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ME 102 Autumn 2021

Learning to turn my design on its side

Interpretation of Prompt

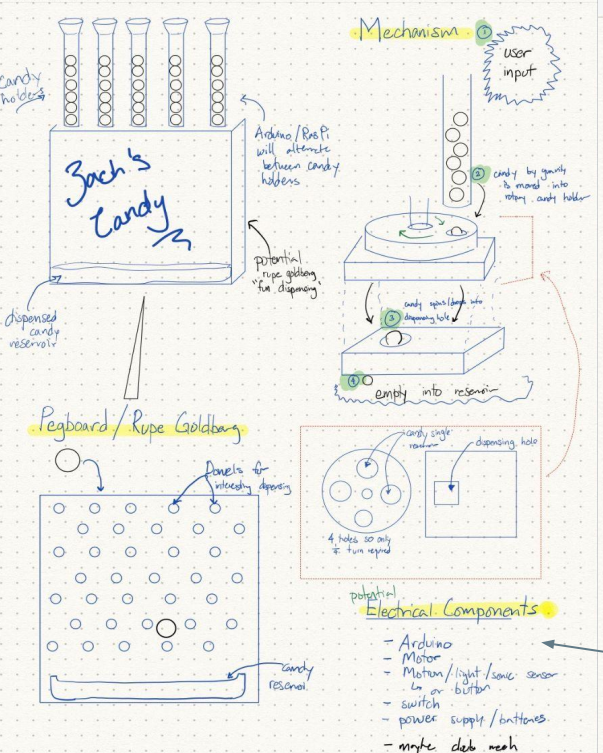
The goal of this project was to build off of the sketching, prototyping, CAD and digital fabrication skills that we have been working on throughout the quarter to create a working desktop candy dispenser.

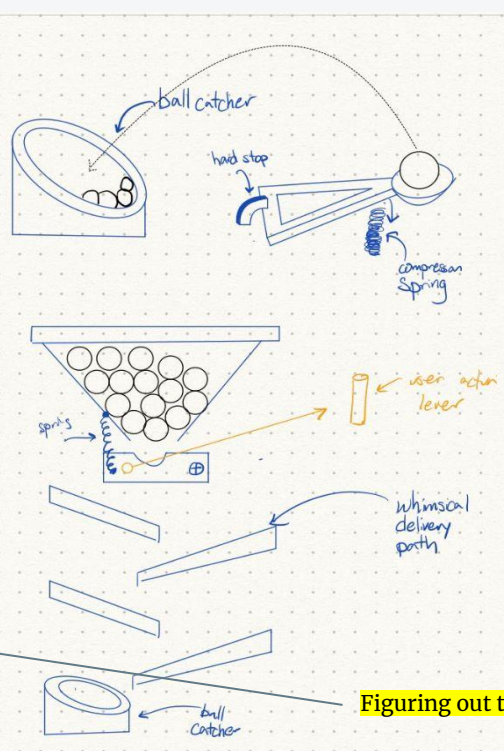
While fulfilling certain requirements, the dispenser must be able to hold 20 candies and integrate mechanical stock components, such as a rotary shaft and spring. The design must also be robust and join parts without glue, so that repairs and adjustments can be made effectively.

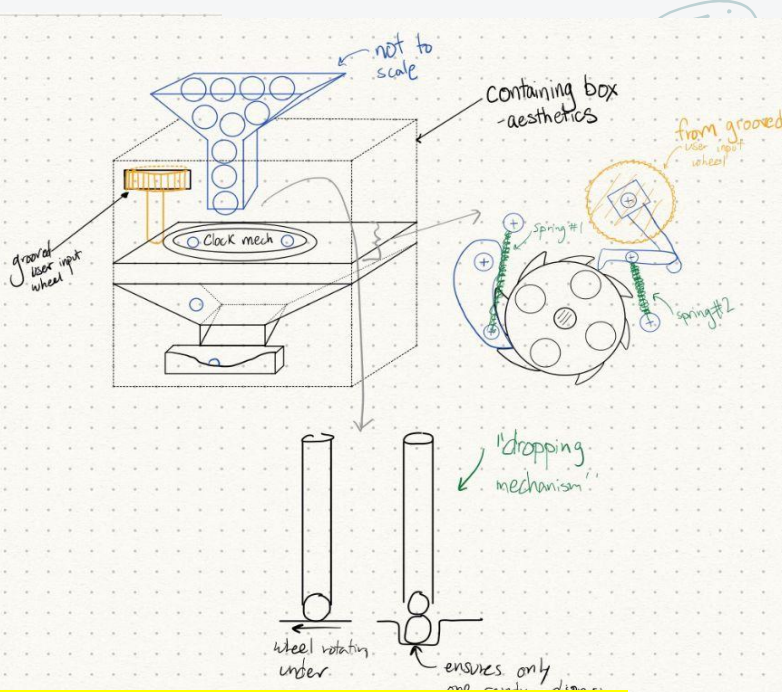
Concept sketches and mechanism research

Exploring physical design

Exploring Mechanisms





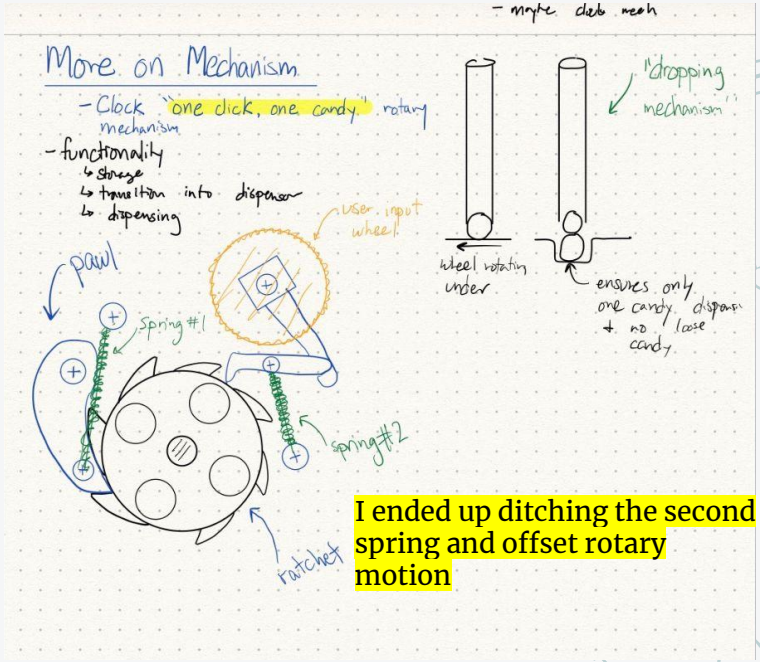


Figuring out the difference between "must-haves" and "want-to-haves"

Concept sketches and mechanism research

For my concept sketches, I dabbled with a few different ideas for the design of the box and the possible mechanisms. For example, I considered the possibility of a whimsical delivery method, and, for the mechanism, I considered various rotary motion methods, ultimately landing on a ratchet and pawl mechanism. I chose this direction because this seemed like a unique application of the spring and could provide for a nicely tactile user interface.

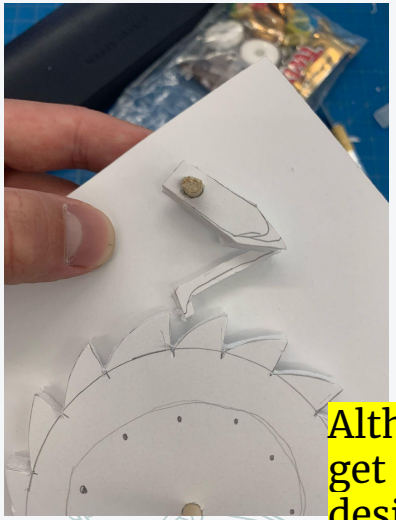
Finalizing and zooming in on mechanisms

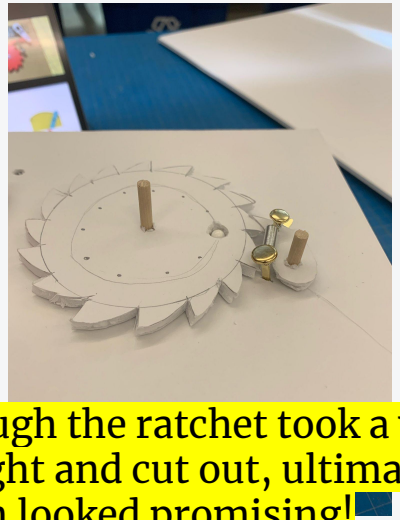


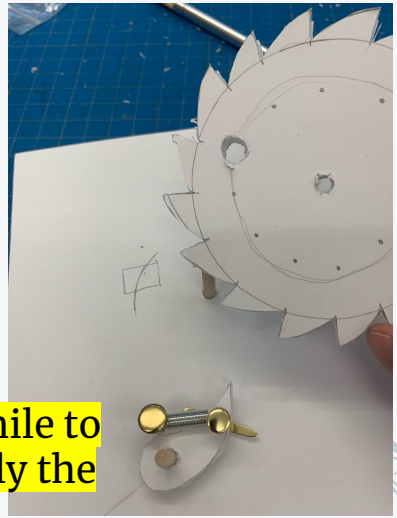
I ended up ditching the second spring and offset rotary motion

Rapid Prototyping

For my rapid prototyping, I wanted to know how the ratchet and pawl mechanism could also be used to dispense the candy. I ended up choosing a 2-plane design in which holes cut through the ratchet would carry the dispensed ball and rotate into a second hole on the plane underneath, where the candy can be served. I found that this method worked quite nicely, even in foam core.



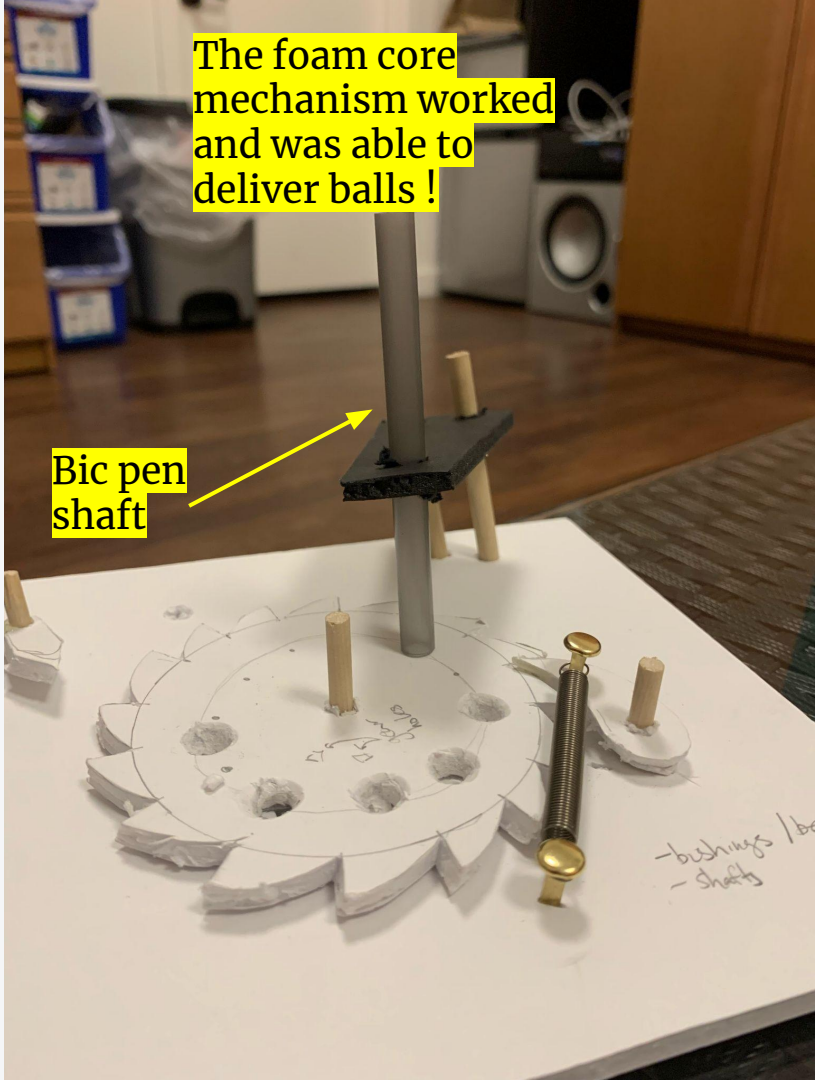




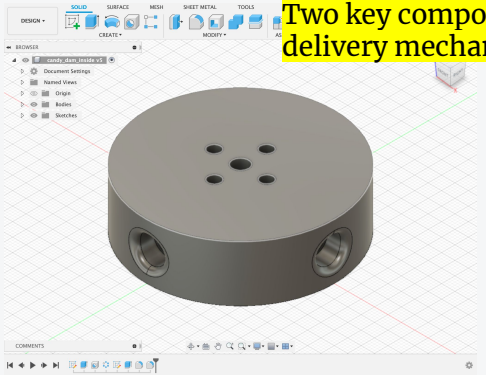
Although the ratchet took a while to get right and cut out, ultimately the design looked promising!

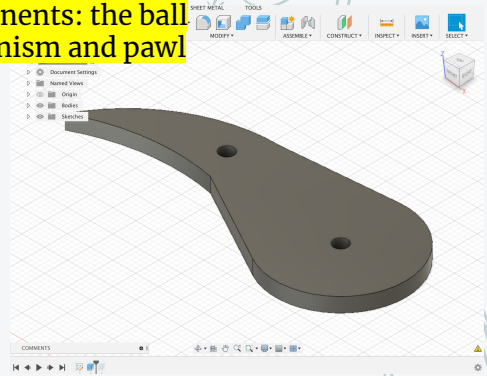
Functional Prototyping

For the function prototype, I chose to test out the spring to see if I could test out the tactile user interface element of my design. I used brass fasteners to secure the spring on both ends on the plane and pawl. I also tested a cylindrical dispensing holder. The main challenge that began to emerge was the amount of force required to turn the ratchet and the lack of friction on the device. However, I had to wait until I started with the digital fabrication to get a better understanding of the weight of my design and whether there was enough friction to resist the rotational force of the rotary actuation.

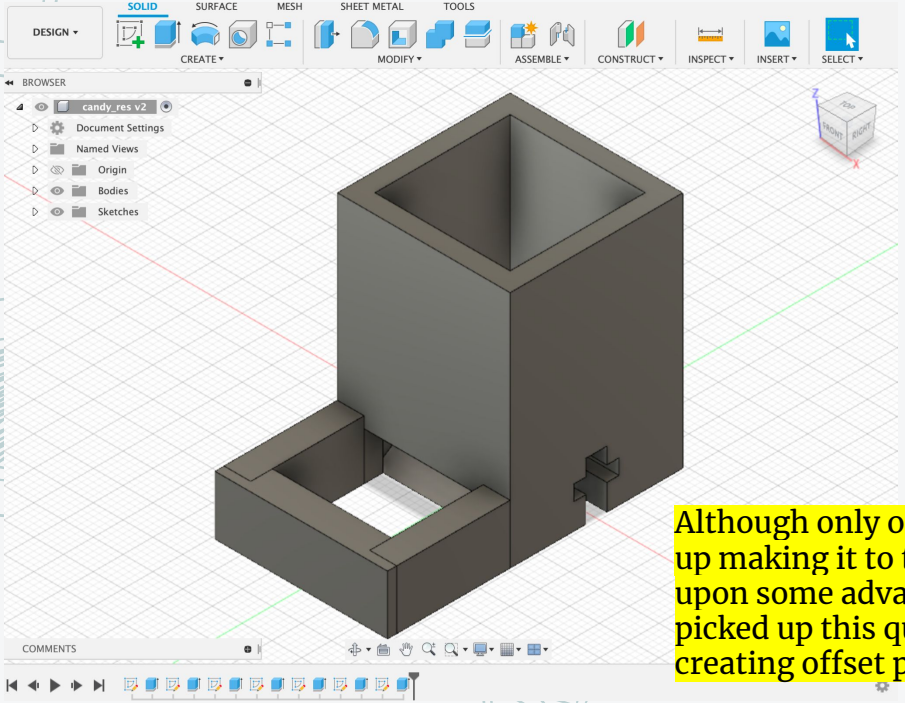


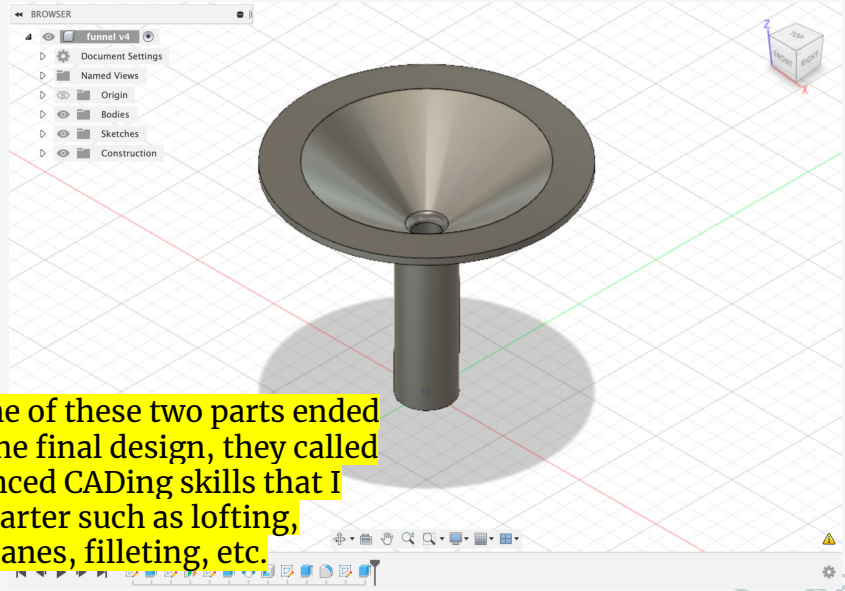
Process: CAD





Two key components: the ball delivery mechanism and pawl





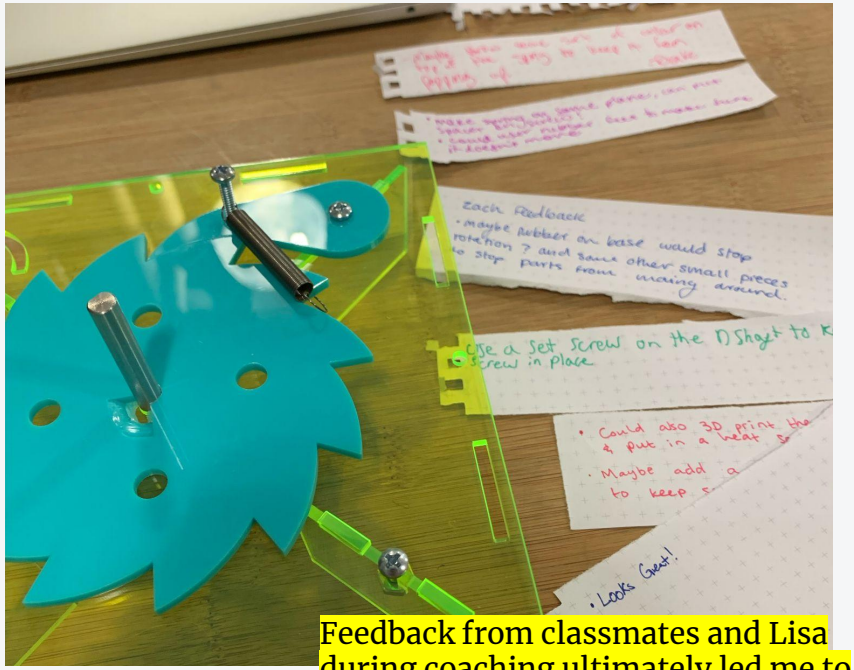
Although only one of these two parts ended up making it to the final design, they called upon some advanced CADing skills that I picked up this quarter such as lofting, creating offset planes, filleting, etc.

Process: Digital Fabrication

I began with the key components (ratchet and pawl, spring, and d-shaft). I attempted to couple the ratchet to the shaft using a press fit. I found that acrylic is too brittle to handle that kind of a press fit, however the mechanism worked well and smoothly as I hoped.

A block of wood worked perfectly well for early digital fab part testing

Process: Digital fabrication

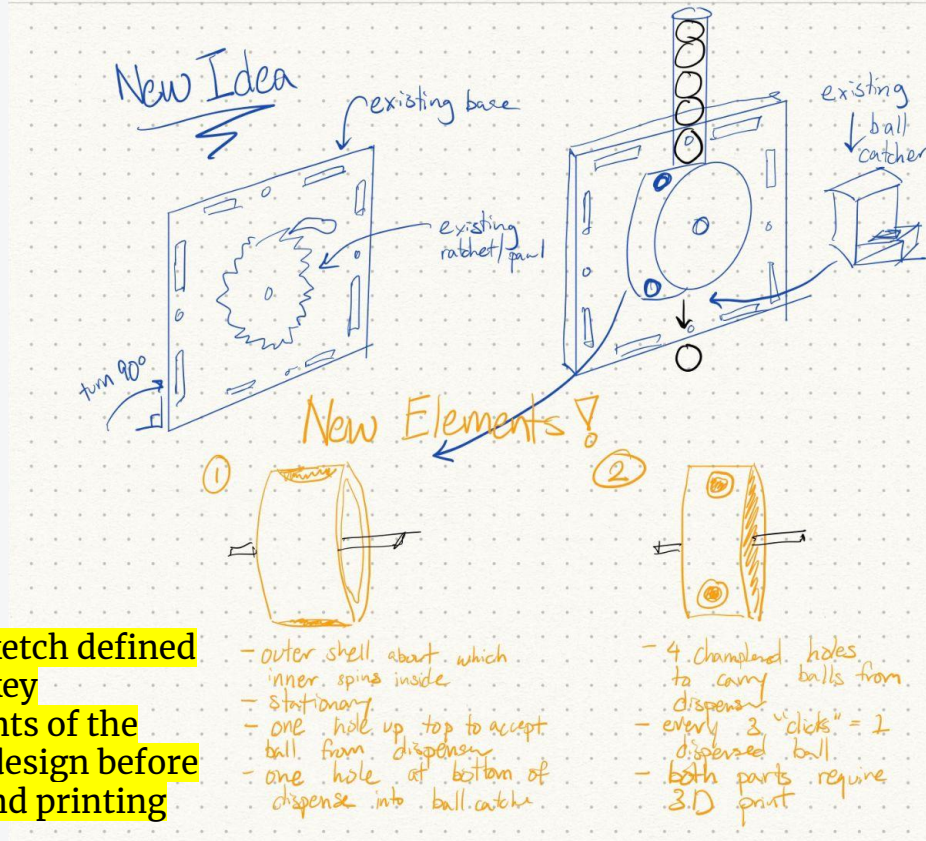


Feedback from classmates and Lisa during coaching ultimately led me to turning my dispenser on its side!

Next, I built up the base of the machine. Initially, I planned for there to be three horizontal planes: one as the base, one as the mechanism plane, and one to hold the candy dispenser. From talking to students and teaching staff in coaching, I quickly realized that my design could not handle the horizontal rotary force required to turn the ratchet without using two hands.

Process: Adjusting Design – Turning My Project on it's Side

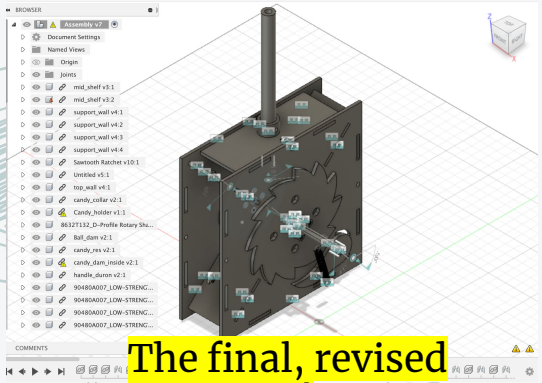
At this point, I decided to turn the entire design on its side, such that the ratchet and pawl were now orthogonal to the base. I redesigned the turning mechanism such that every four "clicks" a candy gets dispensed, a design that required multiple 3D parts.



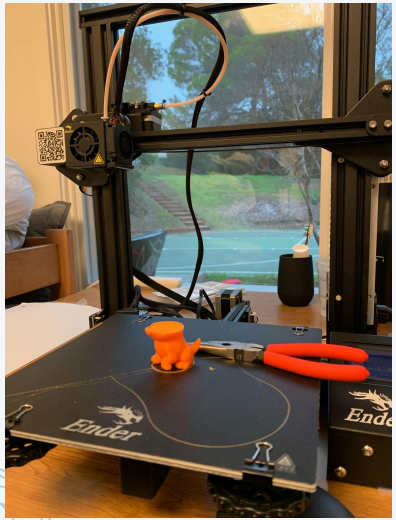
A quick sketch defined two new key components of the adjusted design before CADing and printing

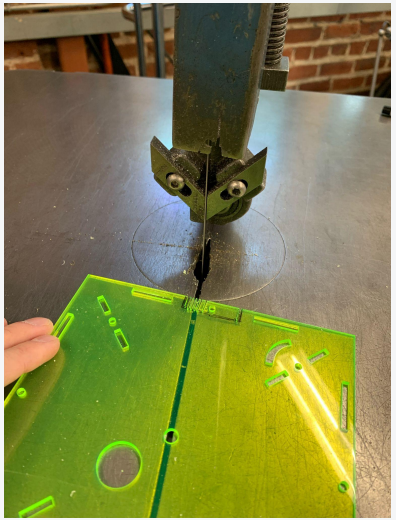
Process: Completing design and Finalizing Fabrication

In the process, I learned how to use the Form 3D printers; utilized drill presses, band saws, arbor presses, and files from the machine shop to adjust the existing pieces of my design; and how to adjust a design on the fly, thinking creatively, economically, and efficiently. In addition, I set up my at home 3D printer to print my final parts so that I did not have to worry about reserving time in the PRL!



The final, revised assembly!

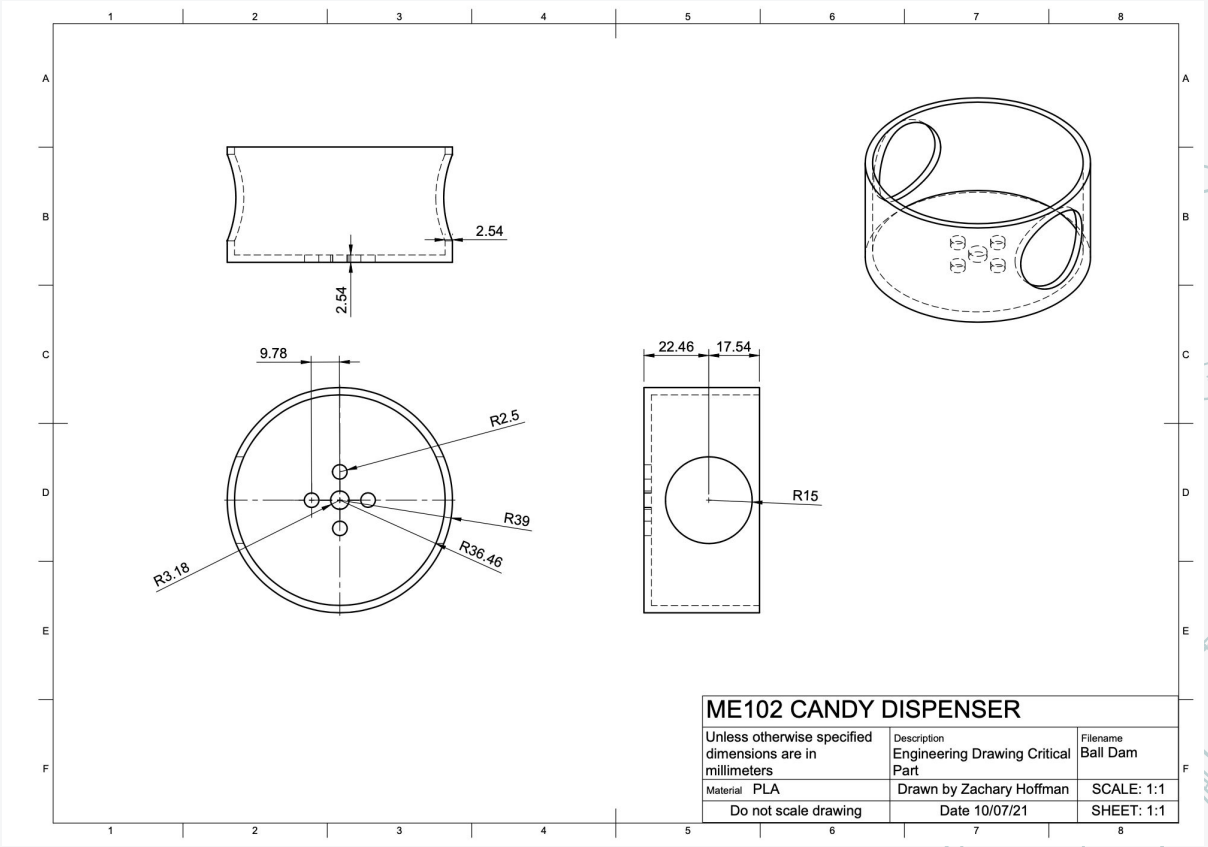




First time using resin printer

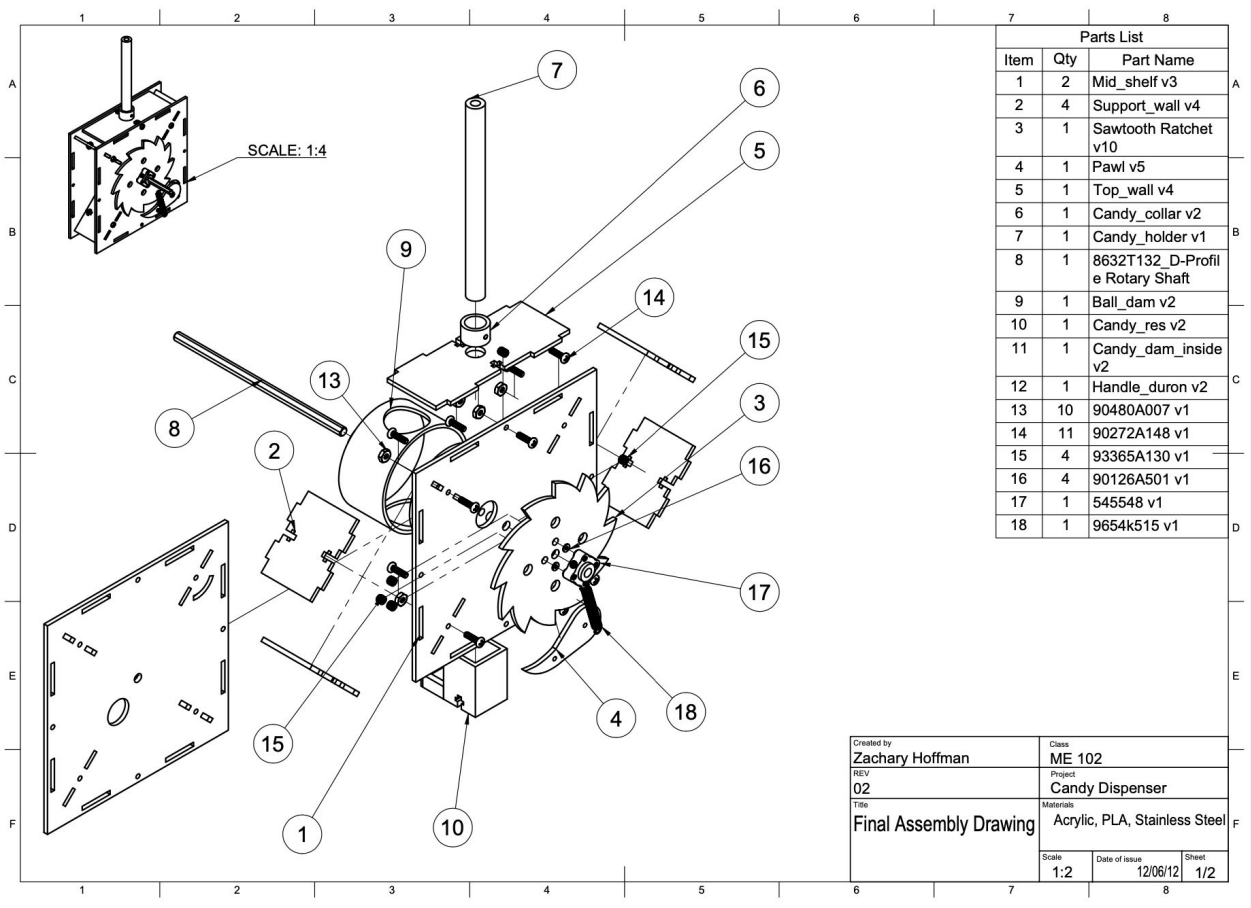
More Digital Files

This is an engineering drawing of the ball dam, the stationary part about which the balls get dispensed.



More Digital Files

This is an assembly drawing of my full dispenser that includes a part list (sheet 1/2)



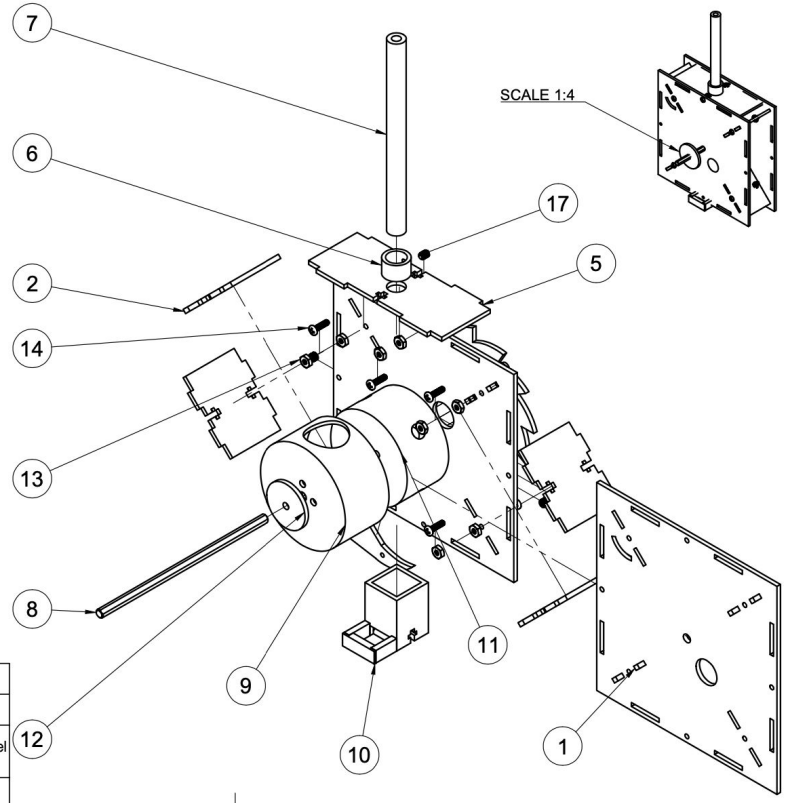
Parts List		
Item	Qty	Part Name
1	2	Mid_shelf v3
2	4	Support_wall v4
3	1	Sawtooth Ratchet v10
4	1	Pawl v5
5	1	Top_wall v4
6	1	Candy_collar v2
7	1	Candy_holder v1
8	1	8632T132_D-Profile Rotary Shaft
9	1	Ball_dam v2
10	1	Candy_res v2
11	1	Candy_dam_inside v2
12	1	Handle_duron v2
13	10	90480A007 v1
14	11	90272A148 v1
15	4	93365A130 v1
16	4	90126A501 v1
17	1	545548 v1
18	1	9654k515 v1

Created by: Zachary Hoffman	Class: ME 102
REV: 02	Project: Candy Dispenser
Title: Final Assembly Drawing	Materials: Acrylic, PLA, Stainless Steel
Scale: 1:2	Date of issue: 12/06/12
Sheet: 1/2	

More Digital Files

This is an assembly drawing of my full dispenser that include a part list (sheet 2/2)

Parts List		
Item	Qty	Part Name
1	2	Mid_shelf v3
2	4	Support_wall v4
3	1	Sawtooth Ratchet v10
4	1	Pawl v5
5	1	Top_wall v4
6	1	Candy_collar v2
7	1	Candy_holder v1
8	1	8632T132_D-Profile Rotary Shaft
9	1	Ball_dam v2
10	1	Candy_res v2
11	1	Candy_dam_inside v2
12	1	Handle_duron v2
13	10	90480A007 v1
14	11	90272A148 v1
15	4	93365A130 v1
16	4	90126A501 v1
17	1	545548 v1
18	1	9654k515 v1



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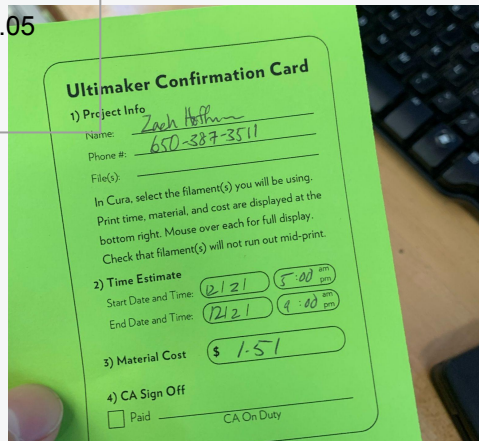
Title: Final Assembly	Materials: Acrylic, PLA, Stainless Steel
Scale: 1:2	Date of issue: 12/06/12
Sheet: 2/2	

FINAL BILL OF MATERIALS

Item	Part Name	Description	Qty	Cost
1	Midshelf	Acrylic	2	$3.50
2	Support wall	Acrylic	4	$1.00
3	Ratchet	Acrylic	1	$1.00
4	Pawl	Acrylic	1	$0.10
5	Top wall	Duron	1	$0.00
6	Candy Collar	PLA	1	$0.05
7	Candy Holder	PLA	1	$0.39
8	634080	¼” D shaft 4”	1	$2.07
9	Ball Dam	PLA	1	$0.71
10	Candy Reserv.	Form Resin	1	$5.60
11	Candy Carrier	PLA	1	$1.12
12	Handle	Duron	1	$0.00

Item	Part Name	Description	Qty	Cost
13	90480A003	2-56 hex nut	10	$0.20
14	90272A148	6-32 x 1/2" machine screw	11	$0.33
15	93365A160	1/4-20 Threaded Brass Heat-Set Insert	4	$1.29
16	90126A501	No. 2 flat washer	4	$0.08
17	545548	Hub, set screw, 1/4" bore	1	$4.33
18	9654K515	Spring, Extension, 1.875L, k=0.8, 1.07lb max	1	$1.05

Total: $22.82



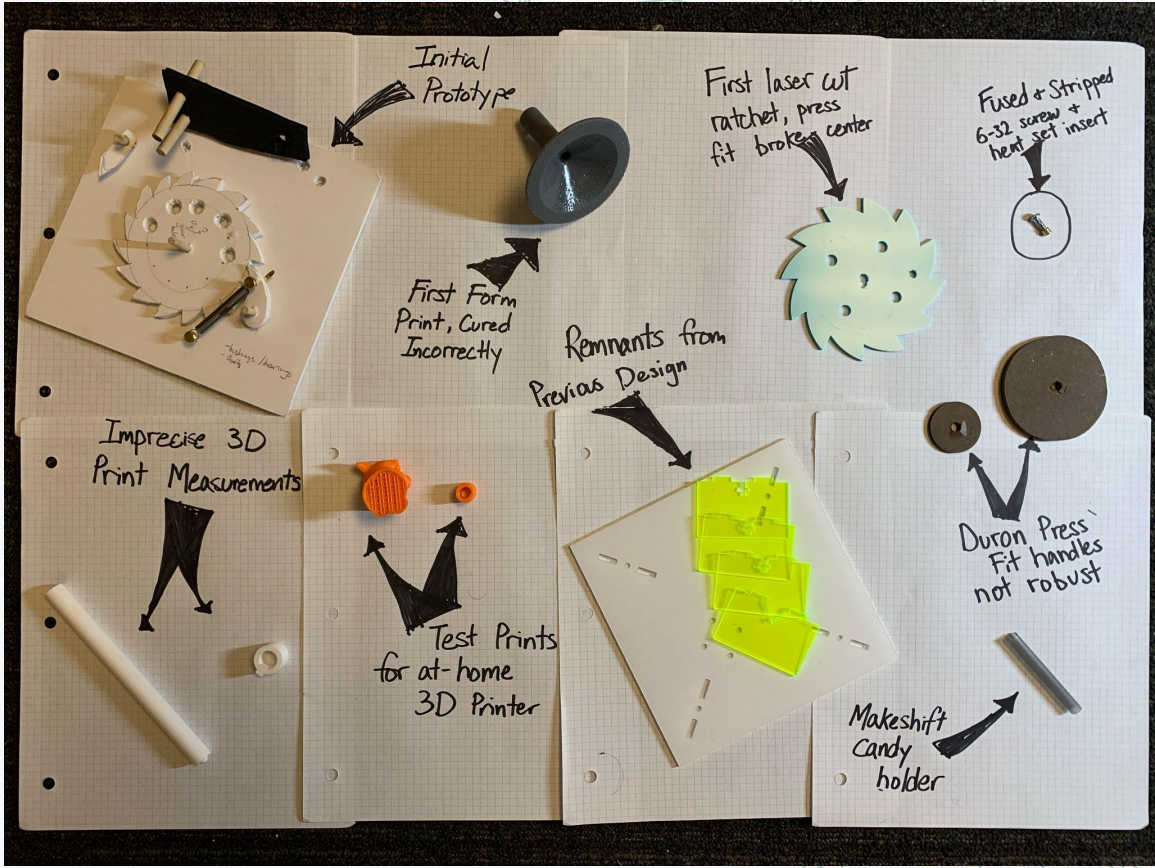
Analysis

The dispenser and the subsystems operated for the most part as intended. However, I had to add a through hole on the mechanism plane to help stabilize the ratchet. When deciding to turn my design on its side, I had to also cut out an opening on the side of my bottom plane to accommodate the new position of the ball holder. I also had to exchange a duron handle with a 3d printed one that includes a set screw, making the design more robust.

Because I adjusted the design, trying to keep as many of the original parts that I had previously digitally fabricated (which I did successfully!), there is a lot of room for improvement. The box itself can be smaller and require fewer pieces of hardware, especially as it pertains to the side supports. This design did require a good amount of hardware, and the main questions still left to be answered is if there is a design that can enable an assembly with fewer parts.

Reflection: *Learning to turn my design on its side*

The biggest thing I learned through the design and prototyping process is not to get too attached to any one idea or design. Instead: be flexible and creative at every step. Because I required flexibility from my digitally fabricated parts, the result of my design is one that can have multiple forms of configurability. For example the side walls can be turned 45 degrees for a different orientation. In addition, this process also left me with a "graveyard" of test, prototype, and unsuccessful parts, sketches, and CAD files. In other words, what is represented in my final product is not nearly the full extent of what I designed and created.



Reflection: *Learning to turn my design on its side*

The biggest challenge I faced was in fact coming up with a successful and working product in a relatively short time frame. To overcome this, I had to allow myself to think outside of the box. When my first design didn't work out, I admittedly stressed at first, but I am proud to say that I ultimately called upon resourcefulness, classmate advice, lots of help from TA's and CA's in and outside the PRL, and kept at it!

In the process I have gained a great deal of skills and efficiency when it comes to prototyping and ideating. I especially improved a lot on my digital design and a fabrication skills. And I feel more confident in those fundamentals moving forward.