

# PC Bottle

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by

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## **ABSTRACT**

This project focuses on the design, development, and prototyping of the PC (Pill Crusher) Water Bottle, a multifunctional solution that integrates pill storage, a pill crushing mechanism, and hydration into a single, user-friendly product. Inspired by the widespread challenge many individuals face when swallowing pills—particularly the elderly, children, and those with phagophobia—this device aims to make medication intake more accessible, portable, and less stressful. Extensive research identified the lack of existing solutions that combine all necessary functions in a compact and practical design.

Three unique design concepts were developed and evaluated, each offering different mechanisms for pill crushing and dosing. The final prototype was produced using additive manufacturing methods, leveraging a 3D printer to minimize production costs while ensuring functional testing. Project management strategies ensured that the timeline and budget remained on track, with minimal material waste.

Ultimately, the PC Water Bottle provides an innovative, convenient, and sustainable option for individuals who need to take medication on the go, improving user experience while promoting consistent medication adherence.

## **PROBLEM DEFINITION AND RESEARCH**

### ***PROBLEM STATEMENT***

At some point in life, everyone needs to take medicine—often in the form of pills. For those with chronic illnesses or who take daily supplements, this can become a daily challenge. This innovative water bottle is designed to make the process easier and more convenient. By combining a pill crusher and built-in pill storage with a water bottle, it simplifies the routine of taking medication. It's especially ideal for people with active lifestyles or who enjoy spending time outdoors, eliminating the need to carry multiple containers and making it easier to stay on top of their health.

### ***BACKGROUND***

According to George Griffenhagen, featured in the *Los Angeles Times Magazine*, “Pills date back to roughly 1500 BC – and they were presumably invented so that measured amounts of medicinal substance could be delivered to a patient” (4). Today, nearly everyone takes medicine at some point in their lives. A report from Georgetown University’s Health Policy Institute states that “more than 131 million people – 66 percent of all adults in the United States – use prescription drugs” (5). As expected, medication use tends to increase with age due to a higher likelihood of illness and the natural effects of aging.

Taking pills, however, is not always easy. Unlike food, which we chew and swallow instinctively, tablets and capsules require us to consciously override that natural reflex. The article notes, “As we naturally chew food before swallowing, tablets and capsules require a conscious over-ride to the normal chew & swallow reflex” (6). For some individuals, this act

can induce anxiety—especially those with phagophobia, a condition defined by the National Library of Medicine as “the avoidance of swallowing foods, liquids, or pills usually based on a fear of choking” (7).

Other factors, such as dry mouth—a common issue among older adults—can also make swallowing difficult. This is particularly prevalent in individuals with conditions like Parkinson’s disease, Multiple Sclerosis, and Motor Neuron diseases (6). Children, too, often experience a mild form of phagophobia, making it difficult for them to take necessary medications or supplements. This can be stressful not only for the children but also for their parents, who worry about the risk of choking on larger tablets.

As we can see, there are many physical and psychological barriers that can make swallowing pills a daily struggle for people of all ages.

## **RESEARCH**

### ***SCOPE OF THE PROBLEM***

Swallowing pills is a common yet often overlooked challenge affecting individuals of all ages. While over two-thirds of adults in the United States take prescription medications regularly, many struggle with the physical and psychological barriers associated with swallowing tablets and capsules. These difficulties are especially pronounced among older adults, who may experience dry mouth or suffer from neurological conditions such as Parkinson’s disease or Multiple Sclerosis. Additionally, children and individuals with phagophobia often experience anxiety when taking oral medication, posing risks to their health and adding stress for caregivers and parents. Despite the widespread need for daily

medication or supplements, there remains a lack of convenient, portable solutions to assist those who find pill swallowing difficult. This problem is particularly pressing for active individuals who need easy access to their medications while on the go. Addressing this issue is essential for improving medication adherence, reducing anxiety, and promoting better health outcomes.

### ***CURRENT STATE OF THE ART***

#### 1. Pill Box Cup Organizer with Water Bottle – Shengmeiying



Figure 1 - Water Bottle with Pill Storage

The product is a water bottle with seven-day pill storage by Shengmeiying. It comes in multiple colors and claims to be completely leak proof. Fits a total of 4 large vitamins, 6 regular capsules, and 15 small pills. The liquid storage amount is 600 mL or about 20 ounces. The price per unit is \$4.99, which was found on Amazon.com.

Pros:

- 7 Day pill storage
- Stores 600 mL of liquid

- Separatable for easy cleaning
- Cheap price of \$4.99

Cons:

- Can only store 2-3 pills per day
- No pill crushing ability
- No handle
- Medium amount of water storage
- No Loop or lanyard
- Generic Plastic material
- Plastic

## 2. E-Pill Smart Water Bottle – e-Pill



Figure 2 - Smart Water Bottle with Pill Storage

This smart water bottle has pill storage in the lower unit of the bottle. The time and timer can

be set to never miss a dosage. Able to store cold or warm liquids with its double walled stainless-steel walls. The liquid storage is 12 oz and can store up to 42 Aspirin sized pills.

The price is \$49.95 per water bottle.

Pros:

- Made from stainless steel
- Multiple alarms for different dosages
- Comes with type-C charging chord
- Moderate pill storage

Cons

- Customers state that alarms are too loud (2)
- Only 12 oz of liquid storage
- Requires charging routinely and does not come with charging block
- Customers state that compartments store only a few pills (2)
- Expensive
- No pill crushing ability

### 3. Ezy Dose Pill Crusher – Ezy Dose



Figure 3 - Pill Crusher with Cup

This product from Ezy Dose crushes pills into a powder. It comes in multiple colors and claims to have a built-in drinking cup for taking medicines on the go. It can hold up to 4 pills and is easy to use. The price of this unit is \$8.99.

Pros:

- Crushes pills
- Has a portable cup for taking pills

Cons:

- No liquid storage
- Made of plastic
- Can only store 4 pills
- Customers claim it leaves chunks of pills (3)
- Customers state that it doesn't work well on bigger pills (3)

## ***END USER***

The PC Bottle is designed for anyone who takes daily supplements or medications. Its primary goal is to reduce the inconvenience of carrying multiple pill bottles while at the gym, at work, or running daily errands. The target demographic includes active, on-the-go individuals who may not always be home to take their medications, as well as those who face difficulties swallowing pills, such as individuals with Phagophobia. The PC Bottle's compact and user-friendly design makes it an ideal solution for anyone seeking a convenient and portable way to manage their medication or supplement routine.

## ***CONCLUSIONS AND SUMMARY OF RESEARCH***

Based on my research, tablets have been used since ancient times, and with advancements in technology, the production and use of pills have increased significantly. However, this presents a challenge for many people, especially since some tablets can be quite large and difficult to swallow. Individuals suffering from Phagophobia, a fear of swallowing, often struggle with taking pills and require alternative solutions. The PC Bottle, designed with an integrated pill crusher and storage compartment, addresses this need by simplifying the process of medication intake. Whether you're a first-time parent administering medicine to a child or someone managing daily medication, the PC Bottle offers a hassle-free, worry-free solution for taking medication and supplements regularly.

## CUSTOMER FEATURES

I conducted a survey asking the public what features they would like to see in the PC Bottle. I received 66 responses, many of whom have taken pills long term or know someone that does. The list below is the customer features and their average importance out of 5.

Customer Features	Average Score
Cheap	1.9
Pill Storage	2.2
Big Liquid Storage	3.2
Versatility	4.4
Ergonomic	2.4
Hands Free Carry	2.2
Ease of Use	2.7
Storage of Hot and Cold	2.6

Table 1 - Customer Feature Rankings from Survey

## PRODUCT OBJECTIVES

The engineering characteristics listed below have been ranked according to their importance, as determined by the analysis conducted using the house of quality. The house of quality allows for a systematic evaluation of each characteristic's impact on meeting customer requirements, ensuring that the most critical aspects are addressed first in the design process. The lines with numbers are the engineering characteristics and the bullet points are how each characteristic will be achieved.

1. Handle (15.0%)

- Multiple prototypes will be made to ensure the best one is selected.
- 2. Cost of Production (14.7%)
  - Explore various avenues for production capabilities.
- 3. Universal Base (14.3%)
  - A smaller base will be designed to allow for most cup holders.
- 4. Pill Organizer (13.5%)
  - A pill organizer will be prototyped with different storage configurations.
- 5. Textured Surfaces (9.4%)
  - Textured surfaces will be explored to increase the ergonomics of the bottle
- 6. Size of Bottle (8.3%)
  - Liquid will be measured in ounces and total dimensions of the bottle will be considered.
- 7. Straw (6.4%)
  - A straw will be experimented with to improve the ease of use.
- 8. Durable (6.0%)
  - Different materials will be researched to find the best material to cost ratio.

## **QUALITY FUNCTION DEPLOYMENT**

### **Engineering Characteristics**

Using the data from the survey, I determined the following engineering characteristics

- Handle
- Cost of Production (\$)
- Universal Base (inches diameter)



## **DESIGN**

### **Concept 1 – Chosen Concept**

There are several innovative ways to combine a pill crusher, water bottle, and pill storage container into a single, functional device. The model shown below features a simple and efficient system for dissolving and consuming a crushed pill.

To use the device, the top lid twists to activate the grinding mechanism, which crushes the pill into a fine powder between two ribbed surfaces. When ready to take the medication, the user aligns the top straw with the check valve located on the right side of the device. This setup allows water to flow through a one-way valve and into the grinding chamber to pick up the sediment carrying the powdered medication for easy consumption.

After the dose has been taken, the lid can be rotated again to align the top straw with the left-side straw. This bypasses the grinding chamber and transforms the device into a regular water bottle, enabling the user to drink normally. This seamless transition between medication and hydration makes the design both convenient and practical, especially for individuals with active lifestyles.

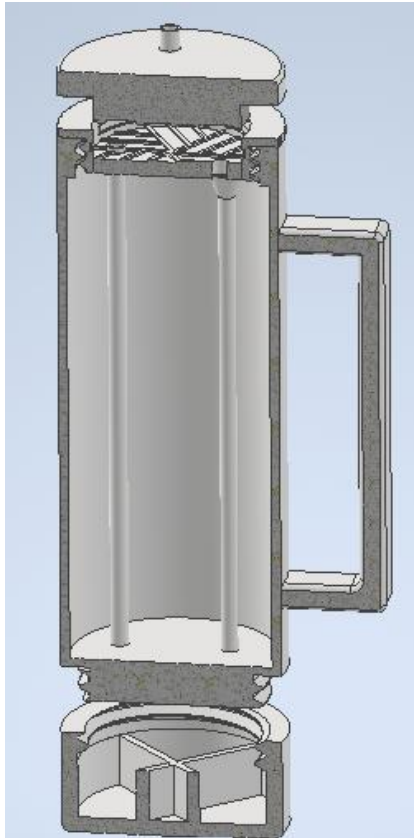


Figure 5 - Exploded View of Concept

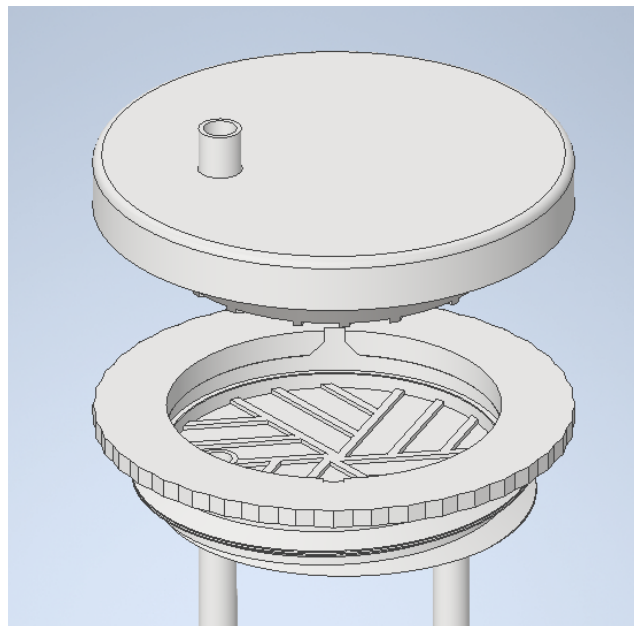


Figure 6 - Close Up View of Grinding Assembly and Lid

## **Concept 2**

This concept incorporates a modern take on the traditional mortar and pestle design to crush pills with ease and efficiency. The mortar is threaded internally, allowing it to screw securely into the bottom of the water bottle. At the base of the mortar bowl, a small hole funnels the crushed powder directly into a detachable shot glass that screws into the bottom of the mortar. The pestle is conveniently stored inside the bowl portion when not in use, keeping all components compact and organized.

To take a dose, the user begins by retrieving pills from the storage compartment located at the top of the bottle. The pills are then crushed using the mortar and pestle. A small amount of water is poured into the mortar, which mixes with the powdered medication and flows into the shot glass below. The user can then unscrew the shot glass to take the dose as a quick sip. Afterward, both the shot glass and the mortar and pestle can be reattached to the bottom of the bottle, allowing it to function like a regular water bottle once again.

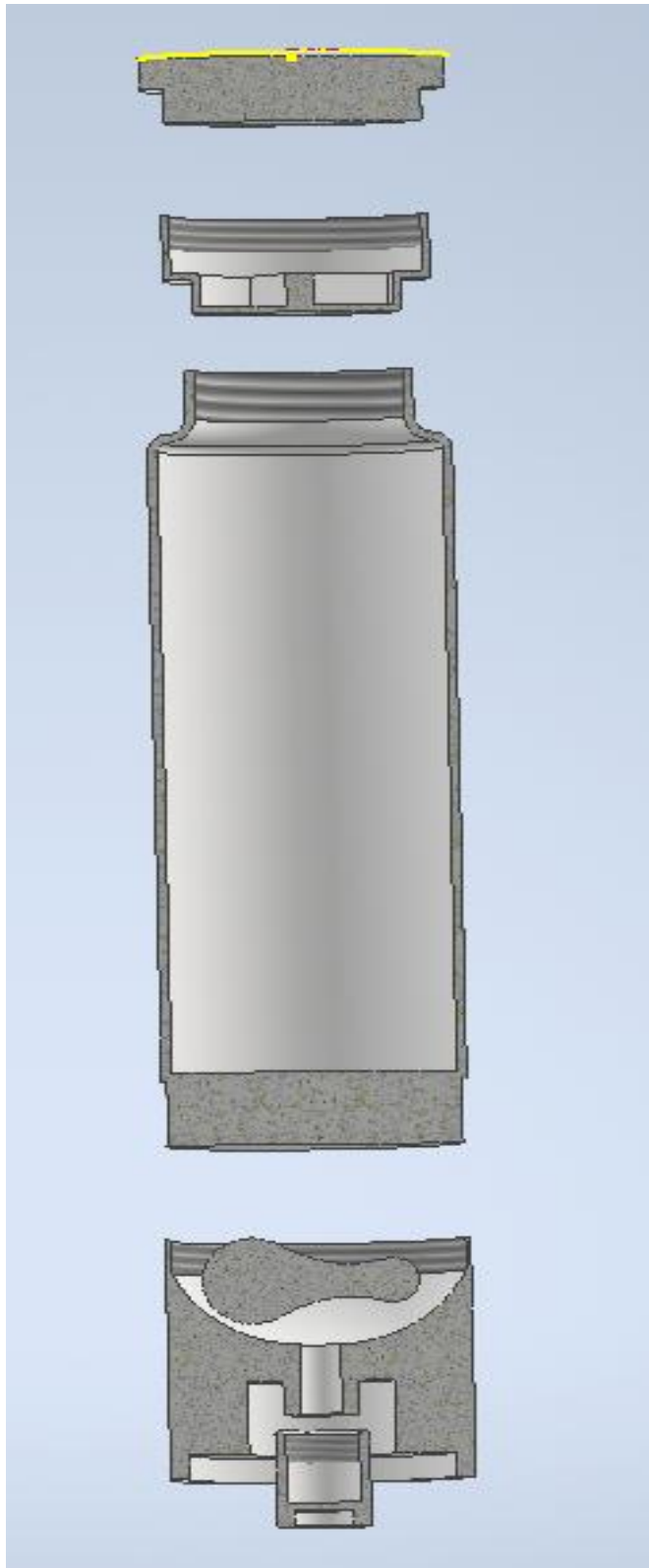


Figure 7 - Mortar and Pestle Inspired Bottle

### **Concept 3**

The final design utilizes a plunger mechanism to crush the pill using pressure differentials. The base of the bottle is twistable, and when fully tightened, it seals the bottom of the straw. To begin the process, retrieve the pill from the storage compartment located at the bottom of the bottle. Unscrew the plunger from the straw and drop the pill inside. Reinsert the plunger into the straw and twist the base until fully secured—this aligns an internal boss to cap the end of the straw, creating a sealed chamber.

To crush the pill, pull the plunger upward to create a vacuum chamber, then release it. The resulting pressure difference crushes the pill effectively inside the straw. Once crushed, slightly unscrew the base to allow water to flow back into the chamber for mixing. The user can then consume the dose through the straw.

After taking the medication, the plunger can be screwed back into place to reseal the straw. The bottle can now function as a typical drink container, similar to a coffee cup, with the user drinking from a separate opening on the lid.

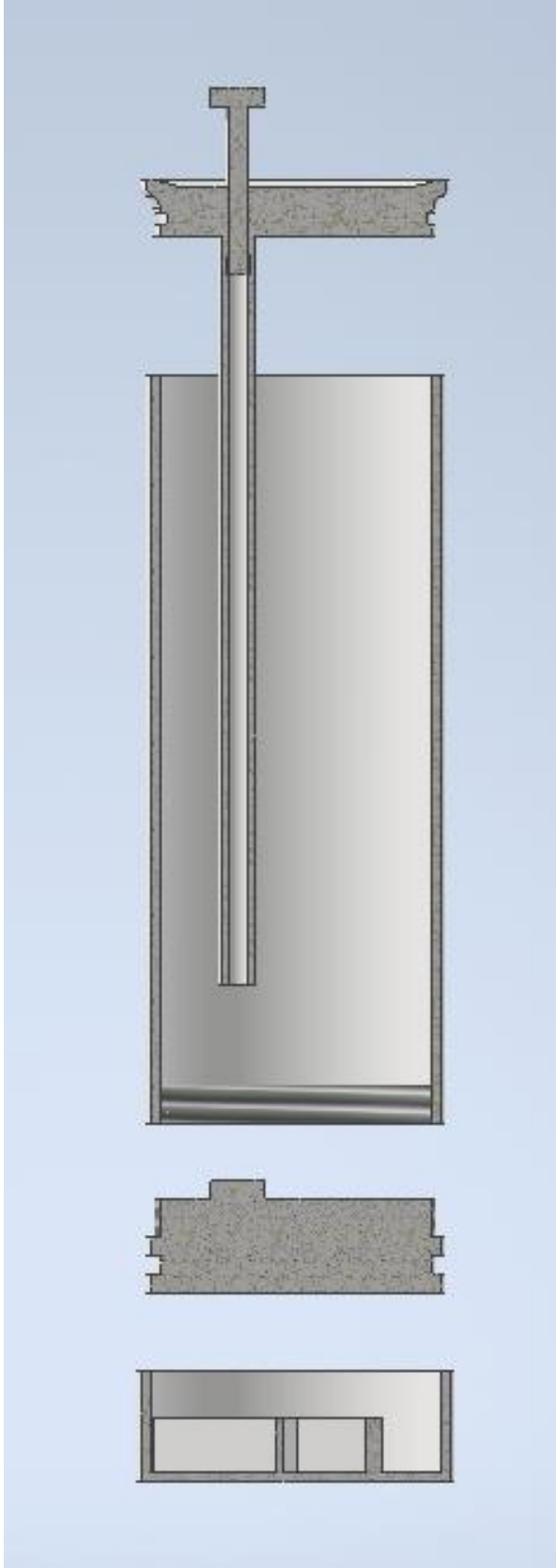


Figure 8 - Concept Design 3

# MANUFACTURING THE PC BOTTLE

All components of the PC Bottle were printed out of a food grade PETG plastic material. The PETG was for \$34.99. The material certification is listed below in figure 8.



**Test Report No. 70.400.22.2592.01-00.01**  
**Rev.00**  
**Dated 2022-09-20**

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Applicant: COMFY MATERIALS  
Address: Tampa, Florida, USA  
Sample Description: PLA pro, PETG pro  
Tested Model No.: 1.75mm  
Additional Model No.: 2.85mm/3.0mm  
Sample Received Date: 2022-09-01  
Test Period: From 2022-09-01 to 2022-09-16  
Purpose of examination: As specified by client, to test as regulated by the  
- U.S. F.D.A. C.F.R. 21

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch  
TÜV SÜD Group

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Designated Reviewer

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Figure 9 - Food Grade PETG Material Certification

All components were printed using the Prusa slicer software and printed on the Creality Ender 3 V1 printer. The printer is shown below. This machine was purchased on Amazon.com.



Figure 10 - Ender 3 V1 3D Printer

## PROJECT MANAGEMENT

### *BUDGET, PROPOSED/ACTUAL*

To reduce the overall cost of designing a state-of-the-art water bottle, I plan to implement several cost-saving strategies. The primary method will be prototyping through additive manufacturing, specifically using a 3D printer. Since I have access to a personal 3D printer, this approach will significantly lower production expenses during the development phase. My final product will be a fully functional prototype that demonstrates the features and usability of the PC Water Bottle. As such, my budget will be based solely on the costs associated with producing this prototype.

Part	Proposed Price	Actual Price
3D Printer Filament	\$36.99	\$58.98
Reusable Straw	\$12.99	\$0.00
Handle	\$6.99	\$0.00
Miscellaneous	\$20.00	\$9.99
Total	\$76.97	\$68.98

Table 2 - Proposed Budget vs Actual Budget

The actual price of materials ended up becoming cheaper after I decided to print my straw and handle instead of buying premade products. I did have to have buy a second roll of 3D filament for test samples which is why the filament cost is higher than I had projected.

*SCHEDULE, PROPOSED /ACTUAL*

The project progressed smoothly overall, and I was able to stay on schedule throughout the development process. The only notable challenges arose during the 3D printing phase. I discovered that the printed components did not match the exact dimensions specified in the CAD models. This required some trial and error to determine the appropriate tolerances for each part. Through this iterative process, I was able to adjust the designs accordingly and achieve proper fit and functionality across all components.

Task	Proposed Date	Actual Date
Problem Statement	9/6/2024	9/6/2024
Background Complete	9/13/2024	9/13/2024
Research Complete	9/13/2024	9/13/2024
Quality Function Deployment	9/27/2024	9/27/2024
Design Proposal	10/11/2024	10/11/2024
Choose Concept Design	11/1/2024	11/1/2024
Order Straw, Filament, and Handle	11/1/2024	11/1/2024
Start Printing	12/1/2024	12/1/2024
Assembly	2/1/2025	3/25/2025
Final Look Over and Testing	2/15/2025	4/1/2025
CEAS Expo	4/8/2025	4/8/2025
Final Senior Design Report	4/25/2025	4/14/2025

Table 3 - Proposed Schedule vs. Actual Schedule

### ***PLAN TO FINISH***

My plan for completing this product includes designing and implementing a sealing component between the top and bottom sections of the grinder to ensure a secure and leak-proof connection. Once the final prototype is complete, I intend to pursue a patent for the design to protect the intellectual property. Long-term, my goal is to bring this product to market by partnering with a manufacturing company capable of producing the water bottle in metal, enhancing both durability and aesthetic appeal. I plan to begin distribution through online platforms and eventually expand into retail stores.

### ***SUSTAINABILITY AND MATERIAL USAGE***

Material usage could have been reduced if I had printed smaller test pieces to calibrate my printer, rather than reprinting full components during the trial-and-error phase. To keep initial costs low, I printed all parts using PLA filament first, which is more affordable than food-grade PETG. This allowed me to refine the designs before committing to more expensive materials. Overall, the project generated minimal waste and was completed with efficient use of resources.

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