PETurn –Stool type plastic bottle compressor

UNIST Design Department
2022 Creative Design

Executive Summary

This project is to design a product that can compress plastic bottles easily and playfully. The name PETurn is a combination of ″PET bottle″ and ″turn″, and as the name suggests, it is a product that can compress PET bottles while rotating.

The process of recycling plastic bottles can be divided into four stages: separation & sending out, transportation, sorting out, and processing. However, the actual recycling rate of plastic bottles was low because each stage was not systemically connected well. Through interviews with the CPSI method, 4 major design opportunities stood out.

Based on this desk research and user research, a new type of compressor that compresses PET bottles through gears was designed. If the user puts the plastic bottle in a stool-type product and rotates the body once while sitting on the product, the inner gear rotates, and the compressed plastic bottle falls off. This action can be repeated several times to throw out the compressed plastic bottles collected in the drawer at once.

The prototypes were made by laser cutting, welding, and polishing of materials such as transparent acrylic and stainless-steel pipes. The prototype was tested for a week from Nov. 7. It was possible to conclude the benefits:

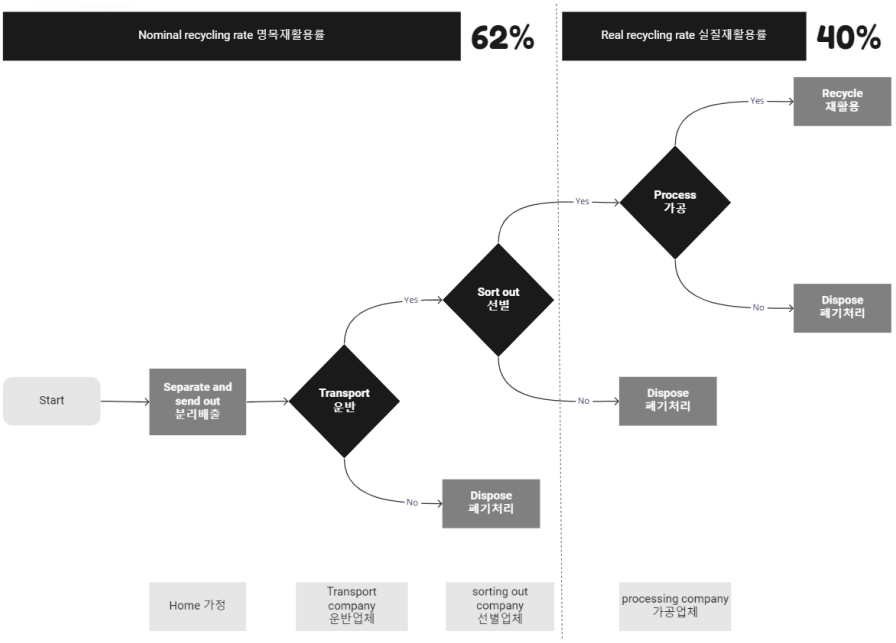
- At home, plastic bottles can be compressed and stored at the same time, and children can naturally learn recycling habits.
- It can be reduced labor and oil costs by reducing the number of transportations.
- Plastic bottles that are compressed to a similar size during the Sorting out process can reduce labor.
- If the previous steps go well, it can be created better R-PET by processing and circulating resources.

In conclusion, limitations and future research were considered through user evaluation.

Index

Problem Definition

More than 200 million tons of plastic waste are discharged every year, and it is increasing by more than 10% every year[1]. A more serious problem is that more than 90% of them are buried, incinerated, or left unattended[1]. COVID-19 played a role in amplifying the plastic waste problem. Plastic use has exploded due to increased awareness of hygiene, take-out, and food delivery, and online shopping. It complains of psychological inconvenience to the extent that it faces pouring plastic every day and expresses it as "guilty". Recycling collectors, separators, and producers want to increase the recycling rate from the recovery stage[1]. They also want consumers to separate and discharge well because the subjective and intuitive separation of consumers does not help to recycle[1]. What should be done to help consumers separate plastic waste well? It was necessary to investigate the life cycle of plastic and observe the problem at each stage.

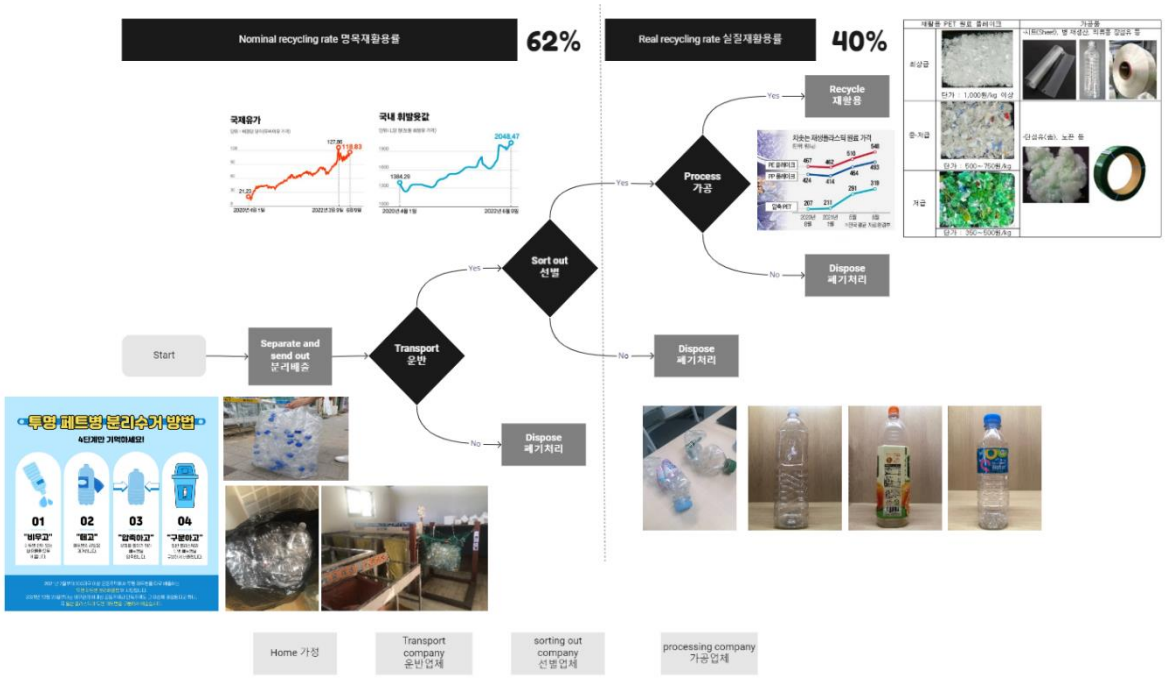


The recycling stages were divided into separate and send out, transport, sort out, and process stages, and I found that each stage was not systematically connected[2]. As a result, the actual recycling percentage was low. Based on these desk research, I conducted user study. Through the semi-structured in-depth interview method, a total of 4 people (housewife, student living alone,

cafe part-timer, and person who working at the sorting center) were interviewed.

- Date: 11-12. Mar / 7. Apr. 2022
- Process[3]:
    I. List as many as possible questions.
    II. Categorize them into thematic questions (interest, experience, opinion)
    III. Interview 4 Targets. It lasted 3-40 minutes per person.
    IV. Organize and analyze interviews by using CPSI.

As a result, there were 4 design opportunities that stood out. First of all, in the home, remove the lid, compress the plastic bottle with user's feet, pick it up and close the lid again. This process is uncomfortable to user. second, the number of transports is a waste of money and labor force. In particular, now that oil prices have risen a lot, there is a growing need to reduce the number of transports by reducing the volume[4]. Third, the more carefully company sort out, the more labor costs they have. plastic bottles should be easily sort out. last, after this process, flakes are made, and high-grade flakes are made from plastic bottles.



After that, further desk research was conducted. PET is the "high-level" plastic that is the easiest to recycle among the various types of plastic, does not

deteriorate in quality even after recycling, and can be recycled almost 100% if it is separated and discharged[5]. The collected PET bottles are selected by human hands, compressed, washed, and pulverized, and then made into small flakes (pieces). The flakes are made from several recycled products and depending on the purity of the flakes, the "pure" PET flakes are so valuable that the price difference is around KRW 1,000 per kilogram and the mid-to low-grade flakes are around KRW 500 to 750 per kilogram[5]. Therefore, it is important to increase the recycling rate of PET bottles.

Design Concept

Objective is to design product that helps compress plastic bottles for users involved in recycling plastic bottles. I sketched a lot about how to reduce the volume of plastic bottles effectively, easily and in a fun way. In addition, I created a mood board as follows to give the feeling of turning, twisting, and folding.

Sitting and rotating on a stool-type product

Like a rotating chair, the plastic bottle is compressed when the user sits on the product and rotates the body once. It can be used as a chair, as well as a compressor.

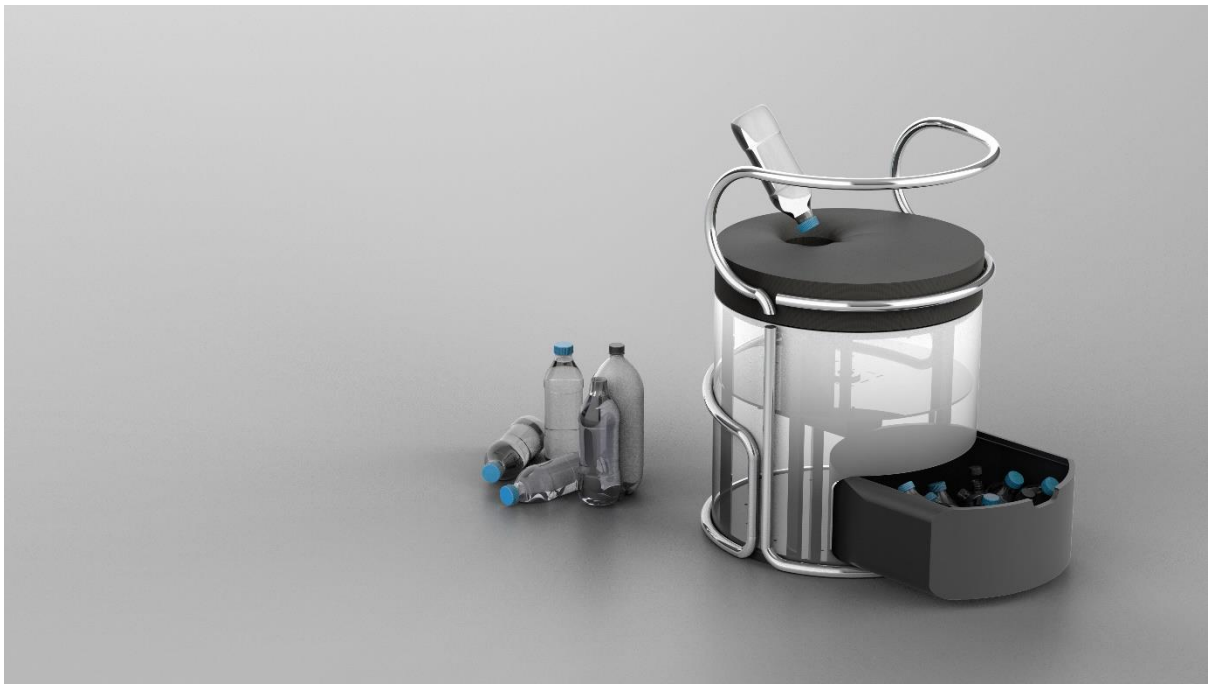
Using gear structure

Using bevel and spur gear′s structure, the PET bottle can be compressed when passing between a pair of spur gear around 2 mm. When the neck of the bottle enters, only the body part is pressed. The deceleration ratio is 1:1.5 and is designed according to the length of the 500ml PET bottle.

Benefits of each stage of PET bottles recycling

The main user benefit of the home is that plastic bottles can be easily compressed, and children can use them, so they can educate them on the importance of recycling as a play. Second, when moving from a separate collection site to a sorting out site, more supplies can be moved at once with the effectively compressed plastic bottle, saving oil and benefiting from economic benefits. Third, plastic bottles of various sizes are compressed into similar sizes and shapes, making them easy to grasp at a glance and easy to choose with one hand. Lastly, plastic bottles can be collected, transported, and sorted out effectively in the previous process, and can be recycled into high-grade plastic flakes more economically.

Outcome



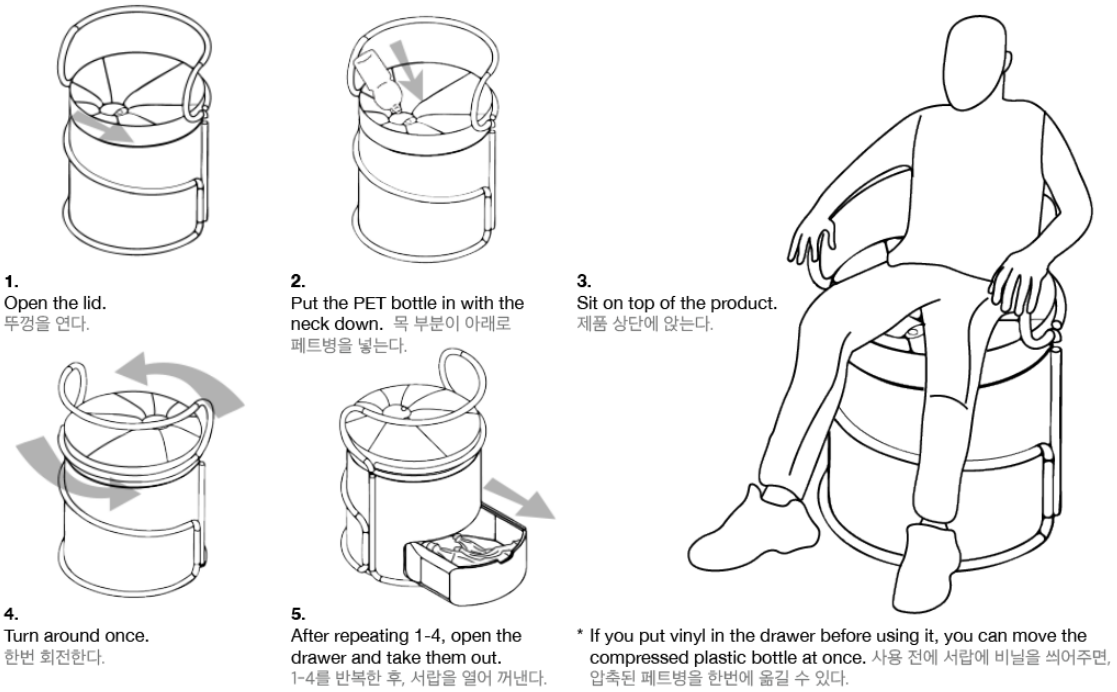
How it works

When rotated while seated, the central axis rotates, with a pair of inner bevel gears and a pair of spurs. It is a product that can be compressed and stored at the same time as the PET bottle passes between a pair of main gears and falls into the drawer.

In more detail, when the user sits on the top and rotates the body, the central axis rotates at the same time. As the bevel gears and the spur gears connected

to this axis rotate, the neck of the PET bottle is engaged between a pair of gears with an eccentric installed, and the PET bottle is compressed. After one rotation, the compressed PET bottle falls onto the drawer and accumulates.

How to use



Prototype

The upper part is made of a material that is comfortable to sit on, and the lid can be closed to prevent entering foreign substances. The main body with a transparent acrylic material reveals its internal structure. It tried to induce the act of turning using a stainless-steel pipe that seemed to be wound around the main body. The drawer part was made to give a clean feeling by using black plastic.

Conclusion

After making the prototype, the user evaluation was conducted at the exhibition to find insights.

The shape made of stainless-steel pipe was evaluated as an element that usually acts as a backrest, a handle that can apply arm force during compression, and a rotating feeling when first used. It was confirmed that form, function, and aesthetic solutions were all well applied.

Previously, it was inconvenient for users to compress plastic bottles and move them back to the storage area, however, through the form of PETurn's drawer, it received positive feedbacks from users as it was possible to compress and store them at the same time. Through the transparent main structure, it can be seen that the internal gear compresses the PET bottle, attracting users' interest.

It was confirmed that the volume of the plastic bottle was significantly reduced when using the PETurn compared to when pressed with feet or hands. This shows that once turned, the internal gearing works well and the gear ratio works well.

Limitation and Future Plan

Currently, the design right is in progress, and the patent will proceed after the design is modified due to several limitations.

Compression can be difficult depending on the thickness or shape of the neck and bottom of the PET bottle. Since the total volume of plastic bottles also affects the height of the product, there is a limitation that the current prototype is best compressing when using a specific 500ml plastic bottle. This is a problem to be solved in future plans, and if the gear is deformed according to the type of plastic bottle, the gap is reduced and widened, and it can be well compressed regardless of the size, thickness, and shape of the plastic bottle. Alternatively, the expected effect would be greater if a structured PET bottle

production collaboration could be carried out in collaboration with research on shape or material in the PET bottle manufacturing stage.

In addition, I received common feedback that the expected effect would be greater if used by kids. The current prototype can be used regardless of age. It will be able to effectively work on children in that the plastic bottle is compressed through a transparent main structure. In future studies, it will be possible to expand from the scenarios used at home and conduct them in kindergartens, and playgrounds that have good access to separation place. In addition, various designs can be found in consideration of the size, height, and strength of the sitting part focused on the kids.

Reference

1. LG Business Research (2021). *Plastic waste issues, companies that act.*
2. Hankookilbo (2020). *Your recycling efforts, 60 per cent, are thrown away*
3. Jieun,Kim (2019). *A Study on the Recognition and Improvement of Plastic Waste Problems Using Contextual Interviews – Focus on a Regulation of Disposable Plastic Cup in Store.*
4. Joongang (2022). *When international oil prices jump eight times, the price of gasoline in Korea rises 60 percent.Oil Tax Paradox [News One Shot].*
5. Joongang (2019). *Separate collection of 'Precious Resources' PET bottles and start high-quality recycling.*

Acknowledge / Epilogue

Thank you to everyone who has been interested in and supported my project. There were many trials and difficulties, however, I was able to finish the project well thanks to the help of many people.

In particular, I would like to thank Professor Huisung Lee and Kwanmyung Kim for their helpful advice on PETurn's function, form, and aesthetic solution for a year.

Through this project, I was able to discover problems, capture design opportunities, sketch ideas, render them, build prototypes, and learn the overall process of product design. Based on this experience, I′m sure that I can be an designer who can understand the user's point of view and can make the product myself. *Thank you!*

About the creator of this issue

Contact information

Minji Choi

최민지

minji99@unist.ac.kr

https://minji99.github.io/

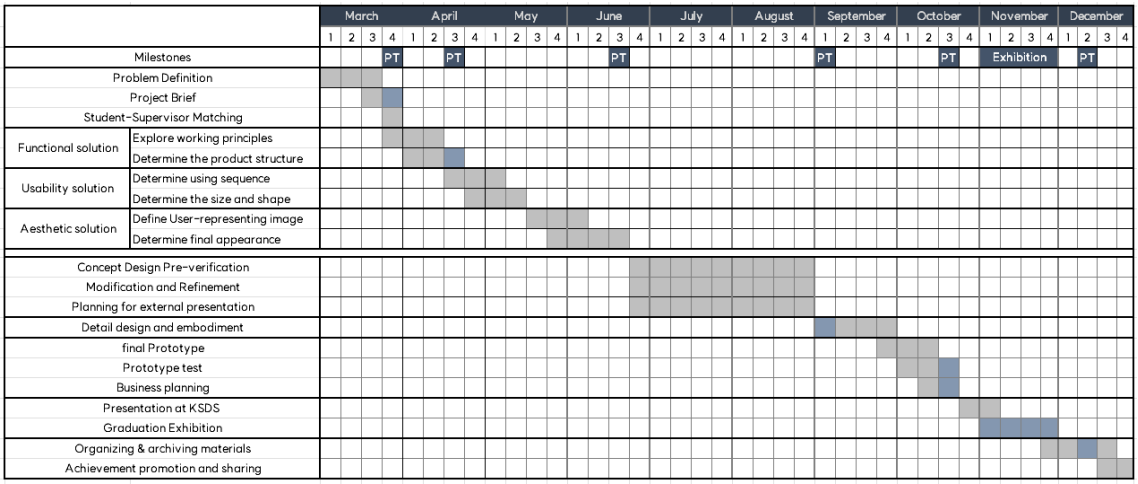
+82) 1026894425

CV

2023. 03 ~ Today	Master of Design at UNIST
2022. 05 ~ 2023. 02	Internship, Design & Electronic Convergence System Lab
2018. 03 ~ 2023. 02	Bachelor of Industrial Design & Computer Science Engineering at UNIST

Appendix

1. Milestone



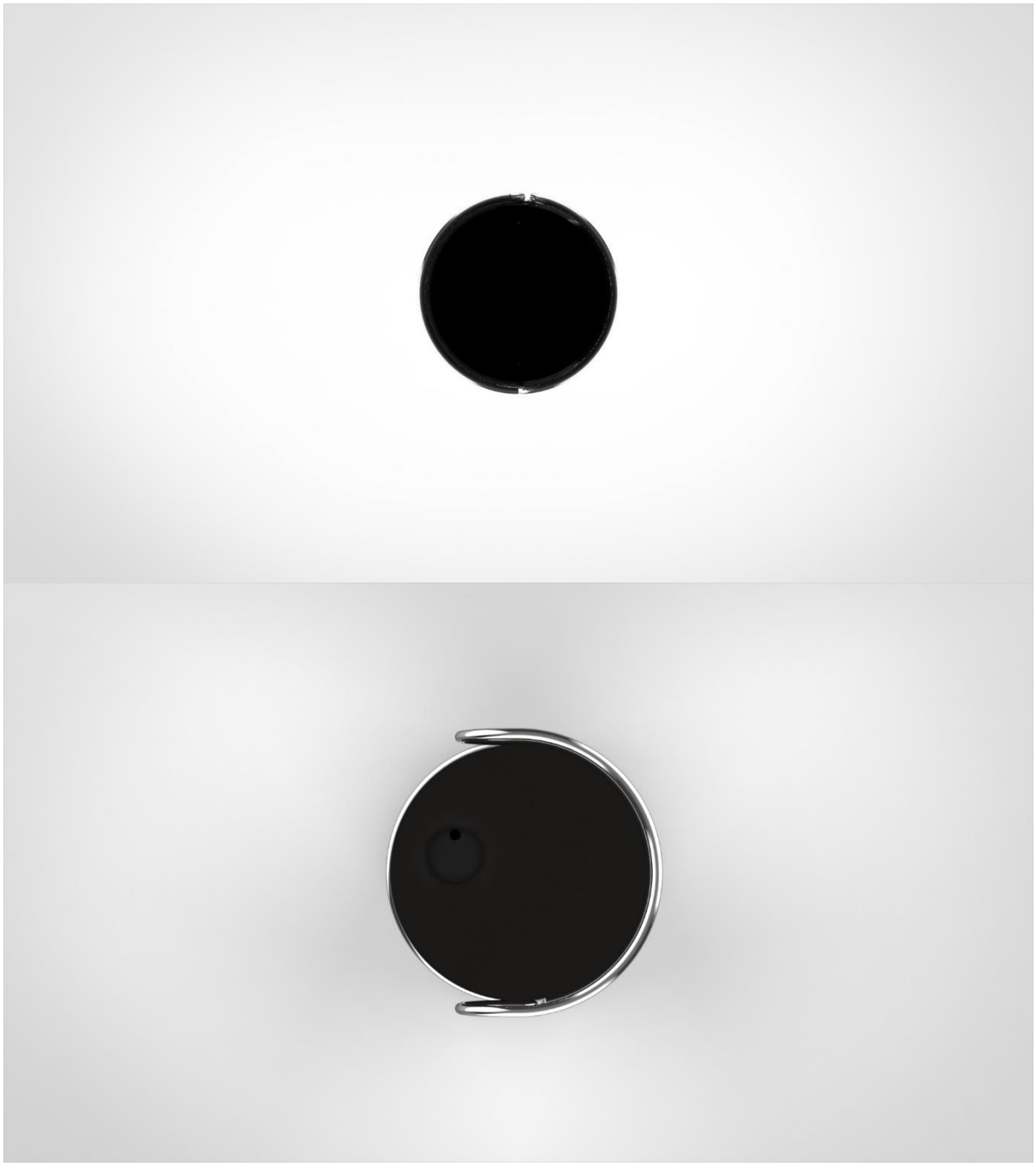
2. Interview

Category	Question
interest	플라스틱 쓰레기 문제에 대해 최근에 생각해본 적 있나요? 언제 생각했나요? 무엇을 하고 있었나요? Please tell me the recent moment when you think "plastic waste". When was it and what was you were doing?
interest	환경 문제에 대한 관심이 있나요? 구체적으로 어떤 문제에 관심이 있나요? Are you interested in environmental issues? What specific issues are you interested in?
interest	플라스틱과 관련된 규제나 캠페인에 대해 들어보거나 알고 있는 것이 있나요? 어떤 것인가요? Do you hear or know anything about plastic-related regulations or campaigns? What is it?
interest	플라스틱 쓰레기가 분리수거 후 어떻게 처리된다고 생각하시나요? 분리수거 이후의 과정에 대해 알고 있는 점이 있나요? How do you think plastic waste is treated after recycling? Do you know anything about the process after recycling?
experience	플라스틱 쓰레기를 처리하는데 어려움을 겪어본 적이 있나요? 그 문제는 얼마나 심각하나요? Do you have any difficulties about disposing of plastic waste? How serious is the problem?
experience	플라스틱 쓰레기를 분리수거하는 빈도는 어느 정도 되나요? 한번 분리수거할 때 어느정도의 양을 분리수거 하나요?How often do you recycle plastic waste? How much do you recycle when you recycle once?
experience	플라스틱 쓰레기를 줄이기 위해 최근에 노력해본 적이 있나요? 어떤 행동을 실천했고, 언제 그렇게 했나요?Have you tried to reduce plastic waste recently? What kind of behavior did you practice and when did you do that?
experience	플라스틱과 관련된 규제 (분리수거, 다회용 컵등)를 경험해본 적이 있나요? 이 경험에서 어떤 어려움이 있었나요? Have you ever experienced regulations related to plastic (repellent collection, multi-use cups, etc.)? What kind of difficulties did you have in this experience?
opinion	알고 있는 플라스틱 규제에 대해 어떻게 생각하시나요? 어떤 포인트가 바뀌어야 발전할 수 있을까요?What do you think about the plastic regulations you know? What kind of points should it change to improve?
opinion	환경 문제 중 플라스틱 쓰레기 문제가 어느 정도로 심각하다고 생각하십니까? 그 이유는 무엇입니까? How serious do you think the plastic waste problem is among environmental problems? What's the reason?
opinion	플라스틱 쓰레기 문제를 위해 어떤 노력을 해야할까요? 정부, 기업, 개인 중에 어떤 노력이 가장 필요하다고 생각하나요? 아니면 생각? What kind of effort should we make for the plastic waste problem? Which effort do you think is the most necessary among the government, company, or i
opinion	플라스틱 쓰레기가 가장 많이 배출되는 행동은 어떤 것이라고 생각하나요? 그러한 행동을 줄일 수 있다고 생각하나요? What kind of behavior do you think plastic waste is the most discharged? Do you think such behavior can be reduced?

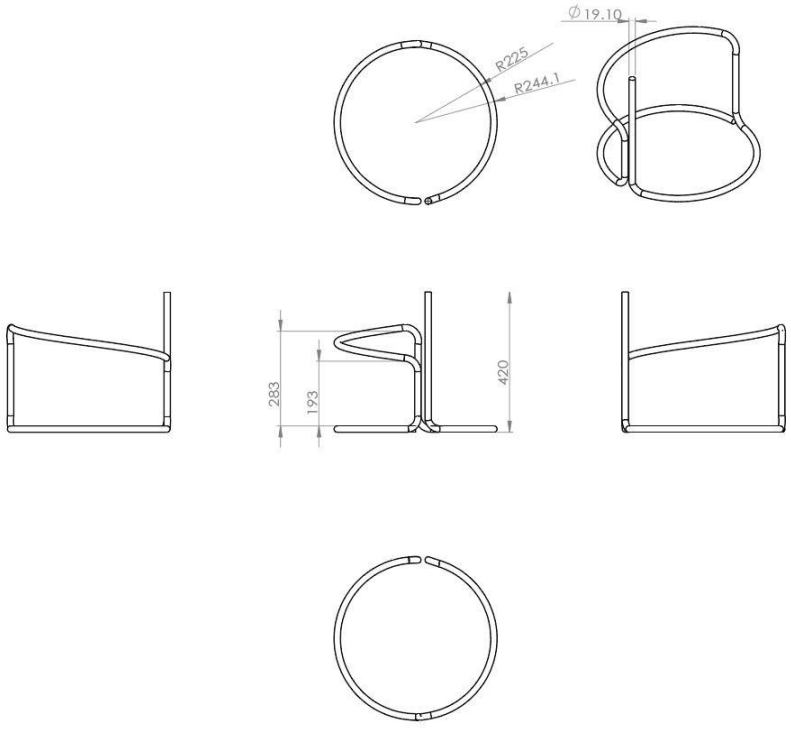
	Desk research	User research (primary research)
	Issues	Actual problems (concerns)
Plastic producers	Production is carried out for cost reduction and mass consumption rather than environmentally conscious production.	
Plastic consumption (consumer)	Amount	Using plastic in all consumer activities such as ordering delivery food, grocery shopping.
	Cost	The producers and users of delivery containers do not bear any share of recycling.
	Processing	Remove the lid, compress the transparent plastic bottle with your feet, and then close the lid again to separeate and discharge.
	Processing	Tired to separate labels from plastic bottles. Not coming off clean.
	Processing	Red sauce gets stuck in plastic containers and doesn't wash off easily.
	Processing	The plastic cover on the plastic container will not be removed neatly.
	Processing	Oil does not wash well in plastic containers.
	Amount	Too much plastic waste. Among them, delivery containers are the most.
	Processing	Not sure which one is not separable.
	Processing	Folded, foreign-stained vinyl not recycled
	Zero-waste	It is difficult to challenge the plastic container challenge. The hassle of consumers taking their own containers.
	Zero-waste	After plastic regulation, the amount of dishwashing has increased.
	Zero-waste	It's hard to manage the tumbler.
Recycling (consumer)	movement, frequency	Hard to carry large amounts of recycled waste at once.
	Processing	Separated collection behavior is carried out under the subjective and intuitive judgment of the individual.
	Management	In the case of apartments, there is not a separate manager, but a security guard sometimes manages them.
	Management and Processing	If the recycling bin is dirty or the recyclables brought in are dirty, there is no room for cleaning.
Recycled Waste collecting&sorting	Amount	(Reason for mixing and taking collected items) The screening center is already saturated, so just take it to the incinerator.
	Processing	Plastic contaminated with food is not recycled
	Processing	Plastic containers with vinyl are not recycled
	Sorting	A person selects the plastic that is placed on the belt one by one.
	Processing	Delivery containers are fundamentally impossible to recycle because they can contain hot food by mixing chemicals to increase
	Cost	The more meticulous recycling is, the more labor costs are incurred, and the bigger the deficit is.
Recycled Goods producing	The more you recycle, the less valuable the product is reproduced. (down-cycling)	
	Only packaging materials can be made with Korean flake quality.	
	Plastic can only be recycled in five types of flakes in transparent, opaque, green, brown, and mixed colors.	
Government	Difficult to check data on how much and how waste is recycled.	

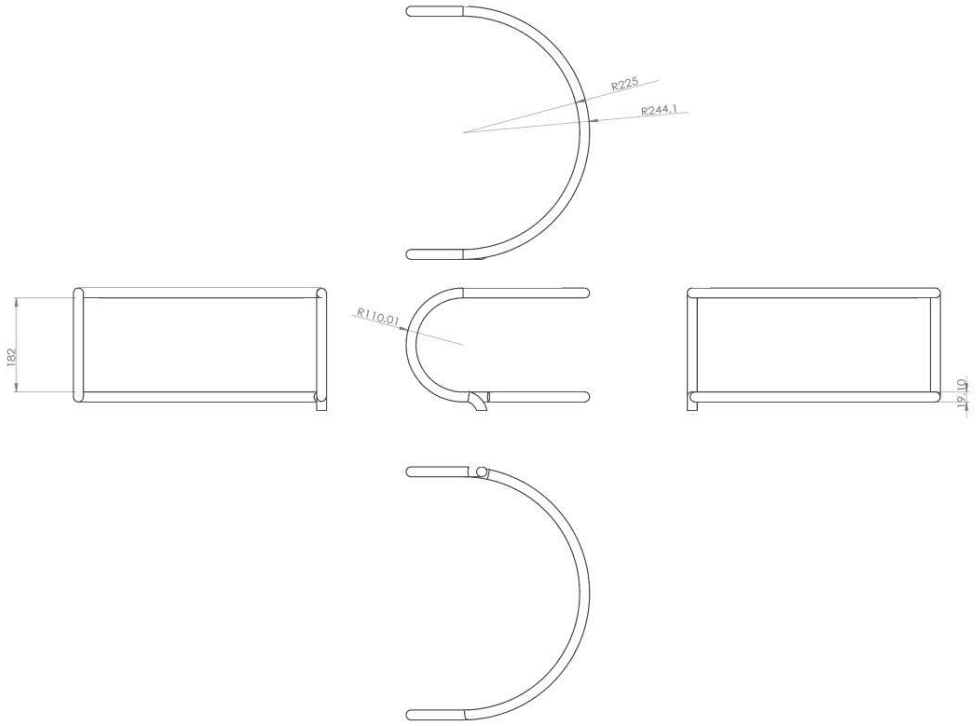
One-step interpretation toward the ideal situation	Idea Generation (Scenario creation)
Needs (one-step interpretation toward the ideal status)	**Solution Direction**
I want to produce eco-friendly products considering the material and design of the products to facilitate re	Products that can be packed in place of plastic
Want to reduce the amount of plastic used.	Products that can be packed in place of plastic
Willing to bear this (Green Consumer)	Affordably priced, eco-friendly products that can be packed in place of plastic + flake products
want to compress the PET bottle with the lid closed / want to separate it without closing the lid again.	Products that reduce the volume of PET bottles with the lid closed
Want to remove labels easily.	Easy to separate and remove labels
Want to wash food well.	Easy to clean recyclables
I want to remove the plastic cover neatly.	A product that is easy to remove the plastic lid / Adjust the adhesive force of the vinyl
I want to clean the oil well.	Recycled goods washing machine
Want to reduce plastic usage when ordering delivery food.	Products that can be packed in place of plastic
I want to distinguish recyclables and household waste easily and objectively.	System that tells you if it is recyclable or not -> Automatic separation collection box, application, and behavior-inducing design collection box
I hope plastic vinyl is not folded and cleaned and collected separately.	System to tell you if it's recyclable -> automatic recycling bin, app
Need products, services to help you with the container challenge	Alternative containers, services that offer discounts when using containers/services that collect and clean containers on behalf of restaurants
I want to do the dishes easily.	Cleaning aid products/services for cleaning
I want to take care of my tumbler easily and cleanly.	Products and services to help manage tumblers
want to carry recyclables to the recycling bin easily and conveniently.	Transport aid that reduce the volume of plastic waste and easily move large amounts of plastic at once
want to distinguish recyclables and household waste easily and objectively.	System that tells users if it is recyclable or not -> Automatic separation collection box, application, and behavior-inducing design collection box
A manager is required for the recycling bin.	Separate collection area management AI, robot, automatic collection box
There should be a cleaning and management facility or system in the recycling bin.	Recycled product washing machine installed in the recycling bin, and a recycling bin that is automatically cleaned
I hope the amount of plastic used will be reduced to cover.	Products that can be packed in place of plastic
The plastic with food stains should be washed and collected separately.	Recycled goods washing machine
I hope plastic that has been removed well will be recycled.	Products that are easy to remove plastic caps / plastic containers that do not use vinyl
I hope plastic screening is automated, not done by humans.	Systems for segregation and collection -> AI recycling screening
Delivery containers should not use plastic as much as possible and need replacement materials.	Products that can be packed instead of plastic -> multiple containers
I want to reduce labor costs because it is easy to sort out plastic waste.	Systems for segregation and collection -> AI recycling screening
I want to improve the quality (purity) of wastes because they are not separated incorrectly in the initial sep	Products that help you separate and discharge well
Want to improve the quality of the flakes.	Separate collection centers that can be separated by color and plastic type
I'd like to receive recyclables that can make this flake.	Separate collection centers that can be separated by color and plastic type
I want to check the data from the production of plastics to recycling and disposal.	Systems that can track and monitor how plastic waste is handled -> Apps

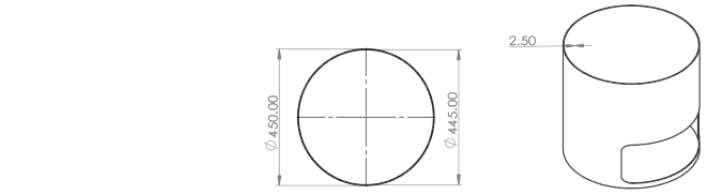
3. Rendering Images

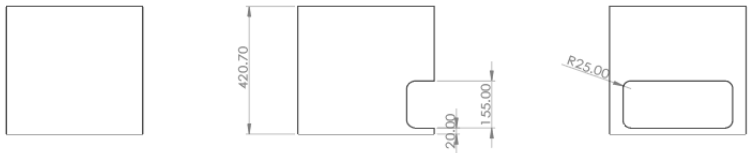


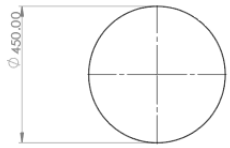
4. Engineering drawings

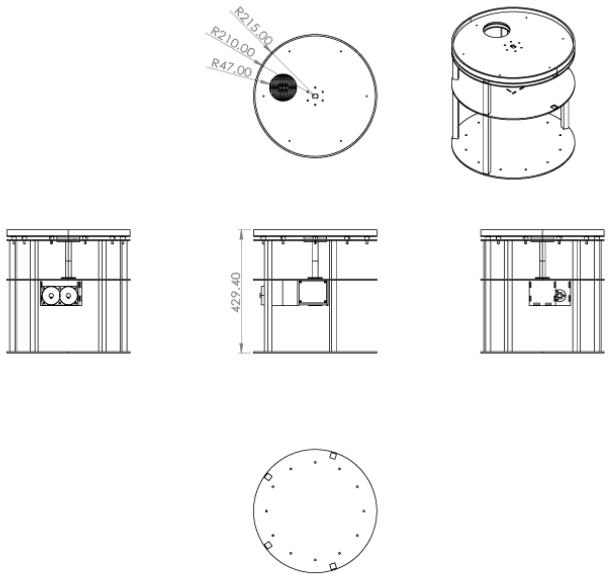



R225
R244.1
182
R110.01
10


Ø450.00
Ø445.00
2.50


420.70
20.00
155.00
R25.00


Ø450.00



5. Videos

- https://youtu.be/FgAuXshxJ3o
- https://youtu.be/zVg6CGJO3HE