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Sustainable Packaging Design for Online Order Delivery

By Fong-Yun Su

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Abstract

Due to the rising demands of package delivery, packaging for online orders has been produced rapidly in recent years. It includes plastic waste, paperboard waste, and energy waste. These wastes negatively impact the surrounding environment, natural creatures, and even human health. In this paper, a sustainable packaging design for online orders is explored that can not only help ecological systems on this planet, but also benefit the online retailers with a better package life cycle.

This project is aimed to design a new packaging solution with adjustable and reusable features, which reduces packaging waste and provides a better package life cycle. The author focuses on redesigning a secondary packaging solution that creates a more efficient and eco-friendly way for online order delivery. In the research section, the author goes through a significant volume of waste caused by online delivery packaging, what aspects of packaging waste affects humans negatively, reasons that lead to severe packaging waste, methods to reduce packaging waste, and the existing sustainable packaging design for online delivery.

After research, the author proposes a few potential packaging design ideas to alleviate the issue of excess packaging waste, enhance the efficiency for people to operate a package, and create a more completed packaging life cycle for retailers. User testing, interviews with experts in packaging science, and potential consumers help to inform the development of this project. The author evaluates ideas based on interviewees' feedback and determined a final idea with most possibilities to continue physical testing and refinement steps. The final solution is durable, resizable, and reusable packaging. Furthermore, the author concludes with the benefit and future potentials of this design.

Keywords: Sustainability, Reuse material, Packaging design, Online order, Personal care products

Introduction

With the fast development of e-commerce businesses in the world, people are having better online order delivery experiences, but also bringing more wastes to the world because of the single use feature of shipping packaging and packaging materials. According to the statistics, about 165 billion packages are shipped in the US each year, with the cardboard used roughly equating to one billion trees¹. Besides the cardboard waste in the US, the amount of plastic waste from online order delivery is also unbelievable. Take Amazon as an example, a study by Oceana found that they generated 465 million pounds of plastic packaging waste in 2019, and the number of air pillows alone could circle the globe 500 times². In addition, many e-commerce companies pack items in bubble mailers. Unfortunately, this kind of mixed materials of plastic and bubble wrap often cannot be recycled and instead block the recycling system.³

Most packing materials are disposable, which is the reason why online shopping and delivery causes a lot of packaging waste. This waste leads to contamination of the environment, damage to natural creatures, and harm to human health. As we see from the statistics above, packaging waste has been a severe issue in our life, and the amount of packaging waste is continuously rising as well. Therefore, people should take the responsibility of this issue.

This project aims to reduce the amount of packaging waste that online shopping leads to. This paper takes readers through the full design process, from early research, ideation, and development to final concept. Finally, the author suggests a resizable and reusable packaging design which provides a new online order experience, and a more completed package life cycle in the future.

¹ Bird, Jon., "What A Waste: Online Retails' Big Packaging Problem" *Frobes*. July 29, 2018. <https://www.forbes.com/sites/jonbird1/2018/07/29/what-a-waste-online-retails-big-packaging-problem/?sh=14db427e371d>

² Chua, Jasmine M., "Online Shopping has Boomed in the Pandemic. But What About All the Packaging?" *Vox*. Jan 8, 2021. <https://www.vox.com/the-goods/22214017/online-shopping-pandemic-packaging-ecommerce-waste-plastic>

³ Morgan, Blake., "Does E-commerce Care About Sustainability?" *Frobes*. November 5, 2019. <https://www.forbes.com/sites/blakemorgan/2019/11/05/does-e-commerce-care-about-sustainability/?sh=446a22c012c8>

Research

People invent and design products to make humans' lives better, but meanwhile produce a great amount of waste. Within the wastes, plastic waste is one of the most severe issues due to its non-degradable nature. Based on the statistic, there were about 8.3 billion metric tons of plastics produced in the past 6 decades, and most of them ended up as trash. Another research estimates that 79% of plastic waste was thrown into landfills, about 12% was incinerated, and only 9% was recycled in 2015.⁴

The amount of plastic produced was unbelievable, as well as the influence from it. The negative impacts that plastic leads to include damaging the natural environment, threatening animal lives, and even harming human health. In fact, animal lifespans are shortened because of consuming plastic. Littered plastic is clogging drains and causing floods, unmanaged plastic is contaminating oceans and waterways, and humans' respiratory issues are increasing because of air pollution from burning plastic.⁵ Furthermore, a study indicates that people unwittingly consume roughly 5 grams of plastic each week, which is about the weight of a credit card.⁶ Plastic consumption has grown at a tremendous rate as plastics now play a significant role in all aspects of modern lifestyles. Collection and disposal of plastic waste has emerged as an important environmental challenge.⁷

So, where do these plastic wastes come from? Many industries produce great amount of plastic waste, including the beverage industry, food industry, personal care product industry, and so on.⁸ In addition, ecommerce companies produce a lot of plastic waste since plastic makes up the majority of packaging materials.⁹ E-commerce businesses have been developing so rapidly in the last decade and became even more popular due to the pandemic. It is considered the fastest-growing industry during past 10 years. According to eMarketer, nearly half of consumers have shifted their spending

⁴ Alla, Omar., "Plastic and the Suffering of the Earth" *Voices of Youth*. June 15, 2019. <https://www.voicesofyouth.org/blog/plastic-and-suffering-earth>

⁵ Kaza, Silpa., Yao, Lisa., "Five Ways Cities Can Curb Plastic Waste" *World Bank Blog*. June 06, 2018. <https://blogs.worldbank.org/sustainablecities/five-ways-cities-can-curb-plastic-waste>

⁶ Rohrllich, Justine. "Here's how you eat a credit card's worth of plastic each week" *Quartz*. June 15, 2019. <https://qz.com/1644802/you-eat-5-grams-of-plastic-per-week/>

⁷ Zafar, Salman., "Methods for Plastic Wastes Collection" *EcoMENA*. May 29, 2020. <https://www.ecomena.org/plastic-waste-collection/>

⁸ Dorger, Samanda., "The Companies Whose Products Result in the Most Plastic Trash" *TheStreet*. February 12, 2019. <https://www.thestreet.com/personal-finance/companies-produce-most-plastic-pollution-14860441#gid=ci0256b279a0002716&pid=9-perfetti-van-melle>

⁹ Teo, Amanda., "How & Why You Should Choose Eco-friendly Packaging for Ecommerce Orders" *ShipBob*. April 19, 2021. <https://www.shipbob.com/blog/eco-friendly-packaging/>

towards online channels. Online orders are seeing two to three times year-on-year growth and it is predicted to remain strong in the future.¹⁰

With the high demand of online orders, mail packing is a burgeoning sustainability concern. Aside from the plastic and cardboard wrapping the products, there are labels and foam packing meant to protect the items inside. It is not unusual to end up with far more packaging materials than the real products inside, and that large amount of waste is staggering.¹¹

Fortunately, some e-commerce companies did start to explore sustainable packaging for their online orders, such as Amazon, Colgate, Nestle, Unilever, etc. Additionally, there were companies established to designed eco-friendly shipping packaging for their businesses as well, such as RePack, PackAge+, The Box, etc. Talking about sustainable packaging, it refers to designs and materials chosen in boxes, mailers, and other packing supplies to minimize their influence on the environment, such as minimizing waste, maximizing the usage of recycled and biodegradable materials, and maximizing the use of renewable energy during production.¹² There are many ways to approach these goals as well, including reduce packaging material, reuse existing packaging, and use recyclable materials, and so on.

Besides the methods listed above, based on the research and the interview results from packaging science experts, the better package fits the size of its contents, the more environmentally friendly the package is because it reduces the empty space waste, and extra fillers waste. Cutting down on the excess packaging and materials is important but challenging. People may not surprise that packages containing only a small item frequently come with a large box and fillers.¹³ In fact, having an option allows products to be shipped without excessive packaging can make a huge change to the world. There are many ways to reduce packaging waste but alleviate excess packaging material is a good direction to explore more in the future.

¹⁰ Picard, Stephen., Rousset, Marc., Williams, Hunter., Thomas-Dupuis, Frederic., Underwood, Curtis., Zhang, Danny., O'Hara, Timothy., "Are You Ready for E-commerce Acceleration?" *OliverWyman*. <https://www.oliverwyman.com/our-expertise/insights/2021/jan/boardroom-volume-6/e-commerce/are-you-ready-for-e-commerce-acceleration1.html>

¹¹ Nuwer, Rachel., Kho, Jennifer., "Thinking Outside the Box: Unwrapping a Massive Packaging Problem" *The Guardian*. November 18, 2014. <https://www.theguardian.com/sustainable-business/2014/nov/18/online-shopping-holidays-packaging-waste-recycling>

¹² Teo, Amanda., "How & Why You Should Choose Eco-friendly Packaging for Ecommerce Orders" *ShipBob*. April 19, 2021. <https://www.shipbob.com/blog/eco-friendly-packaging/>

¹³ Kim, Eun K., "5 Tips to Reduce Packaging Waste from Shopping Online" *TODAY*. April 18, 2019. <https://www.today.com/series/one-small-thing/5-tips-reduce-packaging-waste-shopping-online-t152203>

Design Solution

Following the result from research section, the better a package fits to its contents, the eco-friendlier the package is. This project is focused on creating a resizable packaging solution to assist retailers with not only reducing packaging waste, but also having a better and easier packing experience. The target audience refers to business companies selling personal care products (e.g., P & G, Unilever) who want to have more efficient and reusable secondary packaging; the end users will be people who purchase personal care products online. The final design will support them with practicing eco-friendly activities and provide easier ways to find the proper size for each order. The reasons for choosing personal care products as my focusing field is because those are consumable items, it is one of the largest online shopping categories. However, most personal care bottles are in bottle or tube shapes, and the rectangular shipping boxes usually cannot fit to the true size or shape, which results in waste.

Therefore, companies selling personal care products and relying on online chains need a resizable and returnable packaging solution to have more efficient and eco-friendly ways for their online order delivery. This project intends to design a secondary packaging solution that creates a more completed life cycle for delivery packaging, which includes reduce, reuse, and recycle features. Certain features, such as resize-ability, reusability, safety, durability, aesthetic, how intuitive it is to use, and efficiency in use, are the main criteria of this project.

Development

Initial Concept

The author comes up with using a flat sheet (main body piece) to form a cylinder based on the shapes of the content. Three reusable adhesive pieces on the main body piece allow the main body piece to attach stably and can result in three different standard sizes (Small, Medium, Large). The final closure system will be two caps with three sizes which fit the diameter of the formed cylinder. By working with three different diameters of the cylindrical tube (Small, Medium, Large) and three different lengths (Short, Medium, Long) of cylinders,

users can create 9 different sizes of packaging in 6 modules (fig. 1,2).

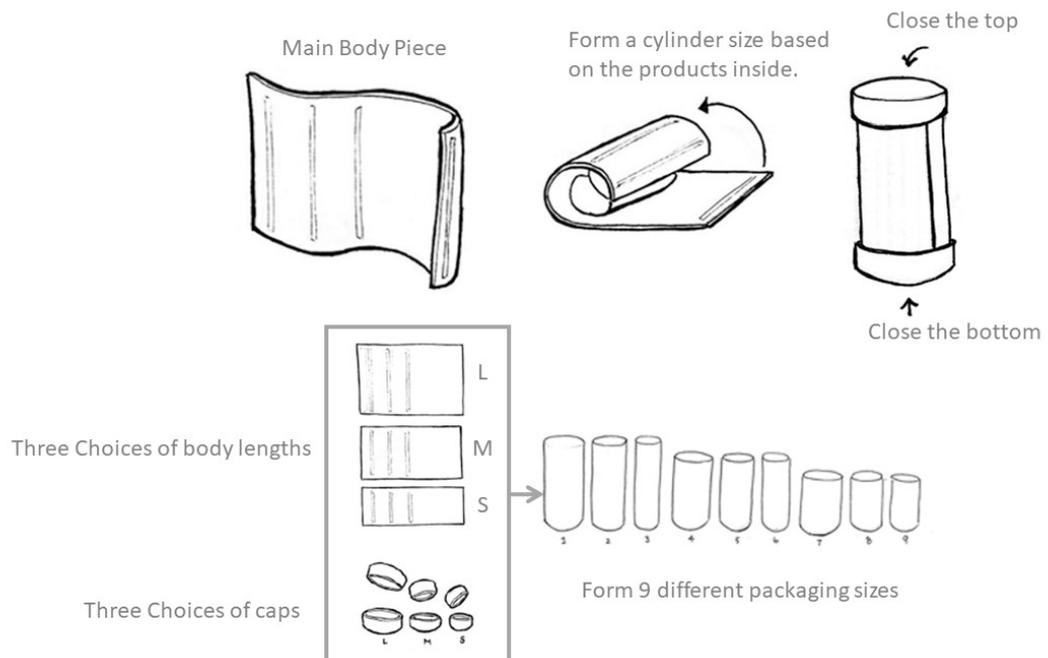


Figure 1: Visualization of Initial Concept



Figure 2: Early Mockup of Initial Concept

Phase 1

Refinement

After brainstorming more ideas from the initial concept, the author narrows down to two ideas with more potential and moved on to explore details.

- Idea1

The main body piece from the initial concept has been designed into few layers, including waterproof material for outer surface, a piece of foam as a protection layer, and a plastic board as a supporting structure. Layers are intended to sew together which make it easier to take apart after the end of the package life cycle. Magnets are installed inside the piece to be the closure system for forming the cylinder (fig.3,4). This idea is intended to combine packaging and the protection layer (fillers) together so that they can both be returned and re-used as a piece. In this phase, cap design is still in progress.

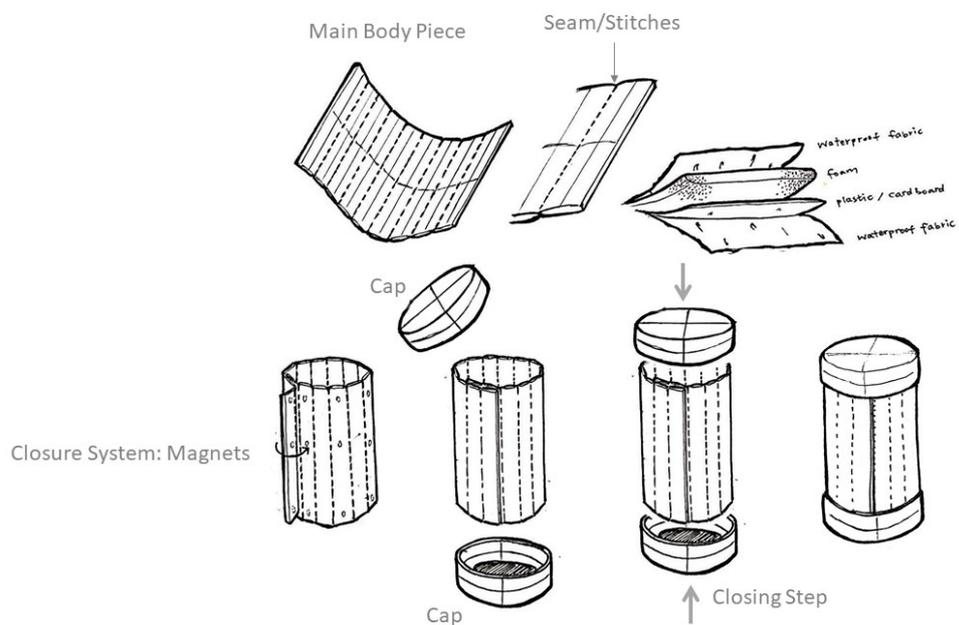


Figure 3: Visualization of Idea 1



Figure 4: Mockups of Idea 1

- Idea 2

The main body piece is made of a few layers as well, but metal sheets are used for supporting the structure in this idea. The metal sheet is a bistable mechanism (same with the mechanism found in slap bracelets) and is used to produce a self-rolling action (fig.5,6). The author intends to approach resize-ability by using a bistable system from the metal sheets. Then, the main body piece can hold the items in the package stably without any adhesive material. Cap design is still developing and will be refined later.

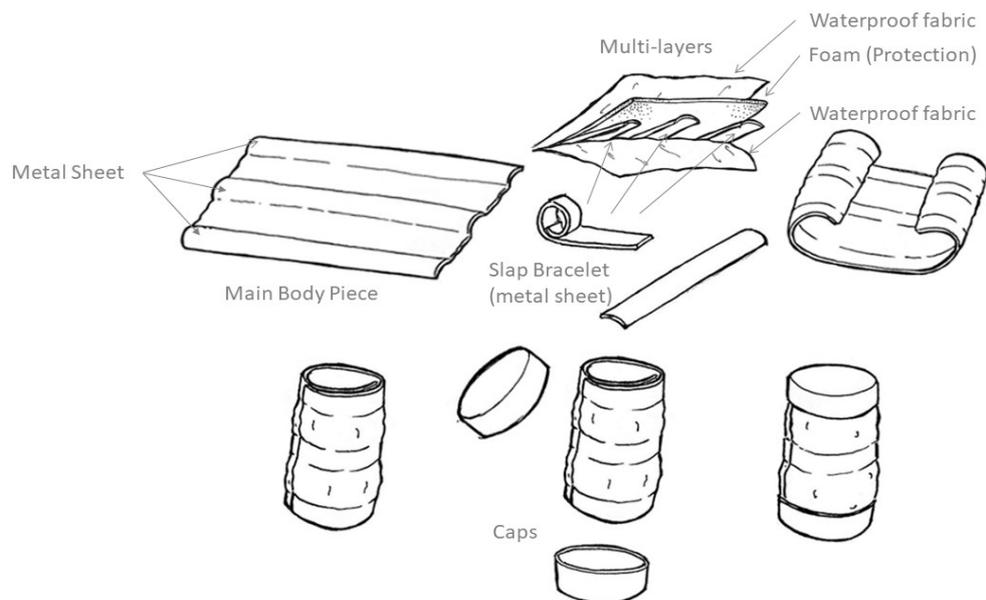


Figure 5: Visualization of Idea 2

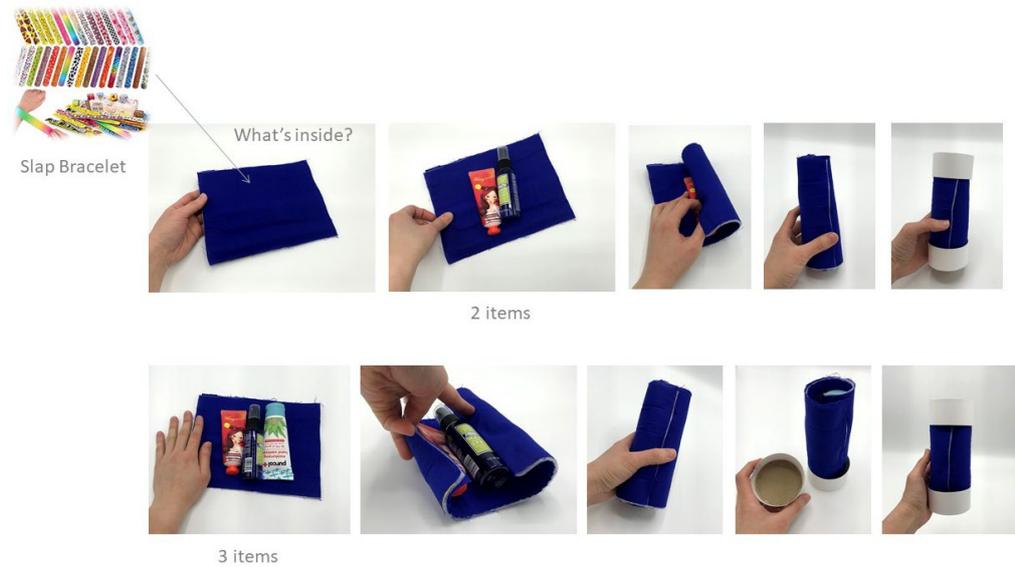


Figure 6: Mockups of Idea 2

User Testing

There are 15 people participating in this section, including potential users and an expert in packaging science. The goal for this section is to understand people's concern about the design and their preference of two ideas at the moment. Beside this, participants are also asked to point out their preferred feature of the design to assure that people are noticing the author's intention intuitively.

The result

The preference from participants closely even out between two ideas mainly because two ideas are not completed yet. For the concerns, few people bring up hygiene issues, protective concerns, and returning process complexity issues, which are taken to be considered and explained more in the further step. However, most people point out that they liked the adjustability of the solution, which is good to know that people are willing to accept this new packaging idea.

Phase 2

Refinement

Based on the result from previous users' feedback, the author gets through more details in this phase and focuses more on the cap design. The author is preparing to make the completed functional prototype for physical user testing.

- Idea 1

This idea explores more in terms of cap design. In this idea, caps are designed separately to the main body piece. However, the sizes of the caps perfectly fit three standard cylindrical forms (fig.7). The final step is designed to seal by tapes. In this design scenario, after consumers receive packages, peel off the tape, then they are supposed to return three components, including two caps and one flat piece, back to the retailer.



Figure 7: Prototypes of Idea 1

- Idea 2

Because of the flexibility of bistable mechanism in this idea, it is difficult to have caps in few standard sizes. Therefore, a more flexible closure system is designed to maintain products inside the package (fig.8). The final step for this idea is also sealed by tape. However, the consumers will only need to return a package piece back to the

retailer after they take out their order inside.



Figure 8: Prototype of Idea 2

User Testing

There are 16 people participating in the user testing process. Within these potential users, there are 7 people who get a chance to operate the physical prototype in person (fig.9), and the other 9 people do the interview remotely while watching the demonstration provided in the slides. The goal of the physical user testing is to observe how people interact with the prototypes without guidance, which directly reveals the idea that has better intuition and efficiency to use. Additionally, all potential users do the interviews with answering the questions about their preferences, concerns about ideas, and the additional features they hoped to be added into the design, etc. Finally, every interviewee is asked to fill out a comparison form to rank the efficiency, convenience, aesthetic, and personal preference between idea 1, idea 2, and the common cardboard box packaging.





Figure 9 : Images from User Testing Step

The result

Most people prefer the interaction of idea 2 as it is straightforward and intuitive to pack. Additionally, it is made in one piece, which is less complex and easier to store and return. The bistable mechanism of idea 2 is not as annoying as the interviewees expected previously, and most people think idea 2 practice the “resize-ability” the best.

Besides the direct feedback from potential users, many people express the dislike of tape as the final closure system. Another suggestion brought up from the interview is digital labels. The digital label can possibly replace the disposable label, which helps to reduce the label waste as well.

	Idea 1	Idea 2	Cardboard Box	Same
Efficiency (Packing)	1	11	2	2
Efficiency (Unpacking)	2	9	2	3
Convenience (Returning)	1	15	x	0
Aesthetic	4	8	1	3
Personal Preference	2	14	0	0

Final design solution

The final solution is resizable and reusable packaging for online orders. It is made of waterproof and recyclable material as an outer layer, a few pieces of foam as a protection layer, and the metal sheet with a bistable mechanism inside(fig.10,11).



Figure 10: Final Solution Image. Photo by Elizabeth Lamark



Figure 11: Final Solution Image 2. Photo by Elizabeth Lamark

The material choice is based on the feature needs and the expert's suggestion. For the outer layer, it is intended to be waterproof and smooth in order to alleviate being stained and dirtied during the shipping process. The expert the author consulted suggests to use reclaimed material or recyclable plastic, such as plastic number 1 or 2, to achieve the project goal more completely and make it more sustainable after the package gets into the end of its life.

This design utilizes the bistable mechanism to accomplish “resize-ability” of the design physically and combine the outer packaging with the protective filler, so that it is easier to return in a piece and reuse both packaging and fillers. Two clips on the end edge help the packaging to close entirely, make the package more stable, and prevent the package from tearing apart during the unpredictable delivery process. An extra small and thinner piece at the end of the packaging piece is the place for retailers to put the warranty sticker on as the final sealing step. The sticker reveals if it has been tampered with, which helps to assure that the package ships to the right person without other people opening it. (fig.12)



Figure 12:Packing Processes of the Final Solution

The package size will vary due to the flexibility of this design. The size, shape, and volume of the items inside the package will directly reflect in the final package. After consumers take their items out from the package, they will be able to roll the whole piece up into a thin cylindrical shape, so that it is small and easy to be stored in the house before being returned (fig.12). The compact feature and

good quality of this design encourages consumers to keep it instead of throwing it away immediately since it is not burdensome.



Figure 13: Pre-returning Processes of Final Design

Benefits

The primary purpose of this project is to design resizable and reusable packaging for delivery. This new design has three sizes but covers most personal care products' scales, so that the manufacturers will have easier manufacturing processes to produce packaging in fewer models. In addition, this new idea provides a more completed package life cycle which achieves the purpose of reusing the existing packaging instead of manufacturing tons of disposable packaging and fillers. It saves manufacturers' effort. Furthermore, it provides the brands who use this sustainable package a better business reputation and helps people who usually purchase personal care products online develop the habit to take eco-friendliness in practice in a natural sequence. Returning the packaging after receiving online orders, though simple, can make a massive change in terms of sustainability.



Figure 14: Three Sizes of Final Design



Figure 15: Three Sizes of Final Design

Expected package life cycle

The entire package life cycle will start with the retailers selling personal care products. The retailers prepare each order and deliver packages to specific destinations. After consumers receive the package and take out items they order, they will be able to store the reusable packaging easily at home since the packaging is resizable. Then, consumers will head to the nearest drop off station to

return the packaging, and retailers will pick up the packaging returned by consumers. Then, they can start the inspection process of the packaging, including sanitizing it and checking its condition. After making sure the reusable packaging is in good condition, retailers will use it for another order, and implement the reusability of the new packaging design. The hope is for this packaging to be utilized as many times as possible.

Future exploration

Next steps in this project will be doing physical testing together with a packaging science engineer. Further exploration of materials and label replacement could be done in the future as well. After a few more refinements based on more research and testing, this design can be developed into packing products from different categories, such as beverages, food, medicine, office supplies, and more. Hopefully, this project can continue and could be tested further and implemented to reduce waste.

Conclusions

Practicing eco-friendliness takes extra effort for each person. Even though multiple methods have existed and worked to certain extents, most people are still not willing to use them. This project presents what the future of shipping packages can be. With a bistable mechanism, the new packaging solution provides resize-ability, and with the combination between packaging itself and the protection layer, the package becomes simpler and more straightforward. This project brought the sustainable packaging design into a new level and explored more possibilities in terms of delivery packages. This addresses the problem of the large amount of packaging waste created in our current society. With this resizable and reusable packaging design and the cooperation of retailers and consumers, packaging waste reduction can be made into an easier and more approachable task.

In witnessing how severe packaging waste is in daily life, it is pleasurable to work on a project that could potentially alleviate damage to the planet, maintain safer habitats for natural creatures, and also improve the quality of humans' lives. By practicing the returning step, maintaining the entire package life cycle, and trying to reuse this new packaging as many times as possible, waste can be reduced. Hopefully, the ecological system will become better in the future.

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