Candy Dispenser

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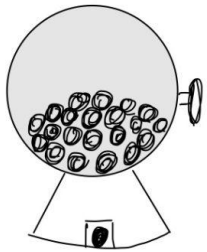
ME102 Photo Essay

My Interpretation of The Prompt

> Use the **sketching**, **prototyping**, **CAD**, and **digital fabrication techniques** that you have been practicing this quarter to enable you to design, prototype, CAD, and digitally fabricate a **mechanical desktop candy dispenser**.

— Final Project: Artificial Candy Dispenser Document



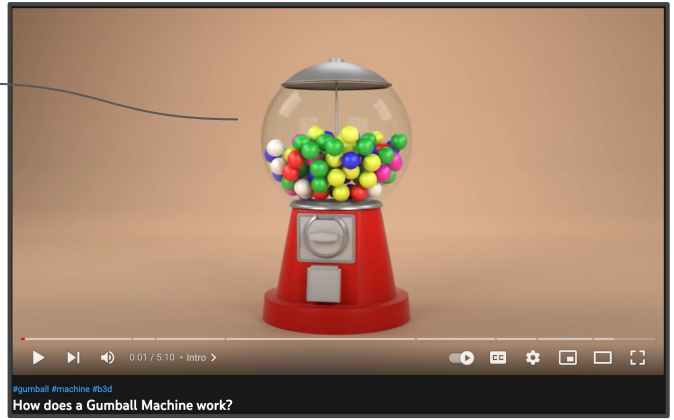
This project reminds me of a gumball dispenser I used to have as a child.

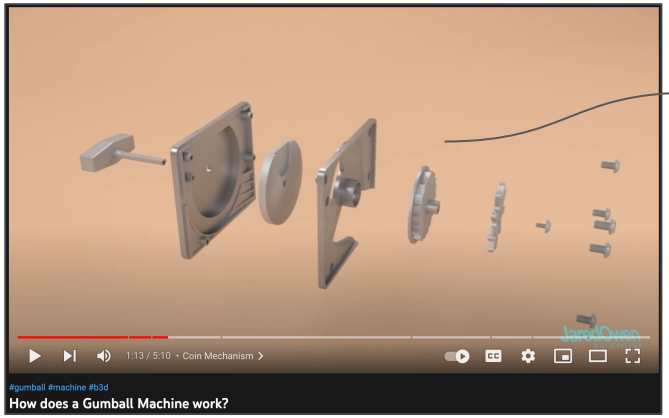
ME102: Final Project

- Must use a mechanism
  - Ratchet & Pawl
  - Cam & Follower
  - Crank & Slider
- Fun
  - Mechanism must be exciting to make for me
  - Could include a game element to dispensing candies.

Research of Existing Mechanisms: Gumball Machine

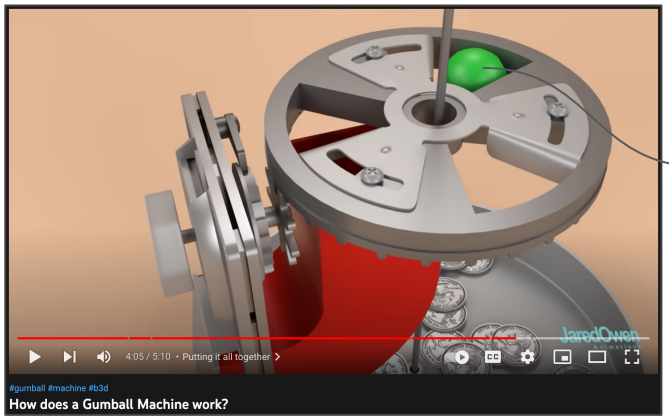
Transparent gumball **storage** department





Exploded view of how mechanism fits together; includes **coin slot** and **coin dump**

Ratchet & Pawl Mechanism to **prevent backwards movement** of the crank



Gumball **collection** is shown using **slots** to catch just **one single gumball**

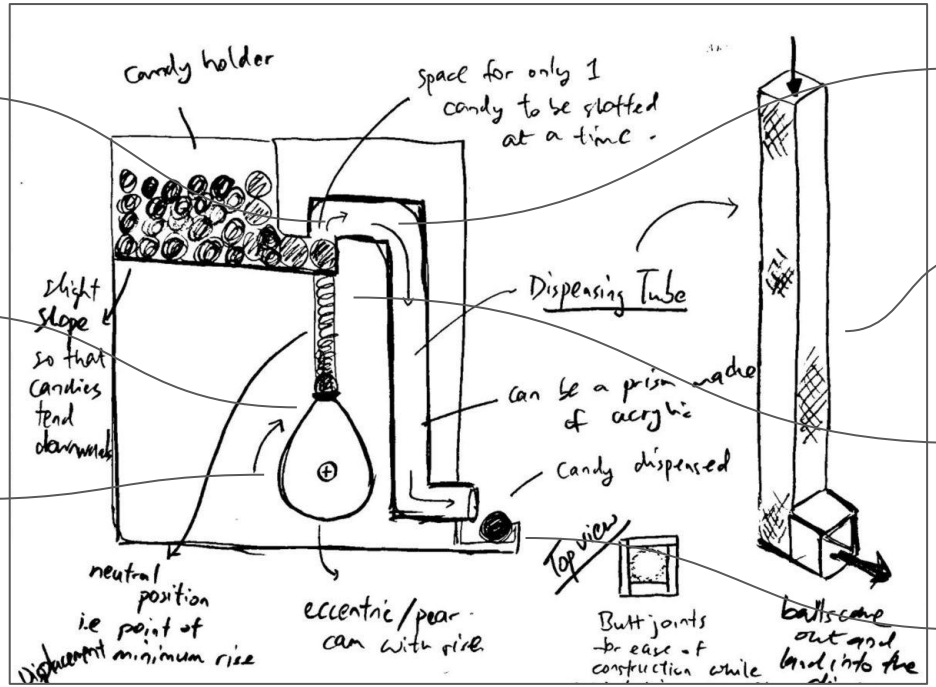
https://bit.ly/3xiyRoK

Concept Sketches: Cam and Follower Mechanism

Could run into the **issue** of a ball just being popped up and **falling straight back down.**

Really **interesting** and **unique mechanism** to build for the given task

Pear cam/eccentric **cam** can be **laser cut** or **3D printed** but **smoothness** needs to be taken into account so the **follower rotates smoothly**



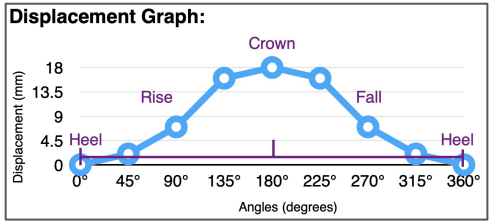
Simple solution to dispense one candy at a time. However, can be **difficult to make precise**

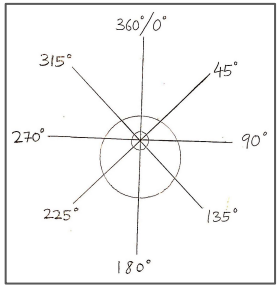
Cylindrical shape would be better since the **candies are round**

Spring does **not** have a **clear function**. **Cannot reset** the mechanism with this structure in place

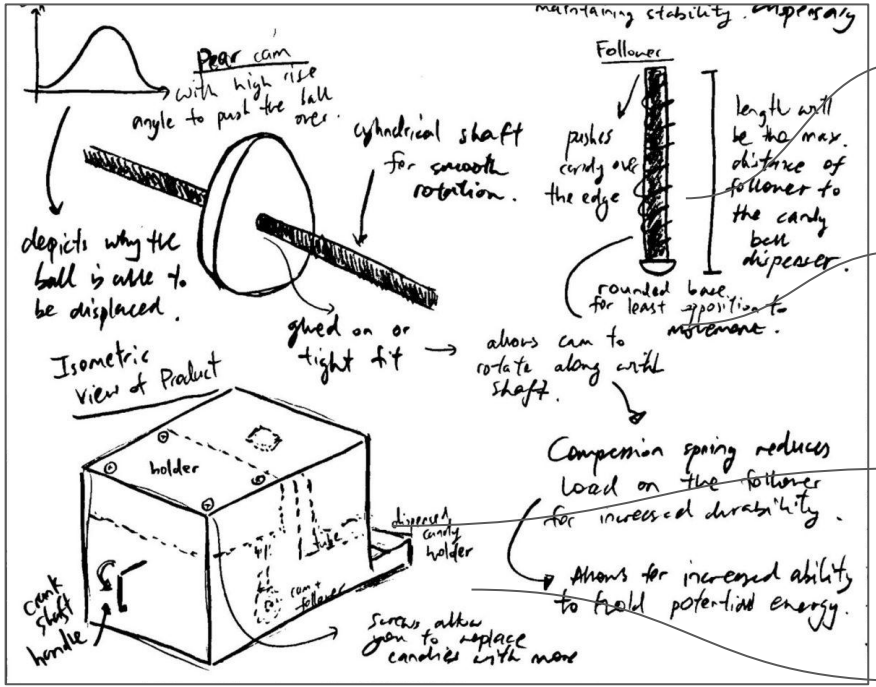
Use of **dish** to **collect candies** as they are dispensed by the user

Concept Sketches: Cam and Follower Mechanism





Eccentric cam displacement graph and model to show how a candy can be **moved upwards** solely by **rotary motion** of the **cam.** I **created** the **eccentric cam** above using **Fusion 360**



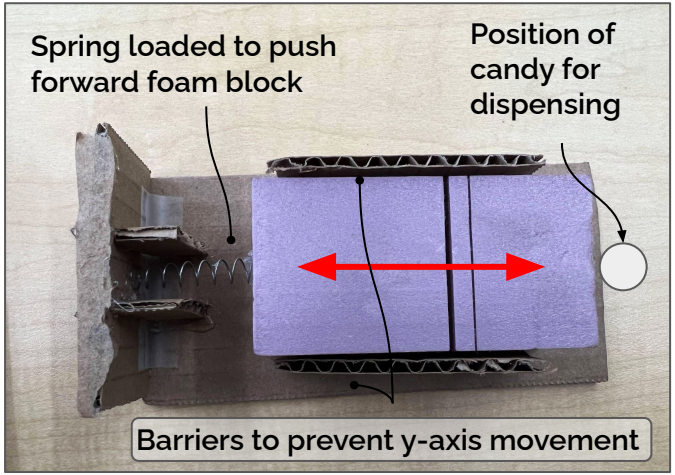
Spring should actually be placed on the **side** of the box for **linear extension** and then a **snapback reset motion**

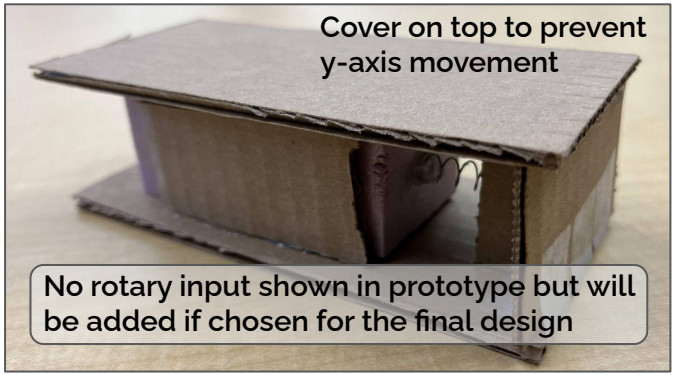
Follower head is **smooth** for **reduced friction** and **smoother motion around cam**

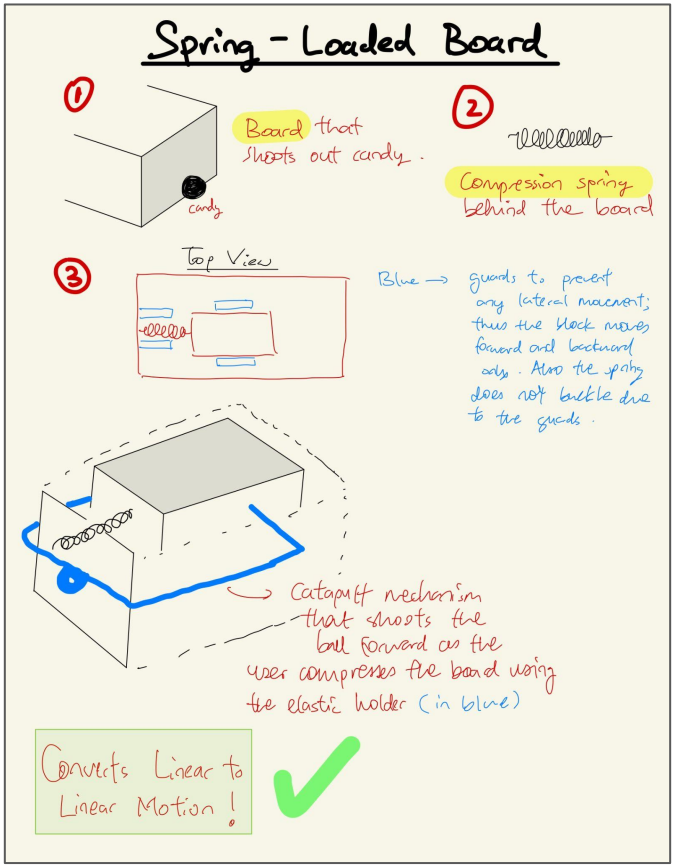
Housing is **slightly large** given the **structure and placement of the subsystems** and **nature of** the cam and follower **mechanism**

Use of **dish** to **collect candies** as they are dispensed by the user

Rapid Prototype 1: Crank and Slider







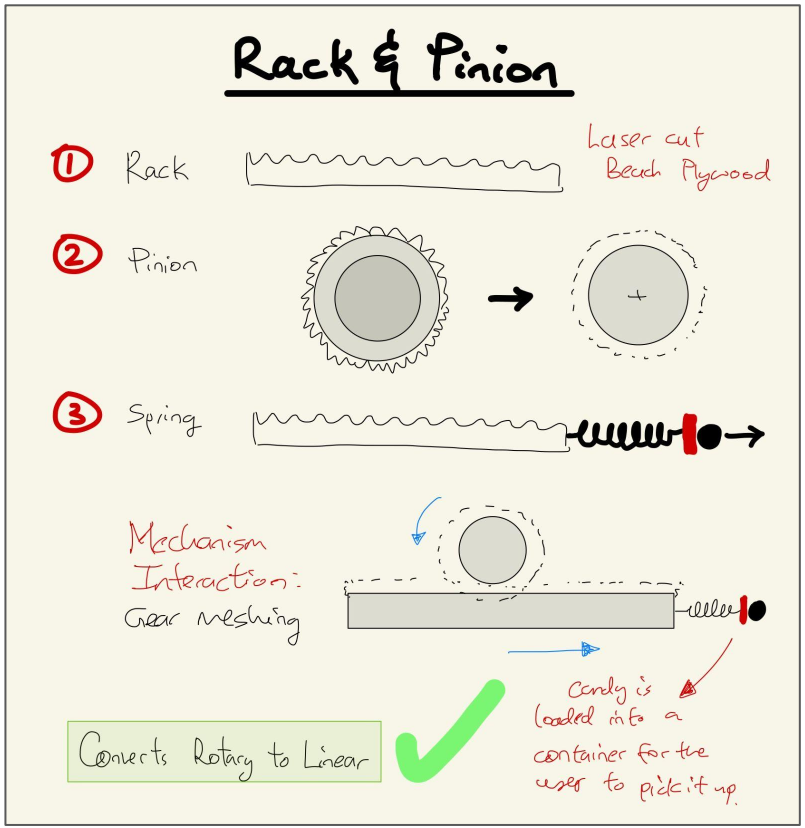
Advantages

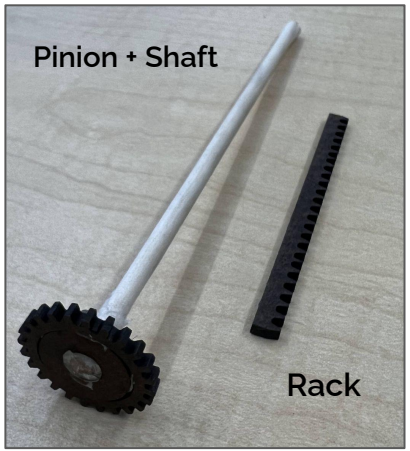
- Quite a **dynamic mechanism** for the push of the candy as it is dispensed with a **large force**
- **Converts rotary to linear motion** which is **interesting** to design
- **Compression spring** has a defined **purpose**

Disadvantages

- Design was **intended** to convert **linear to linear** motion but this **does not meet** the **specifications** of the given task
- Very **large surface area of block** with **no clear** mechanism for dispensing **just one** candy

Rapid Prototype 2: Rack and Pinion



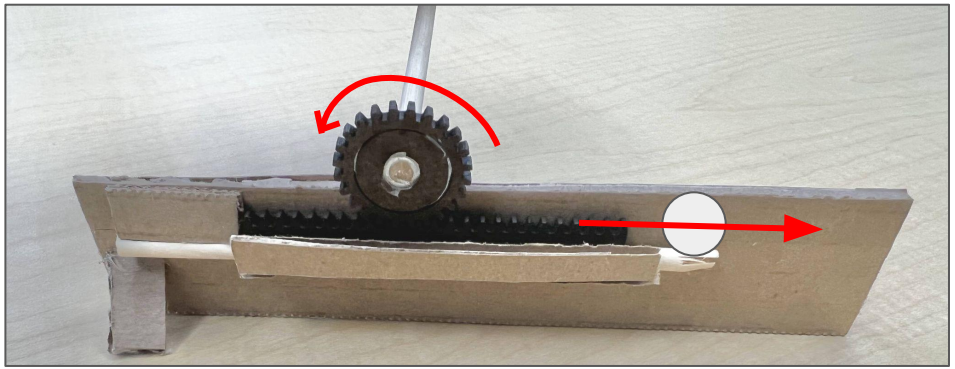


Advantages

- **Successfully** converts **rotary to linear** motion
- **Simple** mechanism that can be **laser cut**
- Utilises **compression spring** well

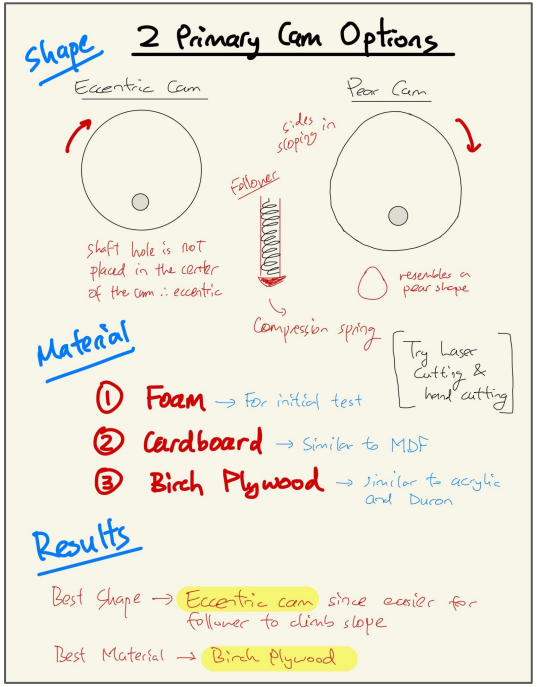
Disadvantages

- Moves quite **slowly** as there is **less mechanical advantage** but a **crank** can fix this
- Slightly **mundane** mechanism to make in my opinion

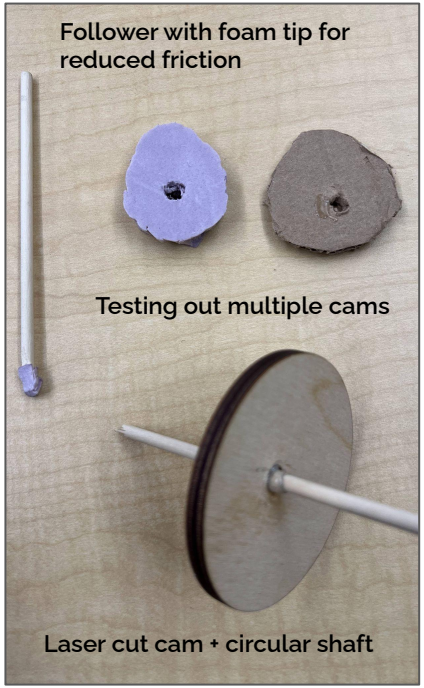


Rapid Prototype 3: Cam and Follower

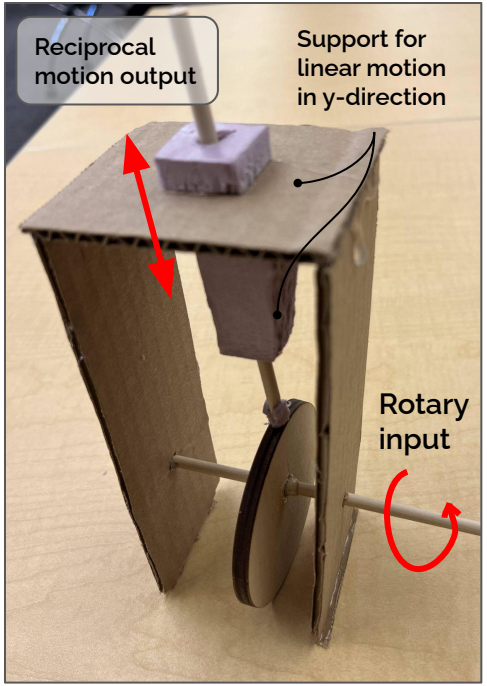
Concept Sketches



Parts Tested



All put together



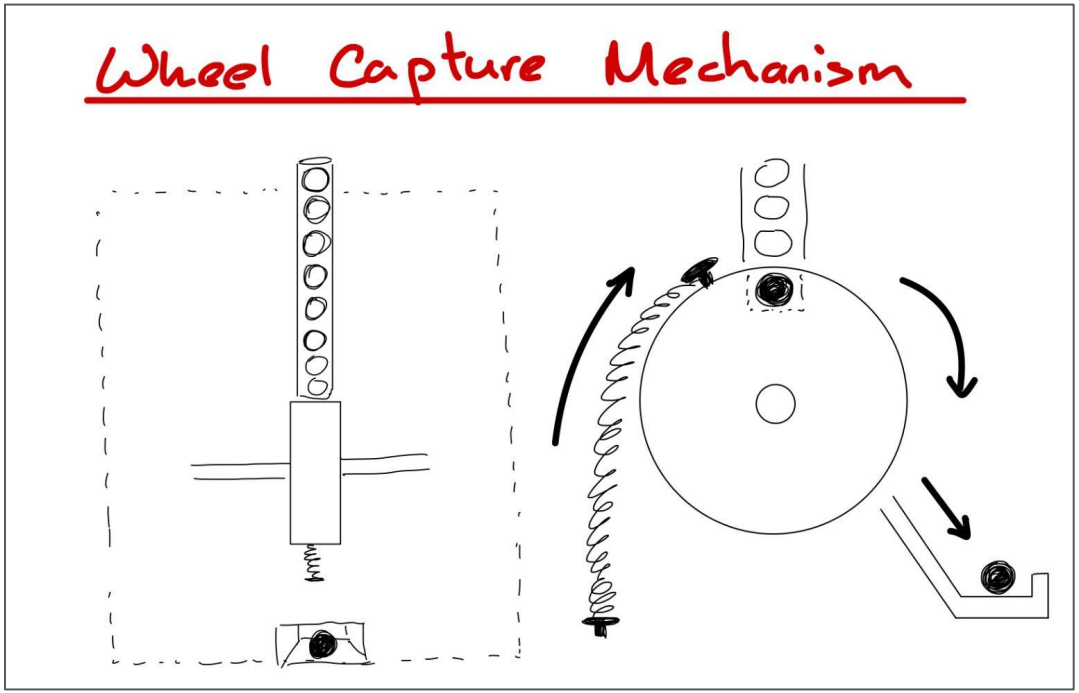
Advantages

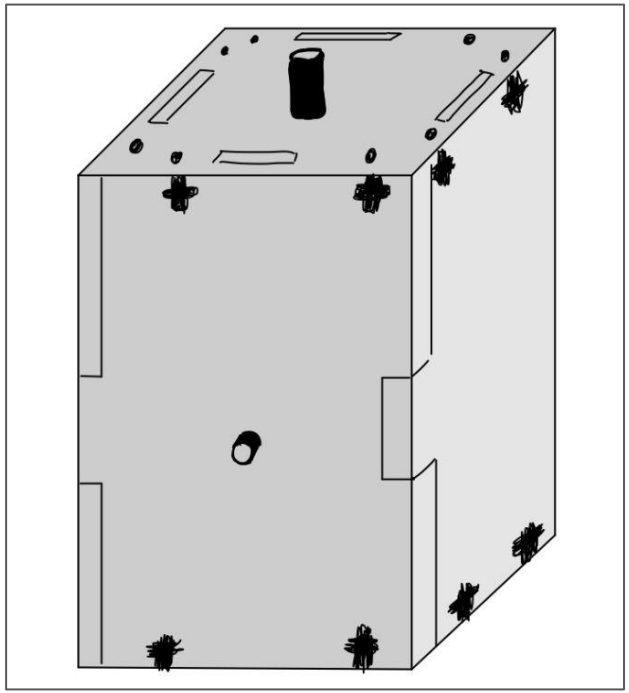
- **Unique** and **interesting** mechanism
- Can use both **3D printing** or **laser cutting** to make the cam

Disadvantages

- **No** clear **purpose** of **spring--does not reset**
- **Difficult** to make the motion **precise** and **consistent** such that it dispenses just **one candy**
- **Difficult to position hardstops** and **spring** and keep **follower around the cam**

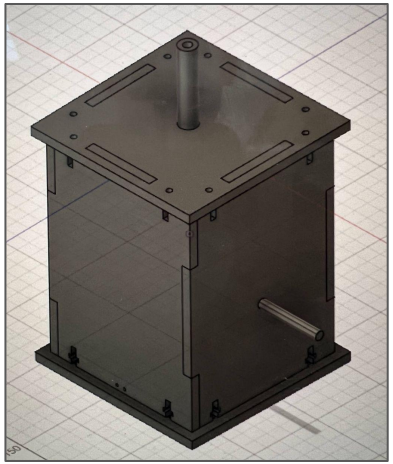
Chosen Design





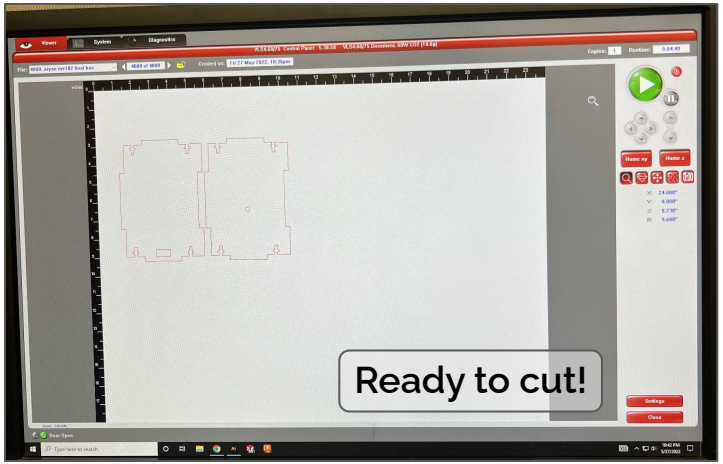
Rapid prototyping **helped** a lot but I was **not fully convinced** by the ideas I came up with. So after **brainstorming** more, I chose this idea because of its **simplicity**, the fact that making this **mechanism** is **exciting** to me, and the **combined** use of **spring**, **pipe**, and **slide** is **interesting** to design while also **challenging** me. After **prototyping**, I know what **materials**, **shapes**, and **sizes** work best. This design will require 3D printing and laser cutting both.x

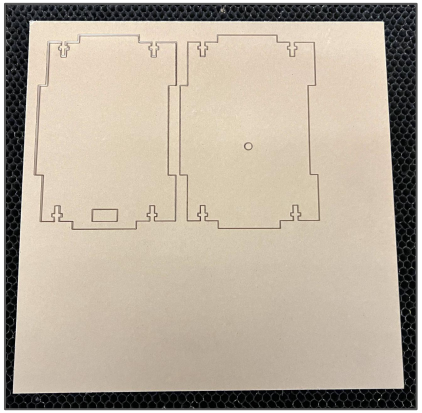
Making the Final Product: Box

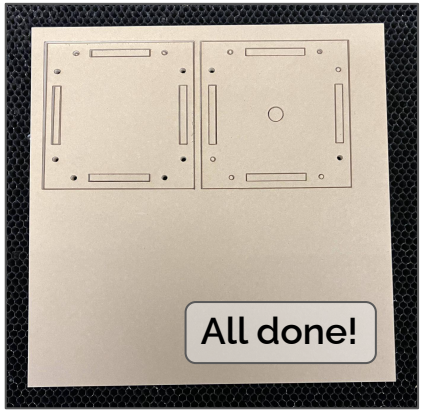


Fusion model -> **laser cut**

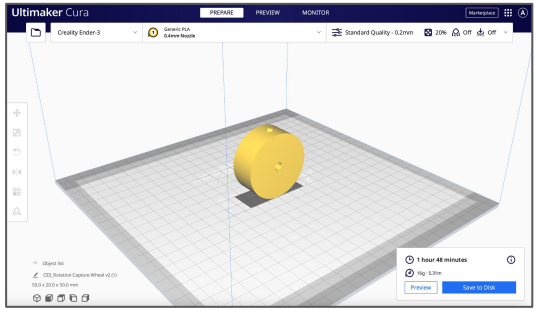
Laser cutter user guide







Making the Final Product: Collection Wheel



Loading onto **Cura** to 3D print ~ 2hrs

Failed 3D print of the hole!

Photo of me **3D printing** again!

Printing once more **worked**––I made sure the **orientation** on **Cura** was completely **perfect**

Making the Final Product: Pipe

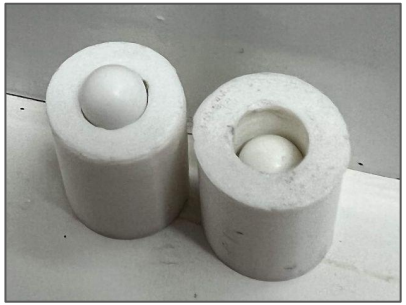
3D printed pipe using **Ender 3** Printer at home! Took ~ **1.25 hrs**

3D printed pipe but it's **too small!** I realise I should have done **test prints** beforehand to **make sure** that the hole was **large enough** and I accounted for the **filament width**.

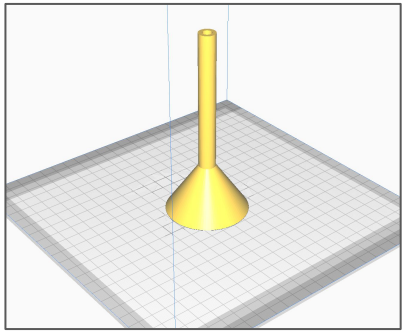
I used **two** main methods to try and **fix** this for the prototype. Firstly, I tried **widening** it by twisting a **0.25" handscrew through the hole** but that **did not work**. Then I fed the **hot wire foam cutter wire** through the hole and tried to **burn off the inside edges** but that made the hole **too rough** and **no candies could fit.** I had to reprint!

Making the Final Product: Pipe with Funnel

Feedback during one-on-one: Use a funnel so that you do not have to place each candy inside one after the other!



This time, I did **test prints** to make sure my **final funnel** would **fit** the **candies.** I decided that 0.272" worked best then loaded it into **Cura**!



This is the **Cura** file of the funnel and it takes about **3 hours** to print since the **base** is quite **large** along with the **height** of the pipe. I used **20% infill** so it is **sturdy** and will **not break easily**.

Pipe with **funnel on top** so candies can be **loaded easily**. Fits **over 20 candies** with ease! It **does not require any tapping** to make sure the candies fall straight down the pipe.

Note: The photo **above** on the **right** was taken **midway** as a candy **fell down the hole**; the candy is **not stuck**!

Making the Final Product: Wheel and Spring

I used a **wooden circular dowel** since there were **no more metal d-shafts** left in the **room 36** at the time. However, one **issue** was that the **wheel** often would **rotate along** with the **shaft**.

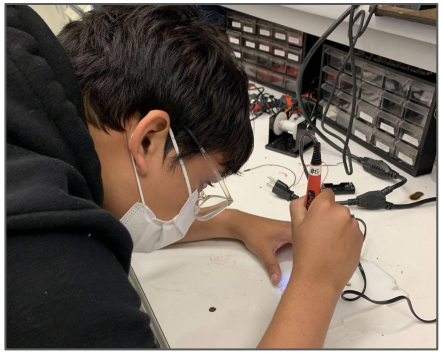
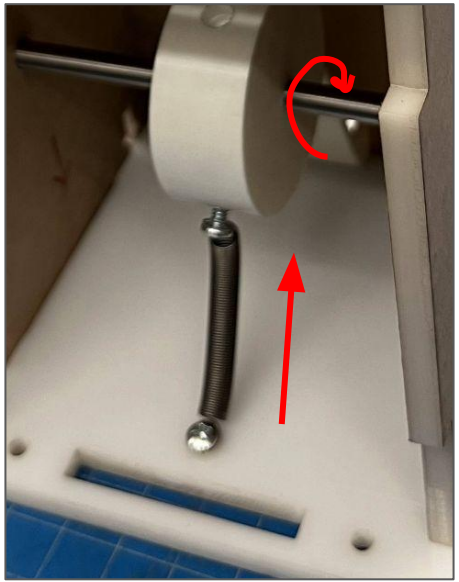
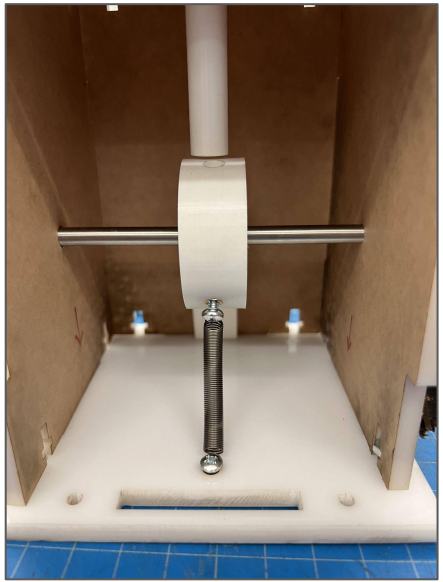


Photo of me heat setting! I used a **6-32 brass knurled nut** and a **1/2" 6-32 screw**. **Issue: spring rotates** around the wheel i.e **non-linearly** at the **maximum point of extension.**

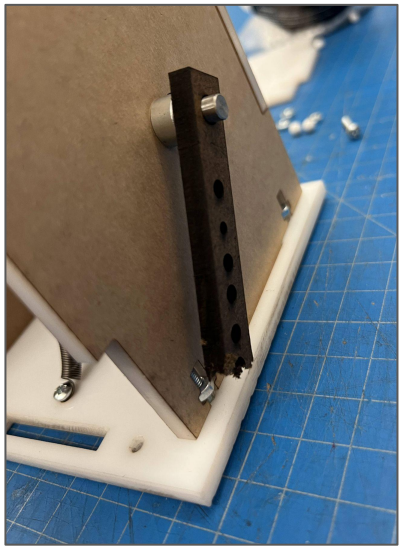


As the **wheel rotates forwards**, the **extension spring** is **pulled** till the point of the heat set **screw** on the wheel (this acts as a **hardstop** as well) and **snaps back** to the **original position**.

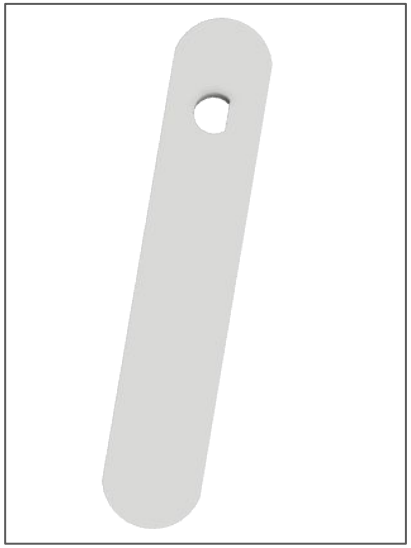


I was able to get a **metal d-shaft**! The box is a lot more well-put together now. The wheel is very **tight-fit** (I used **soft hammer blows** to get it to fit) on the shaft so it will **not rotate** at all.

Making the Final Product: Crank and Shaft



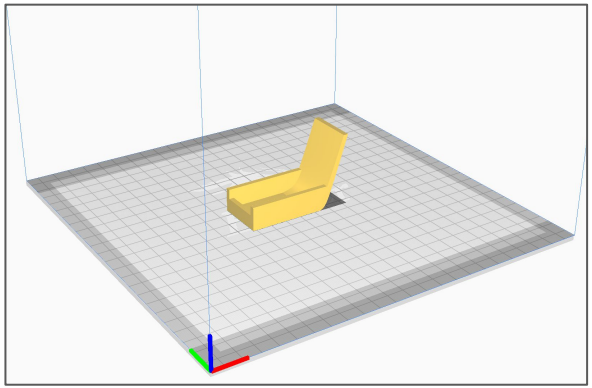
I did some **test holes** on a piece of **scrap Duron** to see what size **d-shaft hole** would work for my crank since it is **not** just a **regular 0.25" circular hole.**



I created my crank model in **Fusion** because the best method to create it would be to laser cut some acrylic.

Crank is **supported** by **shaft collars** on **either side** to **prevent movement along** the **shaft**

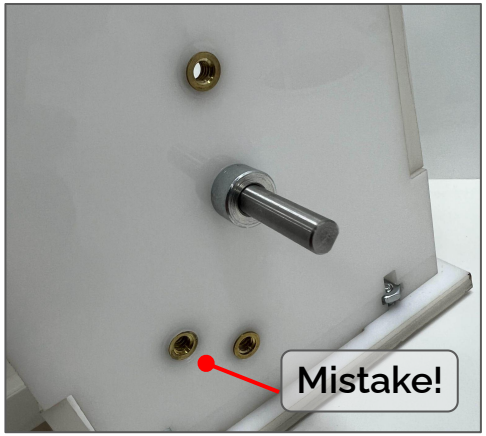
Making the Final Product: Slide



Initially, the slide I designed **did not have enough clearance** for your fingers to fit through and pick up a candy. This was a **problem** as the main point is for the user to get a candy but that was **not happening**. Hence, I printed a **new slide** that is **wider** and **recut** the **box panel** to fit this **new** slide. After loading it into **Cura**, the **print** took **~1.5 hours** to complete **successfully**.

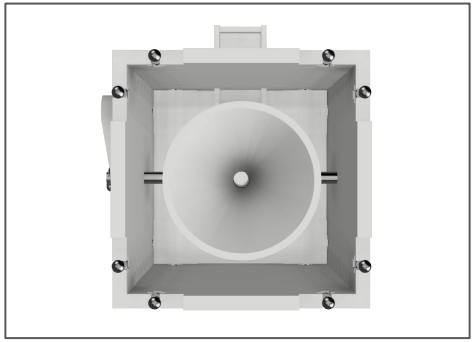
The **newly printed slide** has **just enough** space for the user to take out a candy with **ease**. As the wheel is **rotated**, the candy **falls** down the **slide** and **into the container** outside for the user to take out!

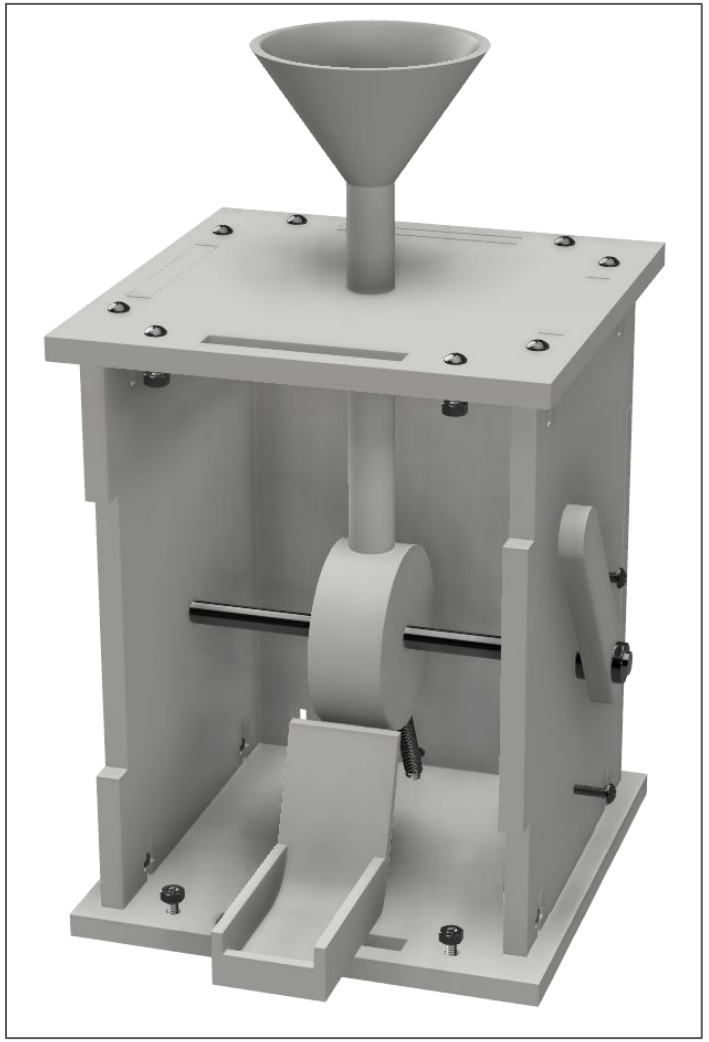
Making the Final Product: Hardstops



I initially made a **mistake** on the **position** of the **bottom hardstop** (as seen in the first image), but I made a **new heat insert to rectify this**. The **spring** is **preloaded** already and the **bottom hardstop** prevents it from **overextending** as the **crank** will **hit** the **screw** to **stop movement**.

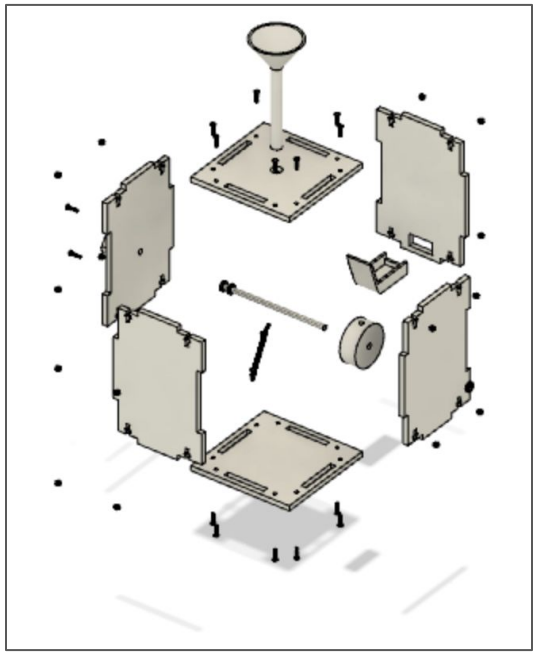
CAD Fusion Model



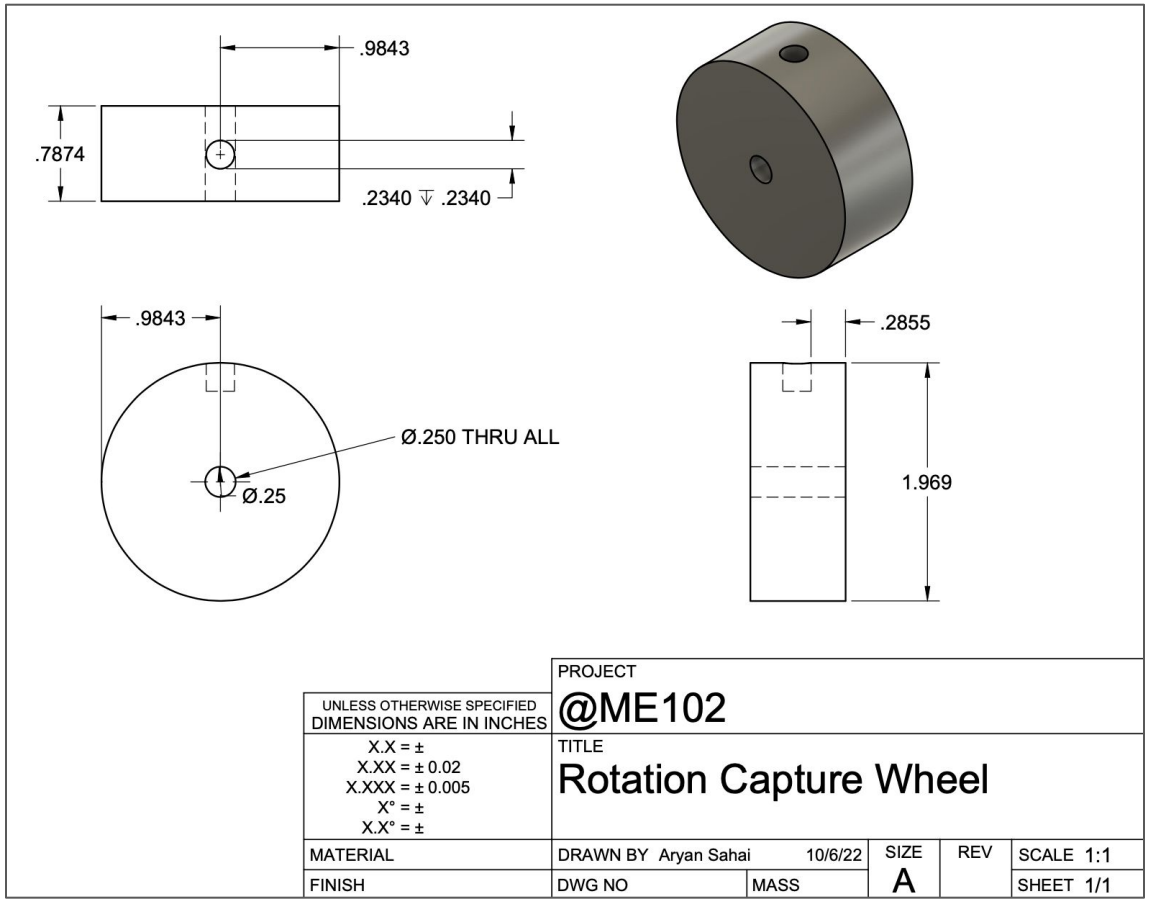


Engineering Drawing: Exploded View

Note: Due to issues with Fusion 360 that are beyond my control, I cannot complete this component fully. Although, I have created exploded views and BOM successfully in the past in Homework 9. Professor Edmark has noted that I can submit this component without penalty. Below is a screenshot of what I was able to create (all I needed to do was “drawing->from animation” but I was unable to do so due to Fusion issues):



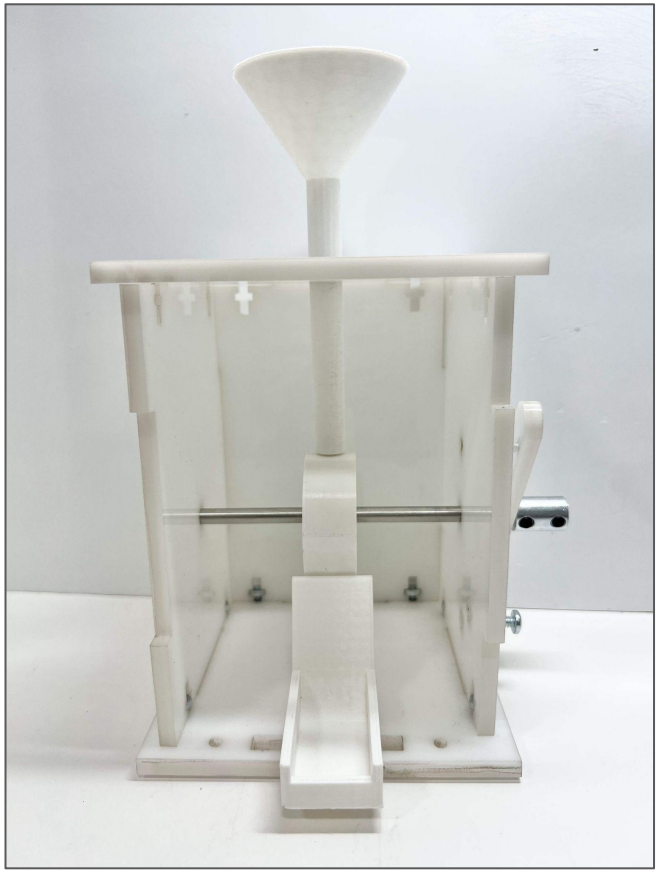
Engineering Drawing: Collection Wheel

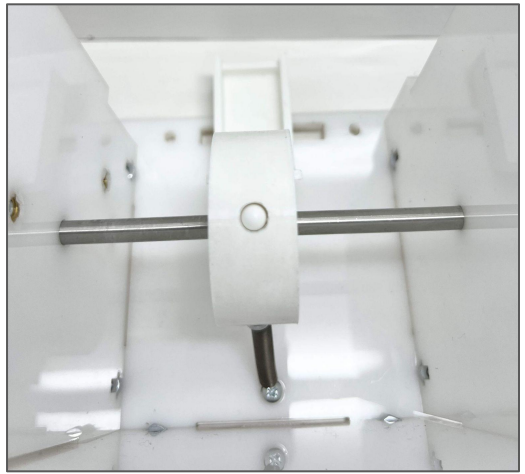


Bill of Materials

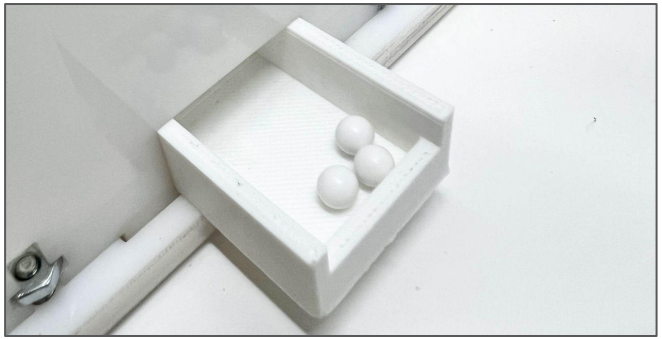
Quantity	Part Number	Description	Unit Cost	Cost
18	90272A148	6-32 x ½" Zinc-Plated Steel Pan Head Phillips Screw	$0.03	$0.54
2	90272A245	10-24 ¾" Zinc-Plated Steel Pan Head Phillips Screw	$0.06	$0.12
16	90480A007	6-32 Low-Strength Steel Hex Nut	$0.02	$0.32
2	8505K754	Cast Acrylic Sheet 12" x 12" x 1/4"	$4	$8
2	90272A245	10-24 ¾" Zinc-Plated Steel Pan Head Phillips Screw	$0.06	$0.12
3	9961K17	½" Zinc-plated Carbon Steel Clamping Shaft Collar	$5.05	$15.2
2	93365A240	10-32 Tapered Brass Heat-Set Inserts for Plastic	$0.53	$1.06
1	9654K515	Steel Extension Spring	$1.05	$1.05
1	3D Printed	Slide (13g)	$0.89	$0.89
1	3D Printed	Rotation Wheel (16g)	$1.16	$1.16
1	3D Printed	Funnel and Pipe (17g)	$1.25	$1.25
			Total Cost	**$29.71**

Final Product!





Final Product!



Analysis of Dispenser

Overall, I am really pleased with how my dispenser turned out. Functionally, it meets all the criteria of the project and it is aesthetically pleasing as well due to the minimalistic design and white acrylic style. Candies are loaded into the funnel and with every crank, a singular candy is dispensed into the container––each subsystem operates as intended.

However, my initial prototyping process could have been more useful. I ended up prototyping 3 designs none of which I chose in the end. The prototypes and one-on-one for my final design were very useful as it allowed me to avoid many issues beforehand such as incorrect hole sizes, errors with 3D printing and loading onto Cura, box measurements, and understanding of the materials and processes (laser cutting and 3D printing) being used. Based on feedback, I edited my design to include a funnel that would allow the user to drop 20 candies in rather than place them individually using a pipe. I was initially worried after attaching the spring that it would take too much force to rotate the wheel but using a handle helped immensely. The added torque allowed the user to use just one hand to operate the system. I also realised the benefit of using a d-shaft––it allowed me some leeway with the crank design since the irregular shape would not let the handle rotate about the shaft anyway. Earlier I was using a wooden shaft but I chose to switch to a d-shaft quite late (once stock arrived in the PRL) and it was very beneficial!

I was quite happy that my design for the rotating wheel to capture just one candy at a time worked in my first print itself! I used extrusion screws to secure each end of the spring and I was pleased that it was highly effective and the spring did not come unattached even once. I was also pleased that my slide worked well! I initially printed one that was too small (10x20cm) and the candies were unable to be picked out by hand. But I adjusted the dimensions to be 15x30 and much longer in length and it worked perfectly!

I was not very happy with my choice of spring placement. I found that as the wheel rotated, the spring curved about it so this did not meet the specifications of the project as the spring was to only move linearly. In hindsight, I should have prototyped this aspect to understand the movement in more detail. Hence, an unanswered question I have is “how can I place the spring in my product such that it extends linearly?”. Also, I feel that my overall design could have been scaled down by a factor of 2-2.5. The box need not be 6x5x5 in as there is a lot of empty space. Moreover, regarding the crank, I felt that I rushed the heat setting process and as a result I made a mistake. I should have done a few test ones on a piece of Duron and then implemented it in my final product. Another issue is that if someone accidentally shakes or drops the product, the candies will all spill from the funnel as it is not secured on the top or at the base either. This is an unanswered question I have as well––”how can I make the product more robust so it can withstand collisions or falls?”. My next steps would be to address the issues mentioned in this paragraph through prototyping thoroughly and making conceptual sketches to ensure the idea is clear in my head.

Reflection

I learnt so much in the 3-4 weeks of creating this candy dispenser! The design process was thoroughly enjoyable, and I learnt so much not only about design but about myself as a designer. I've grown to appreciate how each small decision you make at any stage of the design process can influence your final product and the path you take to get to it.

Firstly, I now truly understand the importance of prototyping thoroughly and with intent. The concept of driving questions and really making conscious decisions at each stage of the design process fascinates me. Earlier, I never properly planned out my prototyping and just went with the process, but I also ended up taking a lot of time to achieve my aim. But by defining my goals, testing methods, and metrics of success beforehand I understand now how to make better use of my time while prototyping. Another learning for me was that design takes time! For any amount of time I planned before going to the lab, it took almost three times longer! This was a rude awakening at first, but it taught me to be more adaptable and flexible with my plans. Not everything needs to go as planned and sometimes you make discoveries in the midst of mistakes! This is not just a learning I will take forth in my PD classes, but in any of my future endeavours.

Furthermore, I understood the importance of reaching out to people for inspiration, assistance, and feedback and also to be willing to help others as well. Throughout working in room 36 for hours on end, I interacted with so many different people; I learn that design is collaborative and that by learning from others, you can expand your own broader understanding. I made lots of friends just from asking them about their thoughts on my design, how I can improve, and by doing the same for them as well. I also realised the importance of test cuts and prints to save yourself time and also prevent wastage of materials. I had a few failed processes that could have been avoided if not for having tests. I was also really happy and proud that I can now use the laser cutter and 3D printer (and set my own 3D printer up!) on my own; however, I want to make sure that I am still thorough in my checking of material width, filament type, material type, and positioning to ensure I do not make any errors in the future.

I realised that I love to take upon design challenges whenever possible––for example, not using adhesives was often challenging and at some points I really felt the need for them to save time. But I chose to instead go back to the drawing board and refine my design and measurements such that I could make it work without the use of a hot glue gun. For example, I initially printed out my slide too small so it would not fit in the hole perfectly. A simple solution would be to glue the edges on so that it is tight, but I instead properly accounted for the filament width and printed a new one to make it a tight-fit.

Overall, I learnt a lot from this entire project and I am really pleased with the amount of effort I put to make my dispenser work!