DESIGNED BY WILLIAM PAN COINCEPTION COINCEPTION COINCEPTION COINCEPTION COINCEPTION

Context & Requirements

Prompt:

- Design a coin sorting machine to help clean up loose change in the PRL with ease and efficiency

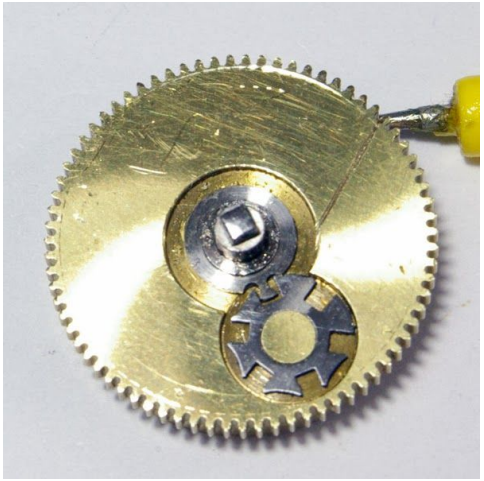
Mission: a broadening exploration 🔎 into advanced and real world mechanisms that drive our cars, airplanes, watches, and more to be integrated into the coin sorter

Requirements:

- Store 15 coins in hopper in any orientation
- Sort pennies, nickels, dimes, and quarters into collection point
- Store at least 5 coins and easily removed
- Sorted through one hand actuation with 2-3” linear direction
- Linear motion to convert to another linear / rotational motion
- Sort one coin at a time and reset on its own with spring
- Include hardware, spring, acrylic, plywood, duron and/or 3D printed materials
- Mechanism is visible and serviceable

Inspiration

Rotating Disk Coin Sorter



Geneva Mechanism

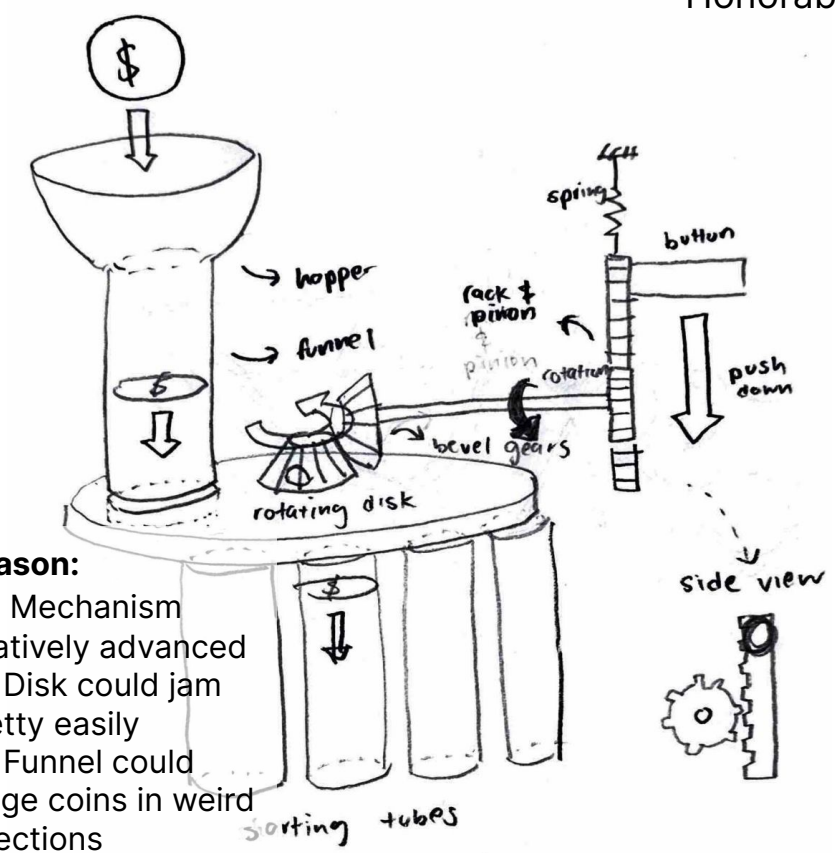
Ratchet Freewheel

Timeline:

(1) Sketching and Design Inspiration for Sorter → **(2)** Rough Prototyping with Rotating Disk → **(3)** CAD and Prototype Realization with Laser Cutter & 3D Printer → **(4)** Assembly of Coin sorter

Concept Sketches

Honorable Mentions

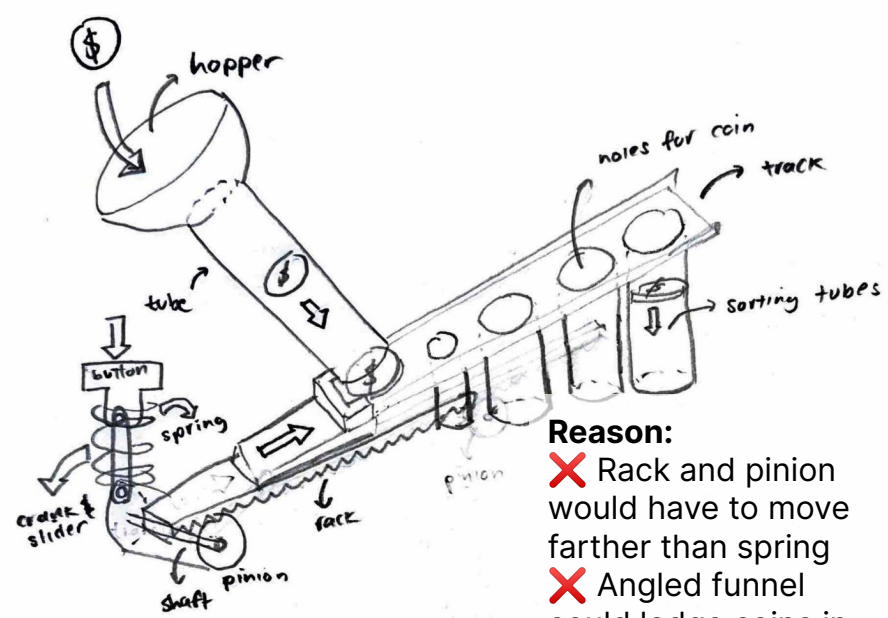


Reason:

✅ Mechanism relatively advanced

❌ Disk could jam pretty easily

❌ Funnel could lodge coins in weird directions



Reason:

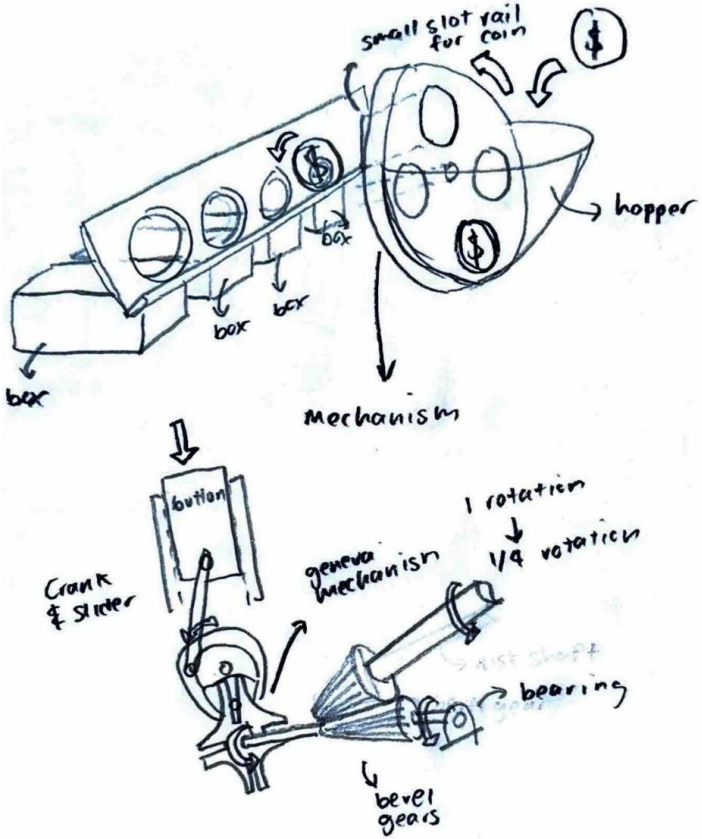
❌ Rack and pinion would have to move farther than spring

❌ Angled funnel could lodge coins in weird directions

❌ Moderate complexity

Concept Sketches

Winner



Reason:

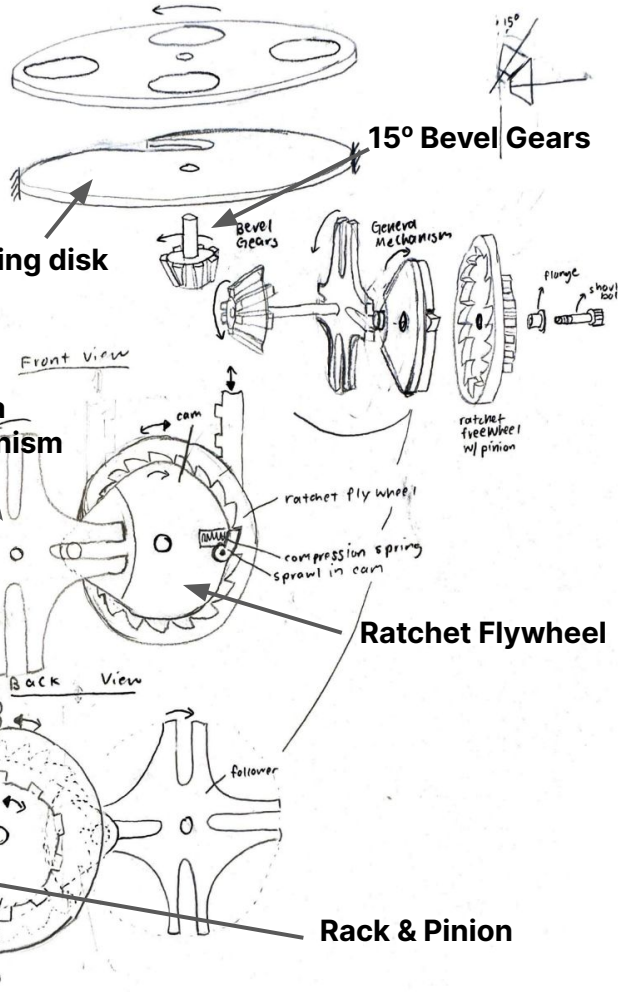
✅ Mechanism is advanced and interesting to build

✅ Disk would not be jammed by coins

✅ Would be actuated with one hand

✅ Can only sort one coin at a time

Further Sketching



Prototyping Plan

Plate Angle

Context:

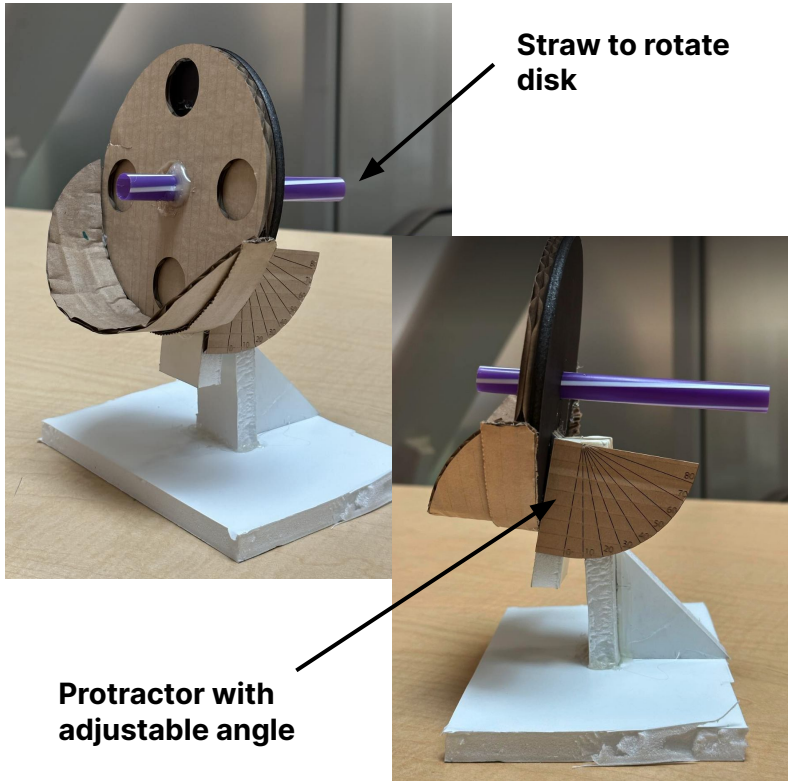
- For the rotating plate to carry the coins to the slot to roll down the ramp, I need to angle the plate at a certain angle that could get all the coins from a random orientation into the hole and with a high success rate

Driver Question:
What is the best range of angles to position the plate that carries all of the coins to its end location?

Metrics for Success:

- Coins get carried up to resulting location in few turns
- No jamming of the plate from coins
- Coins enter holes regardless of orientation

Physical Prototype



Prototyping Plan

Plate Angle

Experiment:

- 7 coins of all shapes and sizes placed into prototype hopper disk at certain angles.
- Spun the disk 5 times and counted the number of coins that made it to the top
- Repeated the experiment 3 times to prevent any error:

	50° ❌	55° ❌	60° ❌	65° ❌	70° ❌	75° ✅	80° ✅
Trial 1	1/7	6/7	2/7	3/7	2/7	7/7	6/7
Trial 2	1/7	4/7	4/7	4/7	4/7	7/7	7/7
Trial 3	1/7	4/7	4/7	5/7	6/7	7/7	7/7

Hopper Picture

Results:

<u>75 to 80 degrees</u> seems like the ideal hopper angle. Where all the coins enter the hopper relatively easily without jamming

Prototyping Plan

Slide Angle

Context:

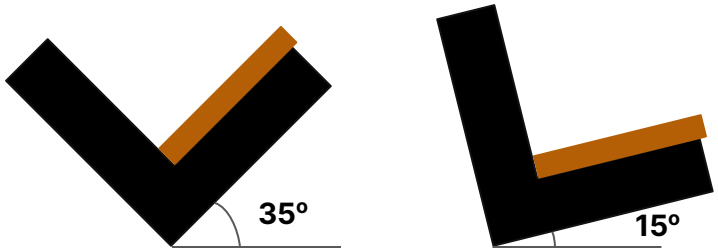
- After the rotating plate carries the coins to the top position, we need to make sure that the coins fall into the ramp and slide well to the sorting holes without stopping or skipping.

Driver Question:
What is the best range of lateral angles to position the ramp to allow coins to slide with ease and sort respectively?

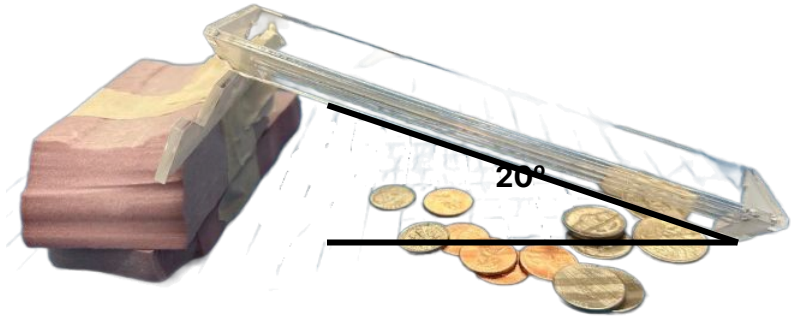
Metrics for Success:

- Coins slide down without skipping allotted sorting spot
- Coins slide flat and do not roll on its edge

Physical Prototype



Dependent Variable: Lateral Angle



Constant: Ramp Angle

Prototyping Plan

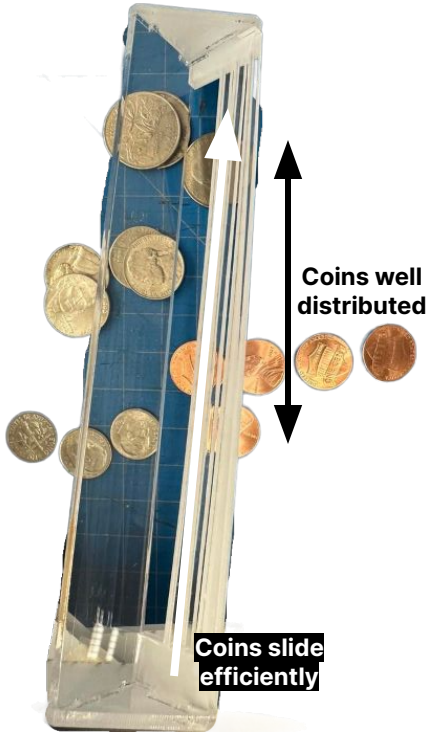
Slide Angle

Experiment:

- 7 coins are placed at the top of the ramp and then determined qualitatively how the coins are falling out of the slots (any friction / coins fall too fast / etc.)

Lateral Angle	Description
35° ❌	No friction, coins slide with too much friction
30° ✅	No friction, coins slide with some momentum
25° ✅	No friction, coins slide down and fall without too much momentum
20° ❌	Some friction, coins having trouble sliding down
15° ❌	Too much friction, coins wouldn't slide down

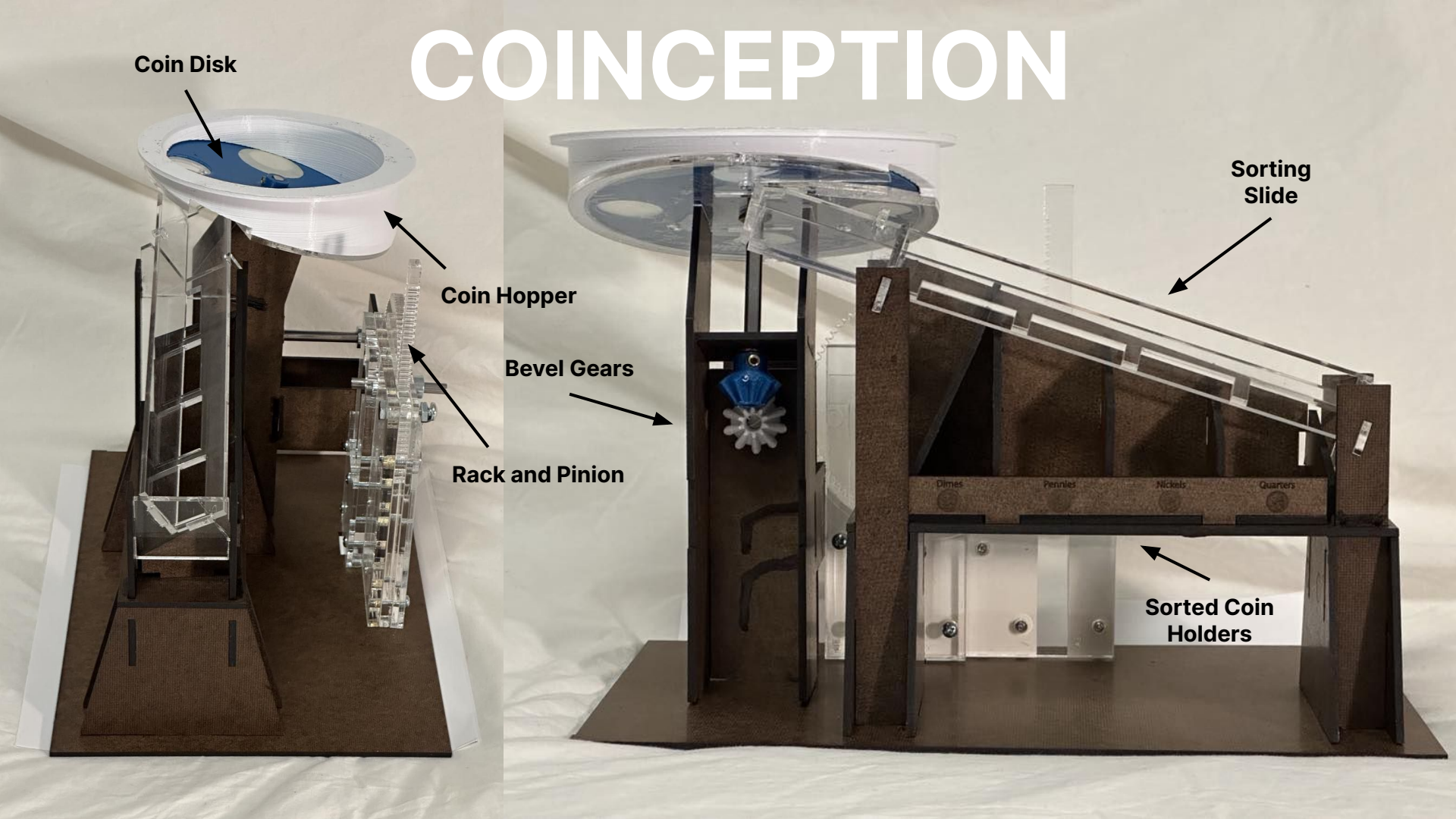
Results of 15° Lateral Angle



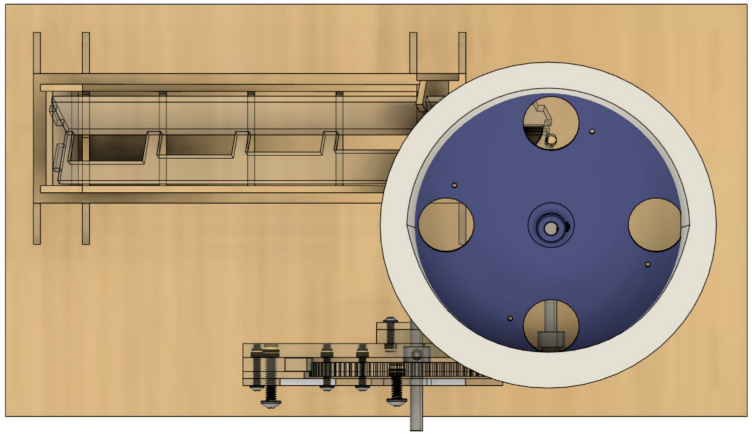
Results:

<u>25 to 30 degrees</u> seems like the ideal lateral ramp angle as the coins slide down well and do not carry too much momentum to skip the sorting boxes

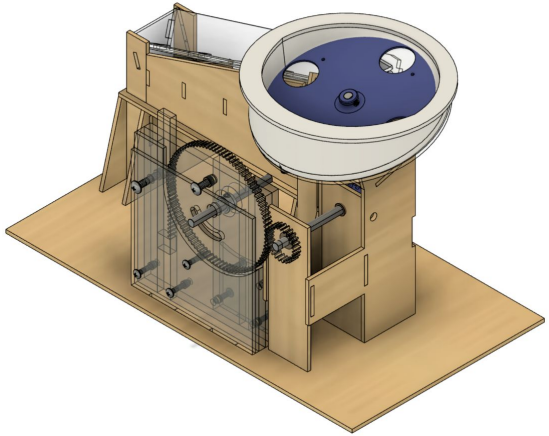
COINCEPTION



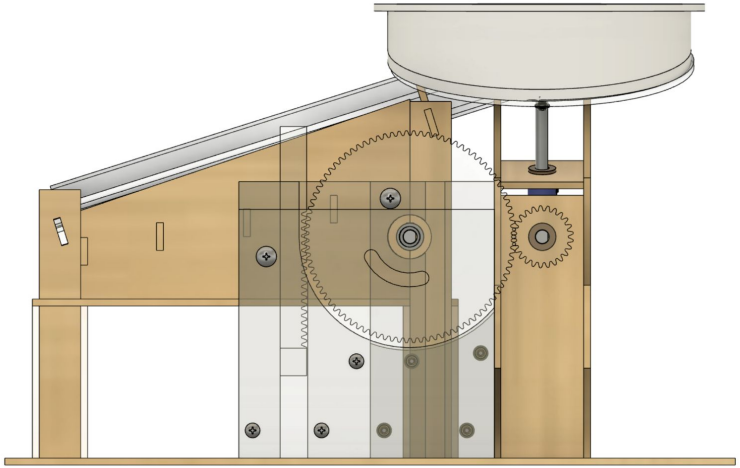
Top View



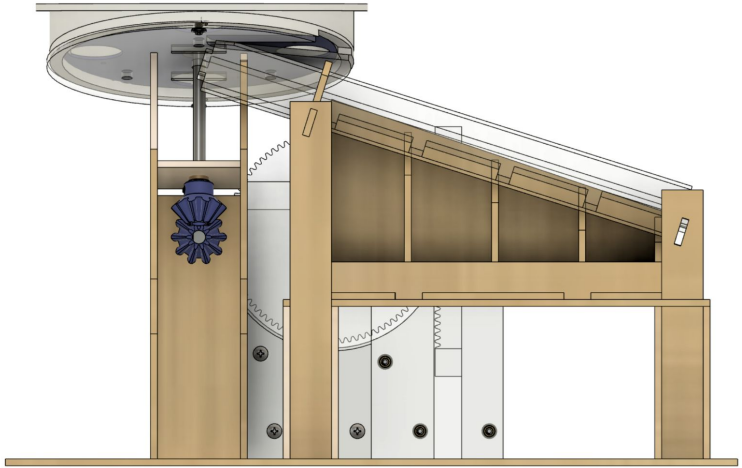
Orthographic View

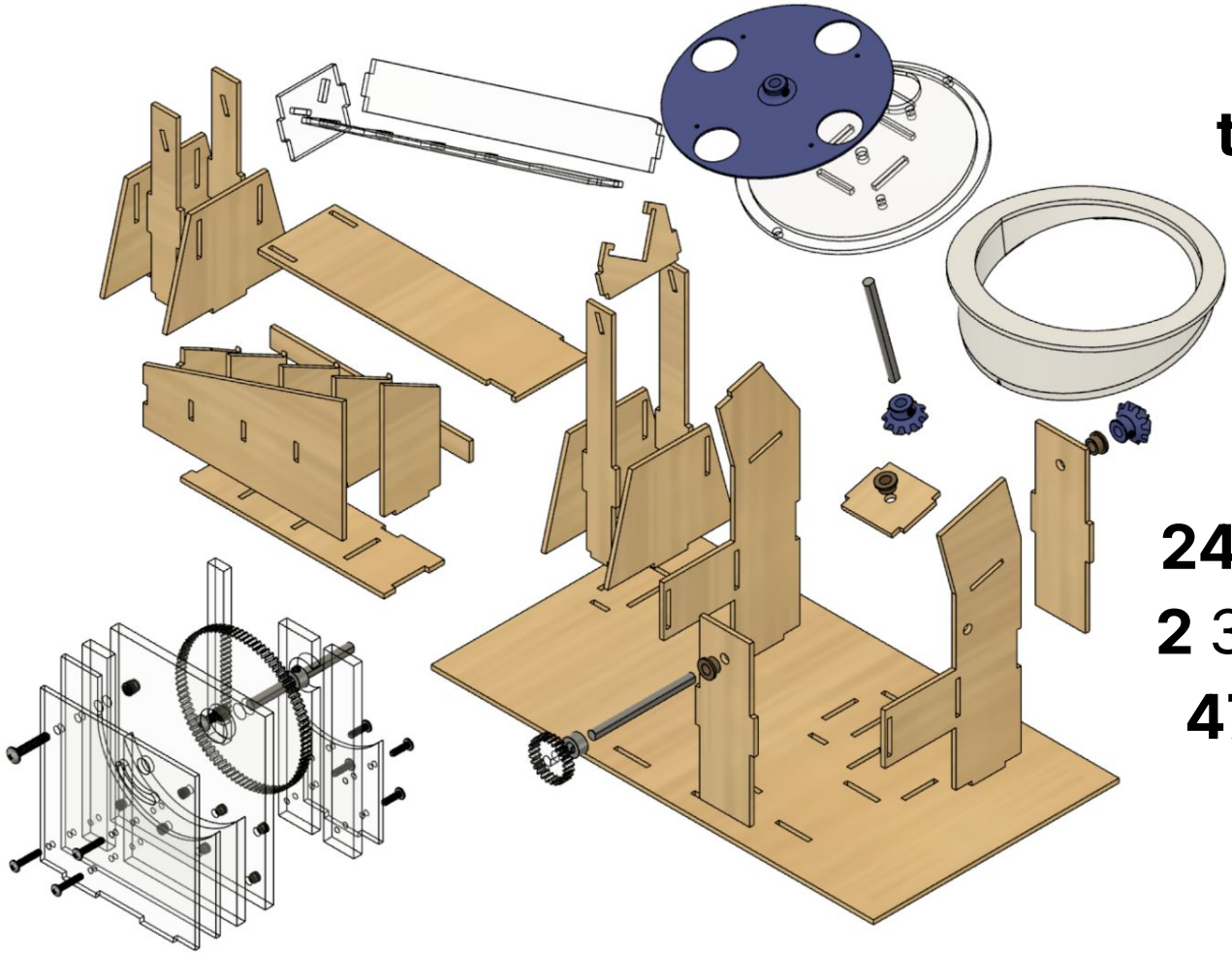


Front View



Back View

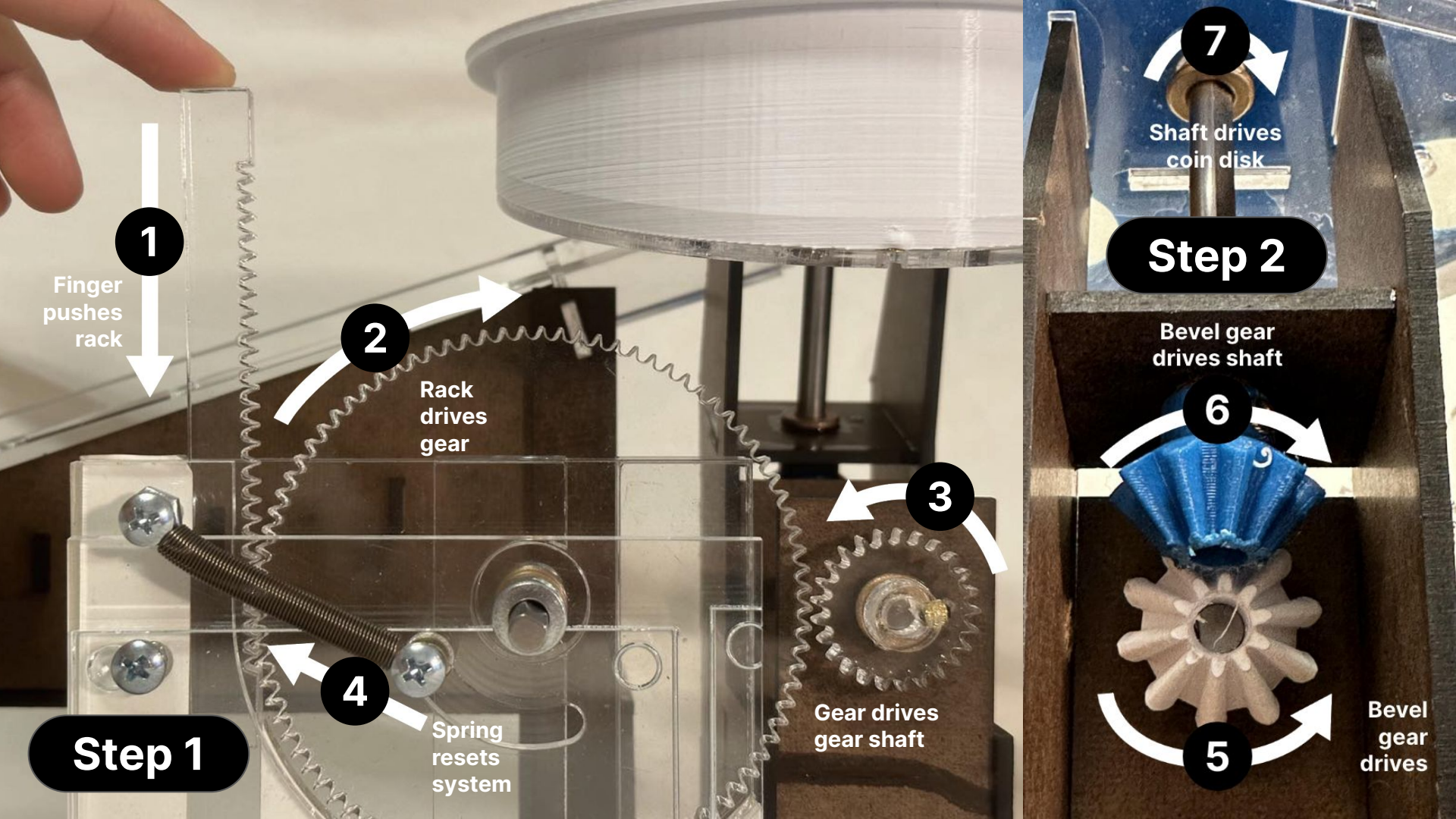


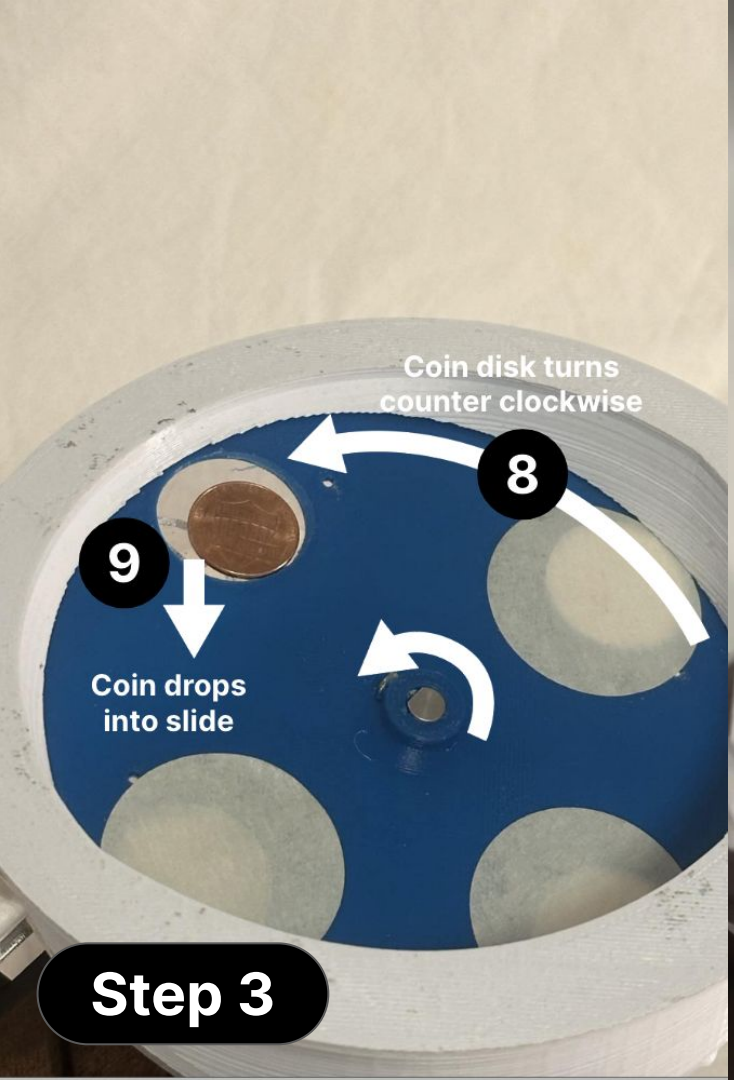


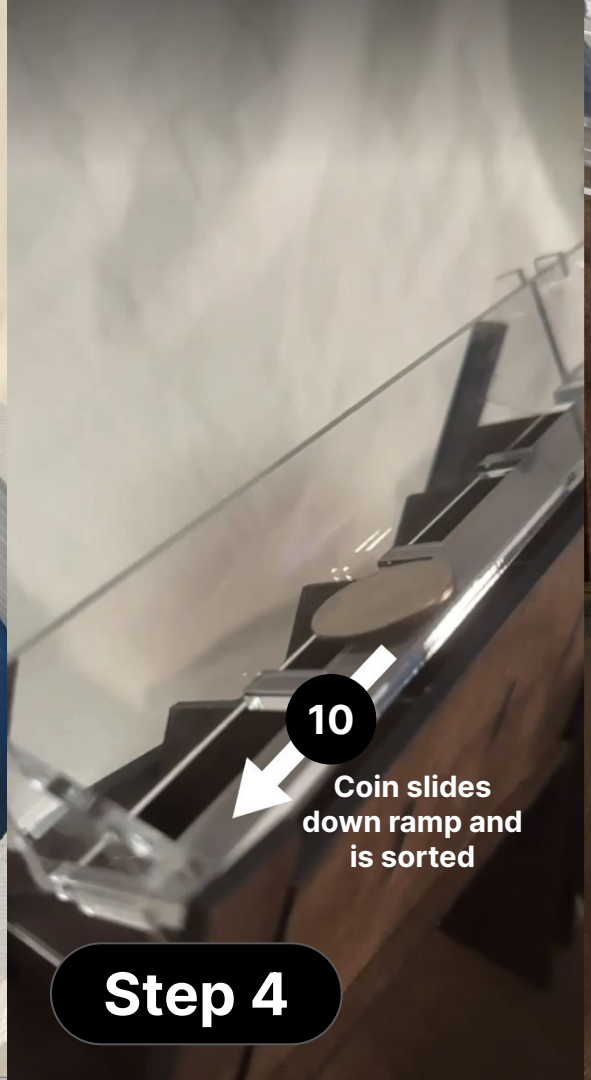
73
total parts

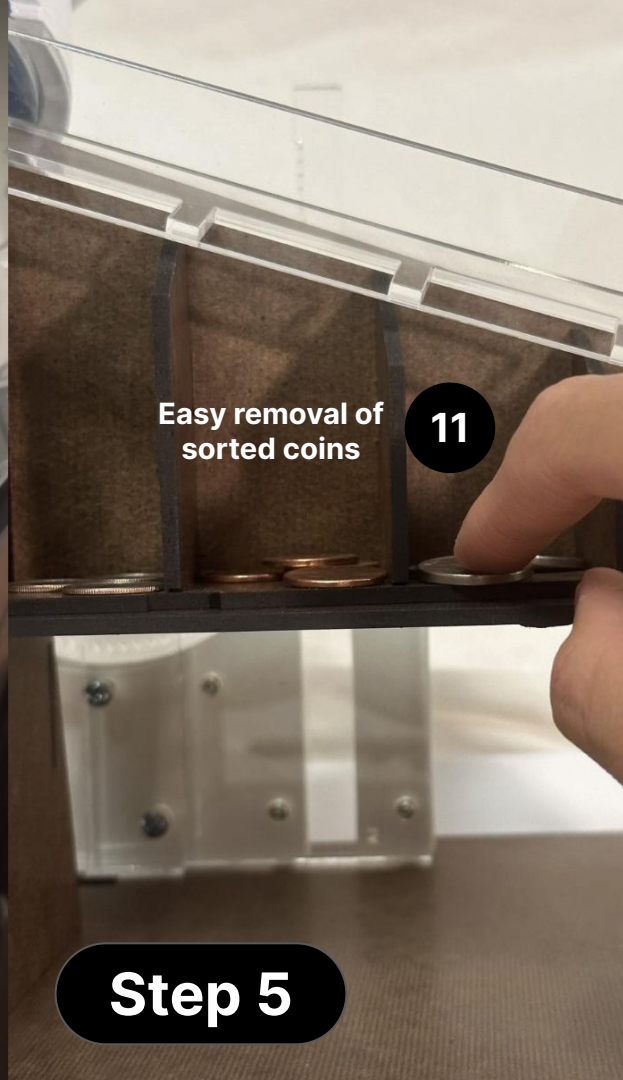
24 hardware
2 3D-printed
47 laser cut

Exploded View


1
Finger pushes rack
2
Rack drives gear
3
Gear drives gear shaft
4
Spring resets system
Step 1
7
Shaft drives coin disk
Step 2
Bevel gear drives shaft
6
5
Bevel gear drives

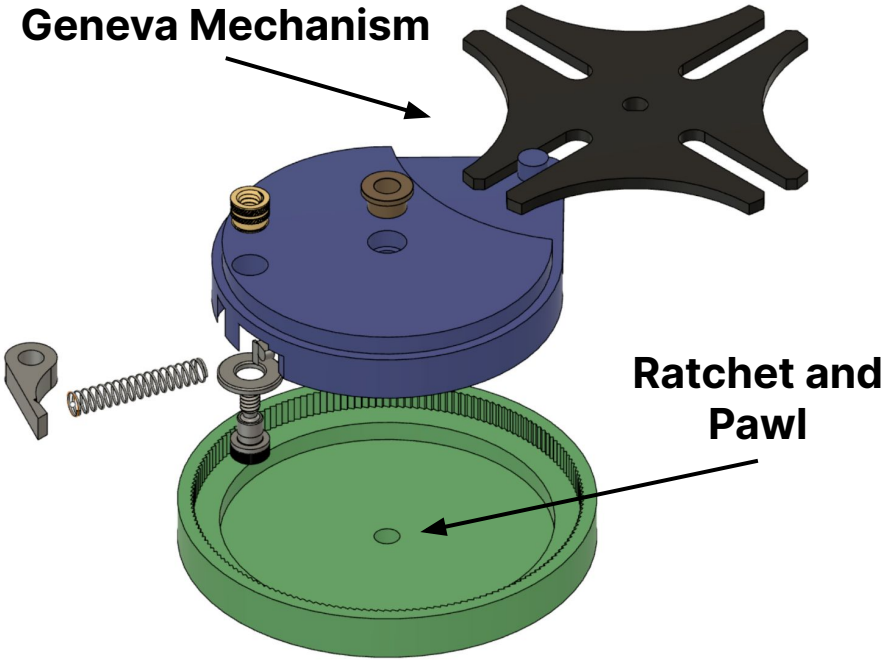

Coin disk turns
counter clockwise
8
9
Coin drops
into slide
Step 3


10
Coin slides
down ramp and
is sorted
Step 4


Easy removal of
sorted coins
11
Step 5

Other Ideas

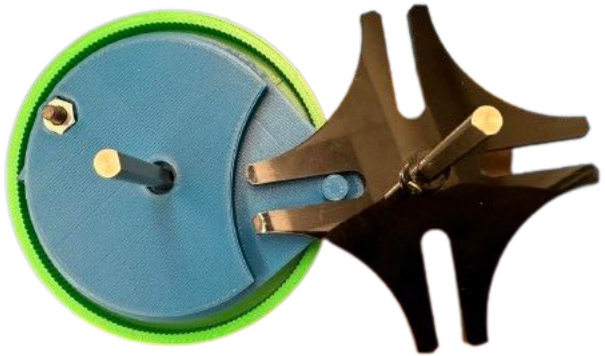
Some designs didn't make the final cut, but still super proud of its design



The Geneva Mechanism would turn the coin disk ¼ of a rotation every rotation

Ratchet made it easy to reset the spring mechanism without turning the coin disk backwards

Issues: Rotation was lopsided



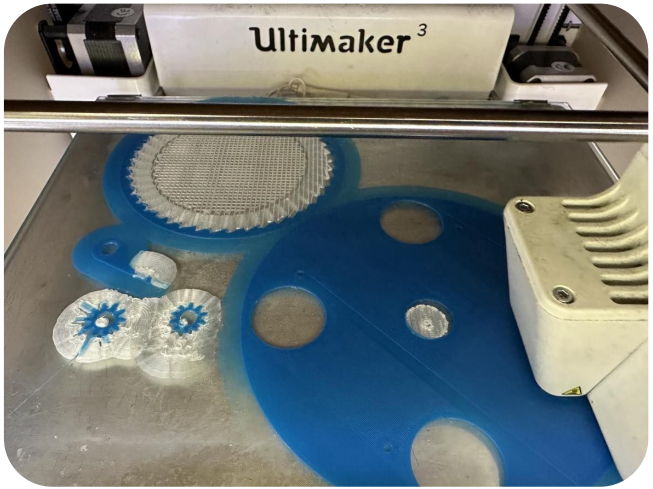
Assembly Process

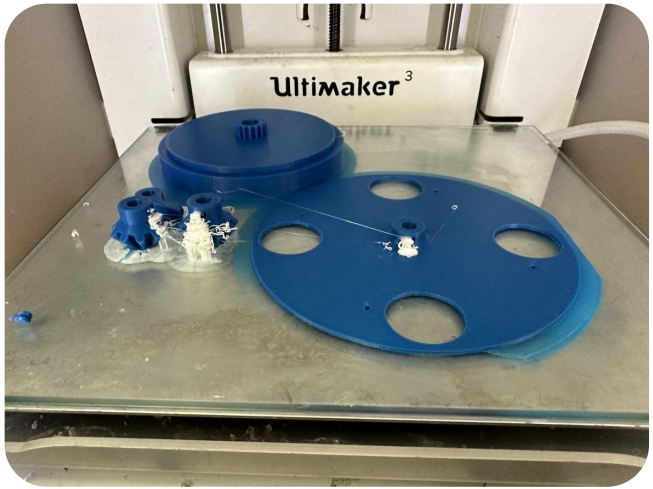
3D Printing

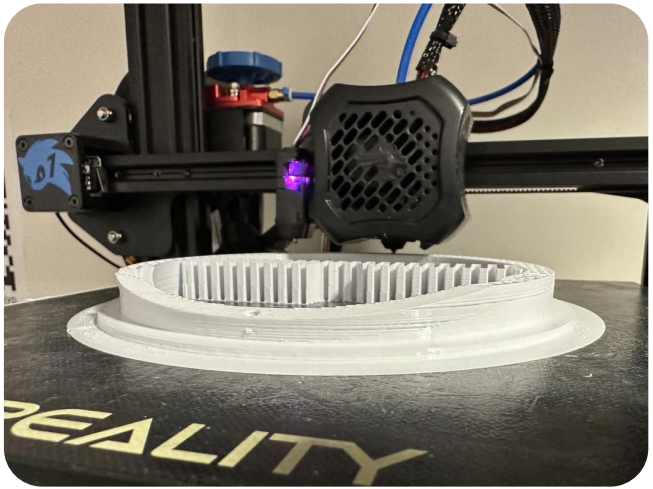
Ultimaker S3: 3D printing coin disk, bevel gears, ratchet and pawl

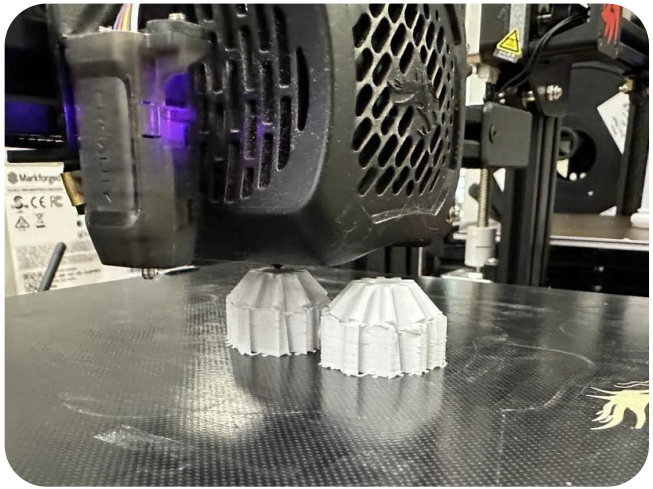
Ender Creality: Coin hopper and bevel gears

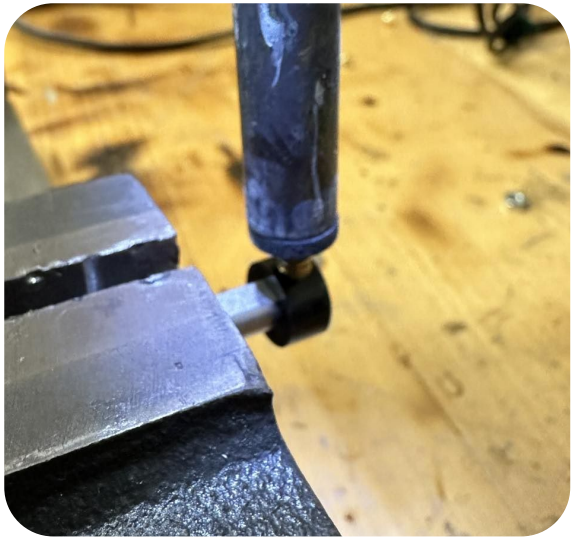
Spent about 12 hours 3D printing these parts











Assembly Process

Laser Cutting

Laser cutting:

- the supports and structure on duron
- the mechanical parts *(gears, coin sorting slide)* on acrylic

Heat Set Inserts:

- Used heat inserts to secure shafts with set screws

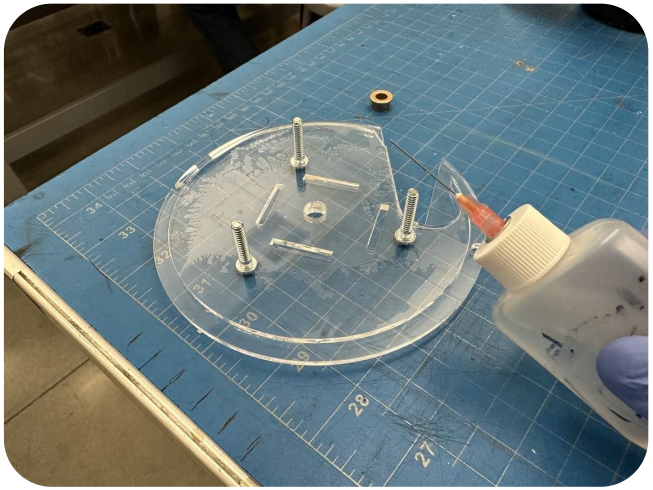
Assembly Process

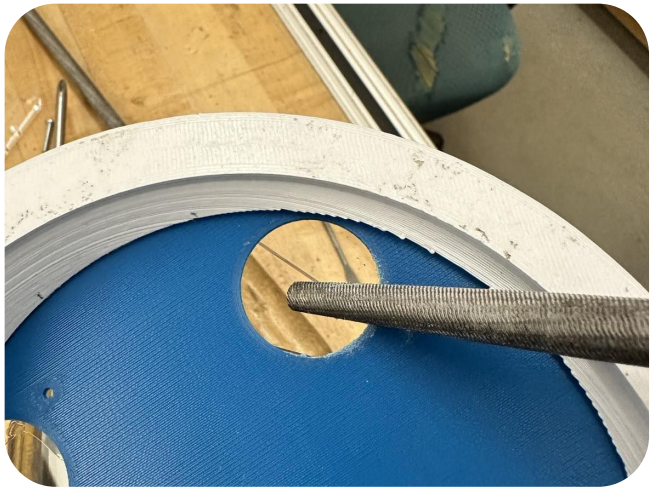
Final Assembly

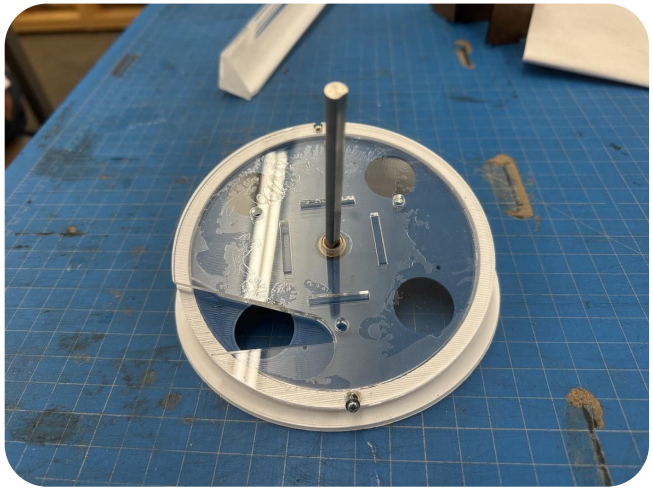
Assembled laser cut and 3D printed parts with acrylic glue and hardware

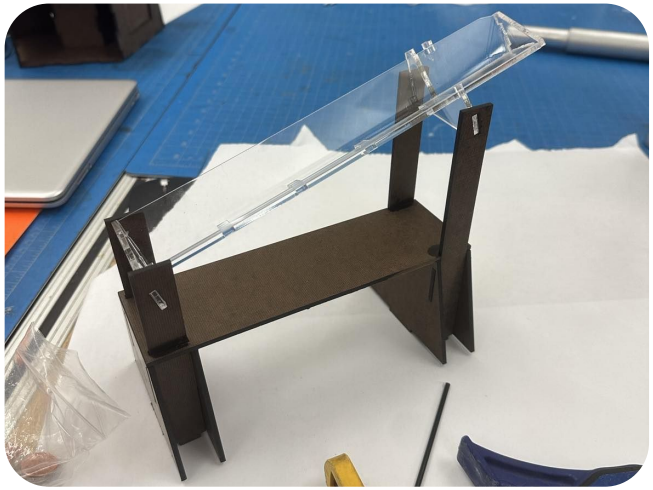
Made some adjustments using filing, sanding, drilling

Piecing supports for frame together and super gluing together









Bill of Materials

- Total number of parts (hardware, 3D printed, and lasercut):
- Total BOM: **$28.86** (Only in final assembly)
- Total Cost: **$36.68** (Includes prototyping and other materials)
- Note: Some materials are free because they were scrap; I just summed up total area needed to laser cut to approximate

Item	ID	Quantity	Base Cost	Cost	
1/4" Shoulder Screw, 3/8"L, 10-24 thread	91259A535	1	$1.40	$1.40	HARDWARE
4-40 set screw, 3/16"L	91375A105	3	$0.20	$0.60	
4-40 Threaded Brass Heat-Set Insert	93365A120	3	$0.15	$0.45	
6-32 Threaded Brass Heat-Set Insert	93365A130	7	$0.15	$1.05	
6-32 × 1/2" machine screw	90272A148	7	$0.03	$0.21	
10-24 hex nut	90480A011	3	$0.03	$0.09	
10-24 Threaded Brass Heat-Set Insert	93365A150	2	$0.25	$0.50	
10-24 × 1" machine screw	90272A247	1	$0.09	$0.09	
10-24 × 1/2" machine screw	90272A242	1	$0.05	$0.05	
Bushing, flanged, 1/4" ID x 1/4" long	6338K411	5	$1.45	$7.25	
Collar, set screw, steel, 1/4"	6432K12	3	$1.50	$4.50	
D-Shaft, Stainless, 1/4"D x 2.00"L	634068	1	$1.50	$1.50	
D-Shaft, Stainless, 1/4"D x 3.00"L	634078	2	$1.90	$3.80	
Spring, Extension, 1.875L, k=0.8, 1.07lb max	1986K66	1	$0.70	$0.70	
Spring, Extension, 1.875L, k=0.8, 1.07lb max	9654K515	1	$1.20	$1.20	
Coin Disk	01	1	$3.02	$3.02	3D PRINT
Bevel Gears	02	2			
Coin Hopper	03	1	$0.00	$0.00	
Acrylic, 0.118 × 12 × 12", Clear	14732	1	$2.45	$2.45	MATERIAL
Acrylic, 0.236 × 12 × 12", Clear	80973	1	$0.00	$0.00	
Duron, 18" x 24" x 1/8"	SS1254825	2	$0.00	$0.00	
TOTAL				**$28.86**	

Reflection

Super proud of first time designing a whole contraption in CAD and with all of these tools in unison ⚙️🔨

Things that went well:

- Pushed myself to build an advanced mechanism with many moving parts
- Started early and was able to pivot smoothly

Things that could have went better:

- Could have prototyped a bit more → especially with the spring, ratchet, and Geneva Mechanism, but was tight on time
- Been more efficient with time → be in PRL when you have reservation; waiting is a waste of time

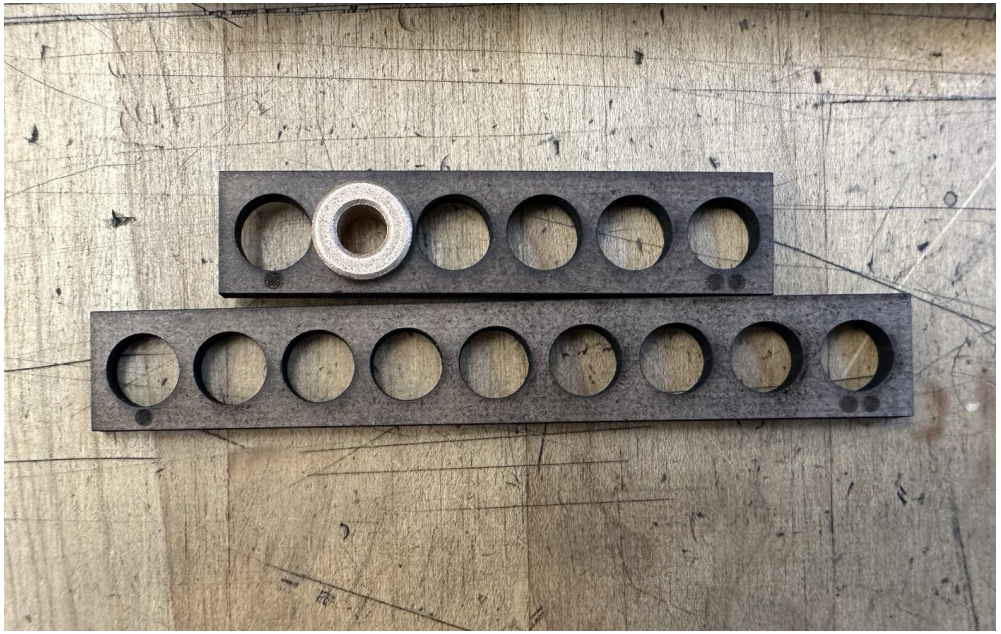
Future:

- I am very confident in building an advanced machine, integrating with the aesthetics and functionality and will build more in the future :)

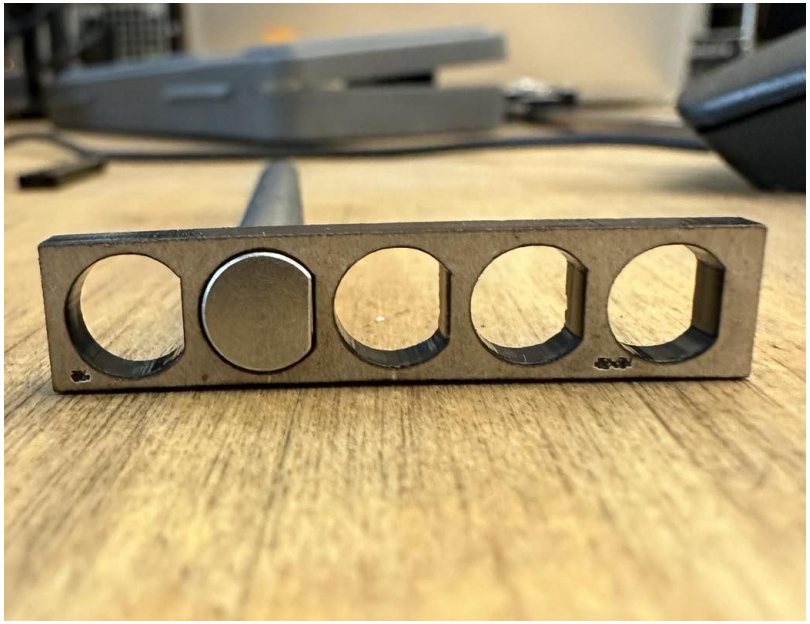
DESIGNED BY WILLIAM PAN COINCEPTION COINCEPTION COINCEPTION COINCEPTION COINCEPTION

Appendix

Miscellaneous Join Tests



0.377” is the best fit for flange bearings



0.05” offset has the right fit for the D-shaft