries (time, budget, and prototyping), the number of respondents was limited to 30. The interviews were conducted for two weeks, in limited hours each day, as governed by the library rules. At each interview session, illustrated in Figure 14, a few samples of the original package and the final models were provided to the respondent. A sign on the main deck in front of the main entrance (How do you recycle it?) clearly showed the intention of the research.

Questions directed toward desired features were close-ended so that the respondent could answer the questions fast and accurately (see Table 5). Direct observation was also used to collect information. Further information was given to those who were interested. The only constraint that was imposed on the respondents was that they were familiar with the original packaging. This constraint was imposed to reduce the time required for the interviews and to have respondents that had prior experience in sorting these packages. Other than this, the choice of respondents was random.

Figure 14. The setup with samples in a public library. The text on the black sign (indicated by a red oval) is translated as 'How do you recycle it?'

Table 5. Close-ended questions were used in the last round of interviews.

			
		Original package	New model
Q1. The package can fulfill my usage expectations		✓	✓
Q2. No problem to recognize the package materials			✓
Q3. The package is easier to clean and empty		✓	✓
Q4. The package is easier to fold			✓
Q5. The package is easier to separate			✓
Q6. The package information is sufficient about how I should sort the package			✓

Concerning Q1, the new model attracted more attention. The majority of participants (80%) thought that the graphic design and vivid color were better than the original package, but fewer thought that the shape was an improvement (20%). Both packages were attributed the same value in terms of performance. Fifty-seven percent of the thirty respondents considered the sharp corners—with the associated flat edges—of the new model as an extra value. They thought that this shape had a better fit with their hands. On the contrary, the others (43%) thought that the original model shape was better suited to fulfill its role as packaging. Both the original package and the new model were considered suitable for fulfilling the respondents' expectations.

The haptic attributes of the new model were significant for the respondents' perceptions. The contrast between the new model materials' texture and color enabled the respondents to differentiate between the paper body and the plastic neck and cap (Q2). When asked whether the model's color or texture is most effective to distinguish between paper and plastic, 67% answered texture and 33% color. The new model has slight depressions on the sides compared to the original package. Some respondents (seven) saw this design feature as an improvement over the original package since it allows easier picking from the refrigerator when placed next to other packages. It also gave the impression that it is safer to grab the package by its body rather than its neck or cap. Moreover, the new model was preferred to the original packaging with respect to the ability to distinguish between the paper and plastic parts of the packaging (Q2). This gave the perception that the new model has a higher value due to its body texture and cap and neck colors.

One explanation is that haptic attributes have deep roots in human experience as a way to discover the surrounding environments. Thus, these attributes can significantly affect human behavior with little cognitive effort. The contrast between these design aspects was the key for respondents to differentiate the model materials and regard the new model as having a higher value. This finding is supported by former studies such as [62–64]. It can be reiterated that physical prototypes have an advantage over images in this regard since the respondents' reactions occur were immediate and natural when they handle the physical prototypes.

Q3 was not easy to answer due to the location (library) of the interview. It would have been preferable if the ability to empty and clean the original package and the new model could have been tested. This was especially true for the new model since the respondents had experience with emptying and cleaning the original package, but not with the new model. Most of the respondents (90%) shared the same view as the respondents in the earlier interviews that emptying and cleaning are critical factors when sorting (as noted above, the wide-mouth prototype shown in Figure 13 was preferred in this regard). The present respondents stated that even if they do not fold the package, it is always emptied and washed before sorting. Although the new model was also approved, the emptying and cleaning functions need to be tested during actual sorting.

All of the respondents thought that the new model was easier to fold than the original package (Q4). The model's sharp corners together with the folding lines on the sides was a clear stimulus that steered the respondents to fold the package as designed. Folding lines are also familiar with other types of packages, which meant that the new model was folded intuitively. This is described in design theory as a 'recognition-over-recall' by William et al. (2003). According to this, any design that is aimed to facilitate specific activities should bridge perceptual information with former experience to minimize cognitive load. The efficiency of the folding lines and how they are used is well known. Here, the contrast in the colors between the original package and the new model acted as semantic constraints and limited the possible position that the user could hold the package, thus supporting the package foldability.

Separating the paper body from the plastic neck and cap (Q5) required less effort with the new model compared to the original package. This was due to the special design features of the new model. In particular, the colored ring surrounding the plastic neck clearly showed the extra function afforded by the new model. Sixteen of the thirty respondents searched for information about sorting the original package and the new model before attempting to fold and separate it (Q6). The rest folded the package first and then pulled the colored strap to remove the plastic neck and cap. The action of this group of respondents, hence, followed the design intention (acting free of instruction) and showed that any information that may have been provided on the packaging was not relevant to their sorting behavior.

Nonetheless, just over half of the respondents (16) looked for information on the new model before folding and separating. This was attributed to the fact that the label and written information were more prominent than on the original package. It could also be due to the fact that they had no experience with the new model and hence looked for all relevant information. In this case, this behavior would reduce in relevance in the long term. Considering the habitual nature of sorting, it is probable that this kind of information may lose its effect on consumer behavior over time. Wever et al. (2008) also highlighted the lack of lasting impact of labeling in their empirical study. This was also mentioned by all respondents, who perceived that this type of information is useful only once (the first time that the package is used), thus offering no extra information in the longer term. Therefore, they do not look for this information in the original package or on any other packaging that is purchased on a regular basis. This reveals the significance of the package's communication with the consumer at the first encounter, and the importance of designing the packaging to increase its impact. The first contact, in this vein, is the best opportunity for the designer to convey specific messages and to make an impression on consumers.

Ten of the respondents showed a deeper interest in the process of identifying new prototypes, and the other models were shown to them. They thought that the model with a detachable head (A-1 in Figure 10) would be a better option if it was practical to develop and use.

Toward the end of the interview, a new proposition was suggested by some of the respondents. The suggestion concerned the paradox between today's dynamic lifestyle versus the capability of the packaging: *"Why the packaging design and functionalities is still the same when everything around us can be customized to fit our living conditions?"*

For example, one respondent suggested that the packaging size or quantity should be customized to the consumer's consumption behavior and how the packaging is used during its lifecycle. The request was based on the respondent's living conditions. For a family with four children, usually, more than one package is stored in the refrigerator. Although the consumption period is given on the packaging, it is not easy to see when the user is under time pressure (the letters are too small to read). (This is similarly true for the packaging after use—when it is to be sorted.) This increases the amount of product that is purchased to ensure that it is available in the refrigerator when needed. This can lead to products that are spoiled since they exceed the consumption deadline. Under this scenario, the user preferred to dispose of the packaging with its content as mixed waste. A conclusion that can be drawn from the above suggestion is that the usage phase can impact how the packaging is sorted.

Addressing this suggestion through prototyping is outside the scope of this research. Sketching was used in an extra meeting to represent some possible solutions regarding the respondents' proposals (see Appendix D). Customizable packaging may not be feasible at present, but it has the potential to enhance packaging value even further. This could, in turn, reduce the likelihood that packaging is missorted by increasing the convenience and decreasing the time required for sorting.

4. Discussion

This empirical study deepens our understanding of how a user-centered approach such as DfSB can affect sorting behavior as well as assist the researcher/designer to understand users' thoughts and desires. Furthermore, it shows how packaging design can shape consumers' perceptions and anticipate some reactions (e.g., empty, folding, or separating). The finding is important as currently packaging roles are mostly dominated by marketing and limited to enhancing "willingness to buy" in consumers. However, with ever-increasing food packaging diversity and its advance in technology, fabrication, and materials, the role of packaging cannot be limited to merely acting as a container or marketing instrument. This study confirms that it is possible for other sectors, particularly waste management, to utilize another potential of packaging design that was not considered previously. Food packaging as shown in this research can provide a variety of actions if its layers of action are aligned with each other and designed to fulfill several purposes.

Some study findings are contradictory to existing research about the DfSB application. The central assumption in DfSB is that the balance of control should weigh more heavily on the users' side and that the user feels little control from the designer [27,43,65]. However, as the study showed, this issue could be context-dependent. In this particular study, the respondents' willingness to be controlled by design was high in favoring the easiness of the sorting process. They were pleased to be steered by packaging functions that imply how the packaging should be folded or separated, for instance.

The study shows maintaining contact between packaging and consumers is crucial to make an impression on consumers' behavior and conveying a special message. For the message to catch the users' attention, it should be clear, concise, and informative. Hence, the stimuli of message framing are necessary to make it effective. Nonetheless, the communication impact may not last long. As Wever et al. (2010) discussed, this could be related to the short period that labels provide significant contact to the consumers. In this research, however, the lack of lasting effect was attributed by respondents to the nature of this message, which usually is duplicated and permanent and, thus, loses its value after a while. In this case, the provided information should be informative, friendly, and dynamic to maintain lasting effects.

It should be noted that message intervention generally involves three essential factors in the communication process: "what" (the content), "how" (to represent the message), and "whom" (audience) [66]. Current research often focuses on "how" and "whom" while, as shown by this study, the content of a message "what" is also essential to prolong users' communication with packaging. As shown by the study, the way of presenting these data is also critical to maintaining consumers' attention, which demands innovative ideas. A suggestion could be to replace relevant barcodes with conventional logos, icons, or legends by considering the advances in technology and the ever-increasing popularity of mobile phones in daily life. Application of acronym terminology on different packaging components, e.g., "P" stands for "Paper", could be another solution to help consumers differentiate between packaging materials. A bigger size to display information and labels and the way that they are positioned can amplify the effect of these data.

Manipulating the graphical elements could be another way to gain consumer attention and convey a message. For instance, some packaging faces are used to provide a recipe, and producers can use these sides to effectively communicate with consumers.

As emphasized by this study, the perception of value is also important in inducing sorting behavior and refers to interventions that convince consumers that packaging waste is worth recycling. As such, a value to influence attitudes and behavior needs to be salient [67]. In this case, some attributes are more important than others to create an impression of value, as they are multi-tasking and thus can influence consumer behavior in different directions. Packaging form, color, and haptic attributes create an impression due to their impact on the perception of value. For instance, packaging texture can affect the perception of quality (relevant to purchase) and, at the same time, provide information that the packaging is recyclable. Moreover, the role of visual attributes is a key to represent

packaging values as well as to empower constraints (physical and semantic), thus "steering" the consumers to behave in a desired way.

The study's interviews show that DfSB, in synergy with other design disciplines, has the potential to direct sorting behavior and make it to some extent predictable. Among the data collection methods, the role of direct observation is vital throughout the process. Observing consumer interaction with the product and design intervention provides a more detailed understanding as to in which direction the design could be further improved.

The current findings indicate that focusing on the use phase in packaging–consumer interaction is essential to support sorting behavior. To this end, consumer–packaging communication should not necessarily happen in the last stages of the packaging life cycle nor when consumers intend to dispose of packaging waste. Contradictory, in the use phase, is more likely for packaging to influence sorting behavior by addressing consumer values and presenting its multiple functions related to sorting such as recyclability or foldability.

5. Conclusions

1. Food packaging can accept further responsibility if considered as a service provider. It could be a unique opportunity for a wide range of actors connected to food packaging to utilize this potential. A challenge, however, is that all expectations from packaging should be aligned. Otherwise, it will be a compromise among these expectations in favoring one of them over the next one; e.g., the packaging is attractive but is difficult to sort, or is recyclable but lacks durability.
2. DfSB is a flexible approach that enables consumers to utilize product functionalities more intuitively and, at the same time, enhances product usability. The use of DfSB to influence sorting behavior seems to be a promising approach to improve packaging design to enhance the proper sorting of packaging waste.
3. The role of the "match" DfSB strategy is critical to align the design with user needs, while the "force" and "steer" strategies try to make the packaging functionalities relevant for long-lasting sorting behavior.
4. A designer/researcher needs to be aware of the challenges that face consumers during sorting, and the potential of packaging to effectively address these challenges. This combined knowledge must be implemented in DfSB.
5. The packaging should continuously support consumer behavior to sort packaging waste properly. To this end, communication should constantly evolve to maintain attraction otherwise could be ignored by consumers.
6. DfSB is capable of collecting data that usually are not confined to the research domain. The additional information gained from DfSB can affect the depth of the designer's knowledge and provide questions for further research.
7. DfSB strategies do not by themselves tell a designer how to use them. There is no defined path for a designer to combine design aspects to influence a specific behavior. In some contexts, differentiating between different strategies is not easy, such as "steering" and "force", and in actual practice, the efficiency of every strategy is dependent on several factors.
8. Identifying intervention is critical to use DfSB. However, the design interventions are determined by factors that are often not easy to identify or define while selecting a strategy, and the outcomes are entirely reliant on them.
9. In DfSB, the experience and knowledge of the designer are essential to use these approaches, as well as to analyze and interpret the results, in order to generate effective solutions. The more experienced a designer is, the more advantages the approach can yield. This is especially important in food packaging design due to the wide range of functions that packaging can possess and its diversity in attributes.
10. Any attempt to manipulate the packaging design should be carefully considered to stimulate the desired effects, and not provoke an adverse reaction from consumers.

11. The final concept designed for this article, due to the geographic constraints, is limited to the research scope and may not be generalized. The design solutions (i.e., concept) that can be generalized require additional investigations on a larger scale. However, the similarity between the study findings and previous research should be taken into account. The design process, approach, and employed DfSB strategies, as the research shows, are highly potential to be an inspiration source for future research in this field. For example, using physical 3D prototypes instead of images within interviews allowed the respondents to show more realistic reactions as they would in everyday waste sorting activities.
12. Sorting behavior is socially acceptable, so consumers' acceptance and adaptation to the applied strategies was high, at least in the scope of the study. Consumers' reactions might be different in another context.

Author Contributions: B.N.: Investigation, Conceptualization, Data curation, Formal analysis, Resources, Visualization, and Writing—original draft. M.R.: Methodology, Supervision, Validation, Resources, Visualization, and Writing—review and editing. K.B.: Supervision, Validation, and Writing—review and editing. K.R.: Supervision, Validation, and Project administration. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors are very grateful to the University of Borås for financing the prototyping sections.

Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Table A1. The sorting process includes sub-tasks and relevant details.

Pattern of Sort	Sub-Tasks	Affordance	Package's Parts That Support Affordance	Possible Design Attributes Affect Affordance
Removing the cap	Grabbing the package, Turning the cap in an anticlockwise.	Grip-ability Grip ability Reclose ability/easy to reseal	Body Body Cap	Body texture Cap texture, Cap & Neck form Size
Emptying	Shaking, Overturn the package. And/or Fill it with water; overturn the package.	Grip-ability Grip-ability Grip-ability Fillable/easy to empty	Body, Body, Top open Body, Top-open	Body texture Body texture, Packaging form Body texture, Packaging form
Cleaning	Fill it with water for washing/cleaning, Reclose the cap, Shaking the package, Removing the cap, Overturn the package	Grip-ability Fillable & Reclose ability /easy to clean Grip-ability Grip-ability Grip-ability	Body, Top–open Cap & Neck–Screw Body Cap & Neck–Screw Body Top-open	Symbol, verbal attributes Body texture, Packaging form Cap & neck form Body texture, Packaging form Cap & neck form Body texture, Packaging form

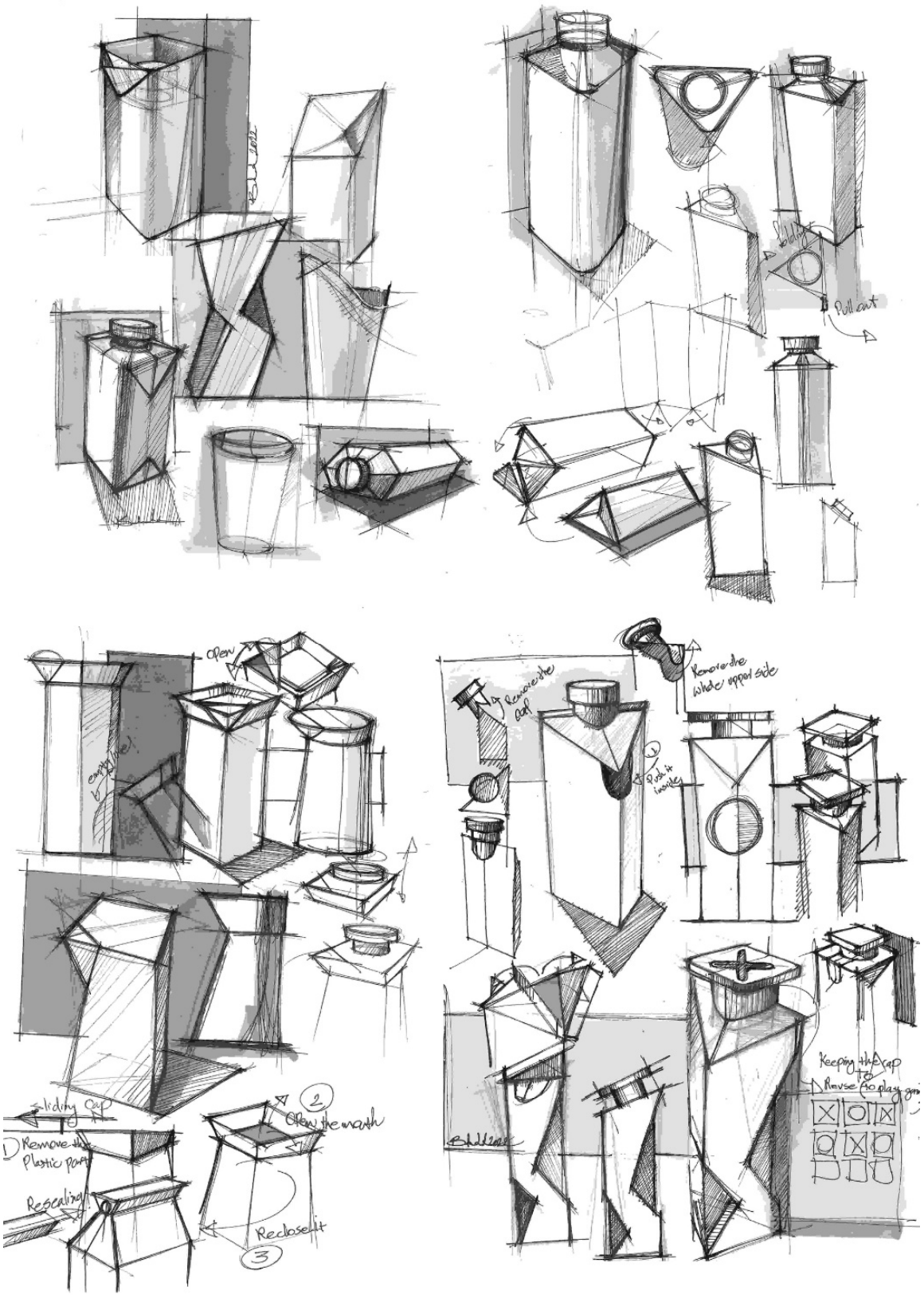
Table A1. *Cont.*

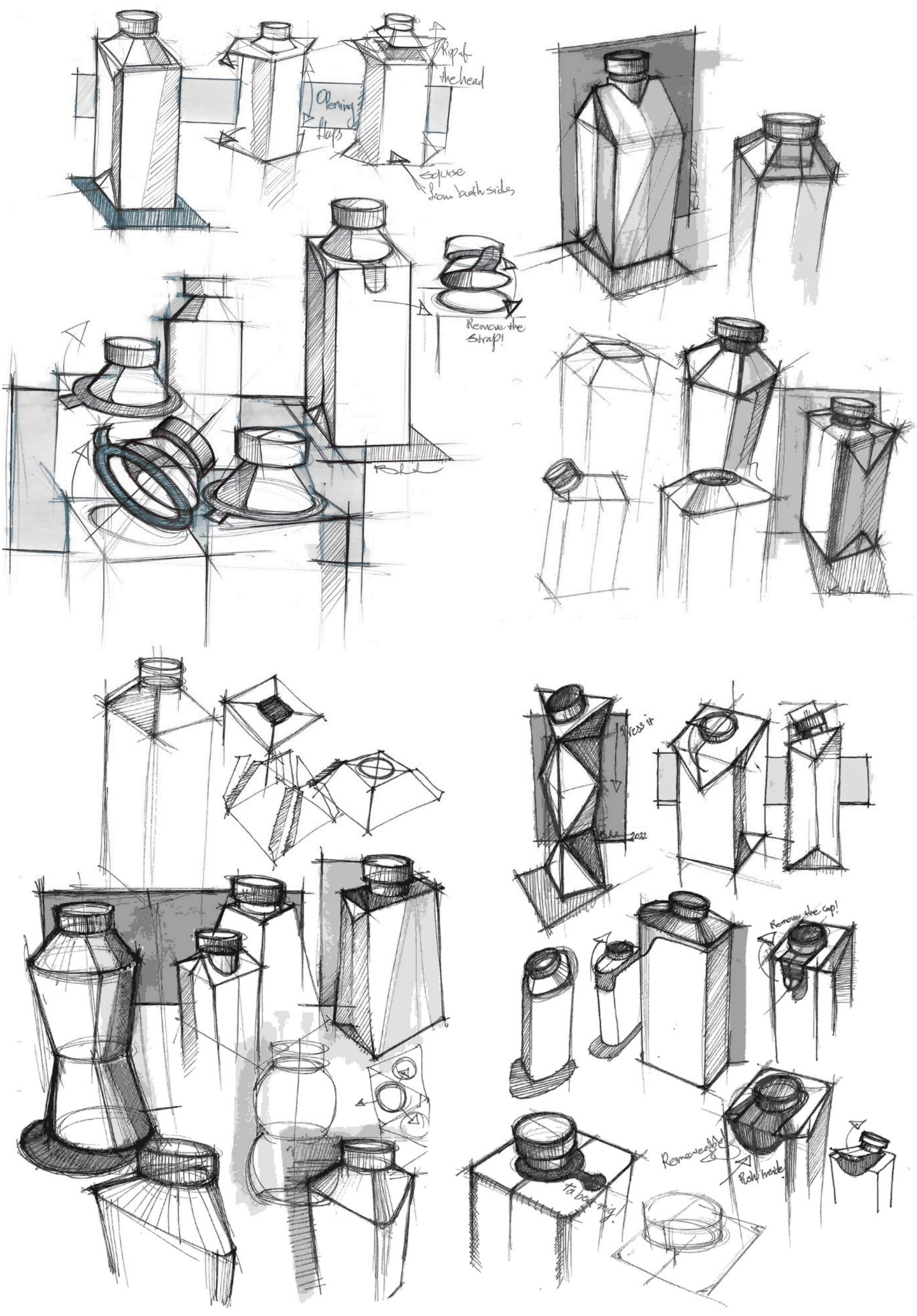
Pattern of Sort	Sub-Tasks	Affordance	Package's Parts That Support Affordance	Possible Design Attributes Affect Affordance
Folding (three scenarios)	(1) Not-folded	Fold-ability	Body	Packaging form
	(2) Crumple the package Reclosed the cap	Fold-ability Grip-ability	Body Cap & Neck-Screw	Packaging form Cap & neck form
	(3) Cutting/Separating the plastic neck, Open the button's folded flaps Folding the main body	Tear-ability Open-ability Fold-ability	Top-body End-body Body	Packaging &Neck formFolding triangular flaps Packaging form Symbol, verbal attributes
Reclose the cap	Turning the cap clockwise	Reclose ability	Cap & Neck-Screw	Cap & neck form Cap texture
Separate the cap	Turning the cap counterclockwise and removing it	Reclose ability Detach-ability	Cap & Neck -Screw	Cap & neck form Cap texture
Sorting under two scenarios: (1) The plastic cap does not separate (a most common scenario)	(1) Sorting the cap as plastic waste, Sorting the whole body as paper packaging	Recyclability Recyclability	Cap Body	Cap material, color, texture Body material, color, texture
(2) The plastic neck detached from the paper body (rare scenario).	(2) Sorting the cap and neck as plastic waste, Sorting the main body as paper packaging	Recyclability Recyclability	Cap, Neck Body	Cap and neck material, color, texture Body material, color, texture

Appendix B

The process was initiated by hand sketching. Selected sketches were converted to 3D digital models using 3D Studio Max and Rhino cross software. The whole plastic parts were sliced into STL files using Creality software and printed as a 3D model using a 1.75 mm PLA (Poly Lactic Acid) filament. Textured cardboard (330 g) was used to build the prototype's body, and all the images were printed on the cardboard. A summary of the designing and prototyping process is presented in subsequence figures.

1. Sketches


Open
Sliding Cap
Remove the Plastic part
Reseating
2
Open the mouth
Reclose it
3
Remove the cap
Remove the white upper side
Push it inside
Keeping the cap to
Reuse


Opening flaps
Rip of the head
Squeeze from both sides
Remove the strap!
Press it
Remove the cap!
Removeable
Push inside

2. 3D modeling, 3D printing, and pre-prototypes.

Appendix C

Comparing conceptual models based on functions abilities and affiliated design elements.
Comparing the A1 concept with the original package

Functions	Same	Better	Worse	Participants' Comments	Texture	Color	Size	Graphic	Material	Form
Reseal	●				●					●
Empty	●						●			●
Fold		●		Generally, it is easier to fold, but the button flaps are still problematic			●		●	●
Separate		●		I had the feeling that I could press it, and the body would be split up from the plastic part		●	●			●
Communicate		●		Obviously is made from paper and plastic. The front icon left no doubt	●	●		●	●	●

Comparing the B1 concept with the original package

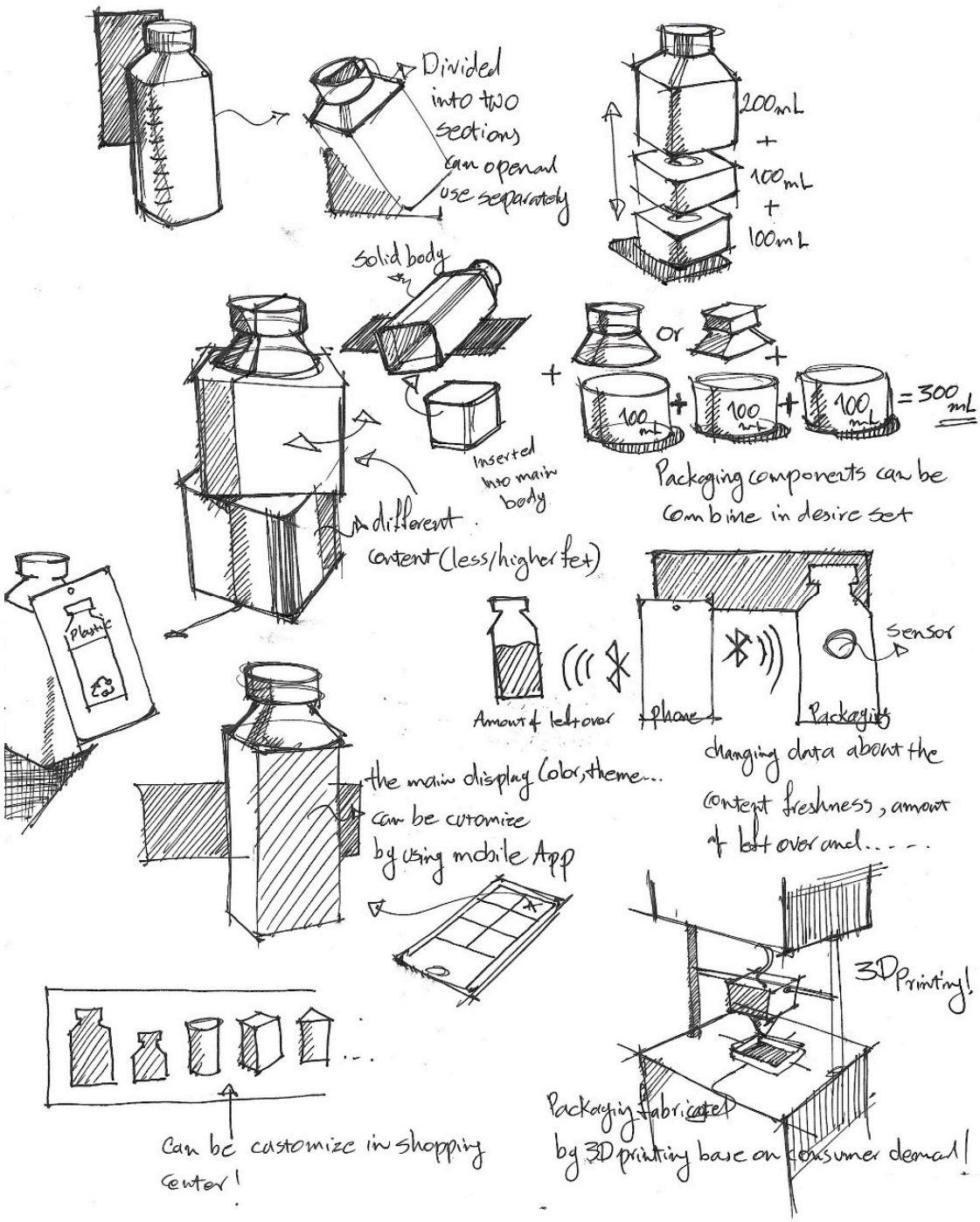
Functions	Same	Better	Worse	Participants' Comments	Texture	Color	Size	Graphic	Material	Form
Reseal			●							●
Empty			●							●
Fold			●	Confusing and hard to fold. I wonder if it is even possible to fold it.			●			●
Separate		●		A little push and the head has been removed from the body.		●				●
Communicate		●		Considering the matt color and big signs I had no problem to recognize that the body is made from recyclable paper.		●		●	●	

Appendix D

Sample of sketches centering a customizable packaging.

Functions	Same	Better	Worse	Participants' Comments	Texture	Color	Size	Graphic	Material	Form
Reseal			●							●
Empty			●							●

Functions	Same	Better	Worse	Participants' Comments	Texture	Color	Size	Graphic	Material	Form
Fold			●	Confusing and hard to fold. I wonder if it is even possible to fold it.			●			●
Separate		●		A little push and the head has been removed from the body.		●				●
Communicate		●		Considering the matt color and big signs I had no problem to recognize that the body is made from recyclable paper.		●		●	●	



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