ME-395 ENGINEERING PRACTICUM-2

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OBJECTIVE- Design and implementation of a mechanical seven-Segment Counter Driven by Cams and Gears.

PARTS REQUIRED- Cams (8), Followers (7), Segments (7), Screw (4), Springs (2), Gears (4), Plates (3), Shaft (1), Pushbutton (1), Rubber bands (2).

All parts are to be 3D-printed and made from Polylactic Acid (PLA) material.

THEORY-

Ratchet and Pawl Mechanism is used in various engineering instruments that support one way motion and used to prevent motion in opposite direction. Ratchet mechanism also converts continuous motion into intermittent motion. In seven segment counters if we press the push button in a continuous manner, it will show the numbers one at a time.

We have designed the push button and spring in a way that it can only goes from 0 to 9 and then reset to 0 without requiring any manual intervention, it can't go in reverse manner.

This mechanism also help us to minimize the wear in the components as counter counts in only one direction, reduces the stress in the components that results in longer working life.

WORKING PRINCIPLE-

1. Seven-Segment Mechanism:

- Each of the seven segments have two states: ON or OFF.
- WE ARE Using a camshaft to control the segments.
- Either pushing a segment into the OFF position or let it stay ON.
- WE are using 8 CAMs.

2. Camshaft Design:

- The camshaft will rotate in 10 steps, with each step corresponding to a new number.
- For each step (0–9), the cam profiles will determine which segments are engaged

- We have designed the cam profiles such that each number gets its unique combination of segments by varying the lift and dwell angles.

3. Gears and Key Mechanism-

- We are using gear train to control the rotation of the camshaft.
- The key mechanism is connected to a ratchet and pawl system that advances the camshaft by a fixed increment with each rotation (e.g., 36° for each of the 10 positions).

4. Reset Mechanism:

- After the ninth position (number 9), the camshaft should reset to the first position (number 0).
- We are achieving this by ensuring that making sure that after 10 rotation each cam is its initial state because it had already rotated by 360 degrees**.**

5. Segment Control Layout:

- Each segment of the display is a lever that is pushed by the cam into the ON position and retracted into the OFF position by a spring.

Calculations:

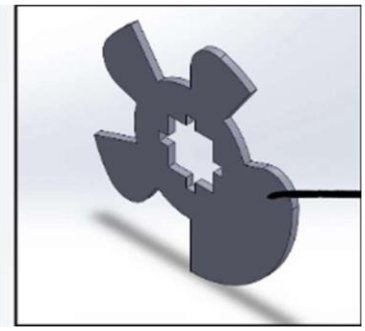
1. **Calculation of the Cam's Degree of Rotation for One Lift -**

- To represent digits from 0 to 9, a total of 10 positions are required. Thus, for each lift of the ratchet and pawl mechanism, the cam must rotate by:
- **Rotation per lift = 360° / 10 = 36°**

2. Calculation of the cam's position for representing a particular digit-

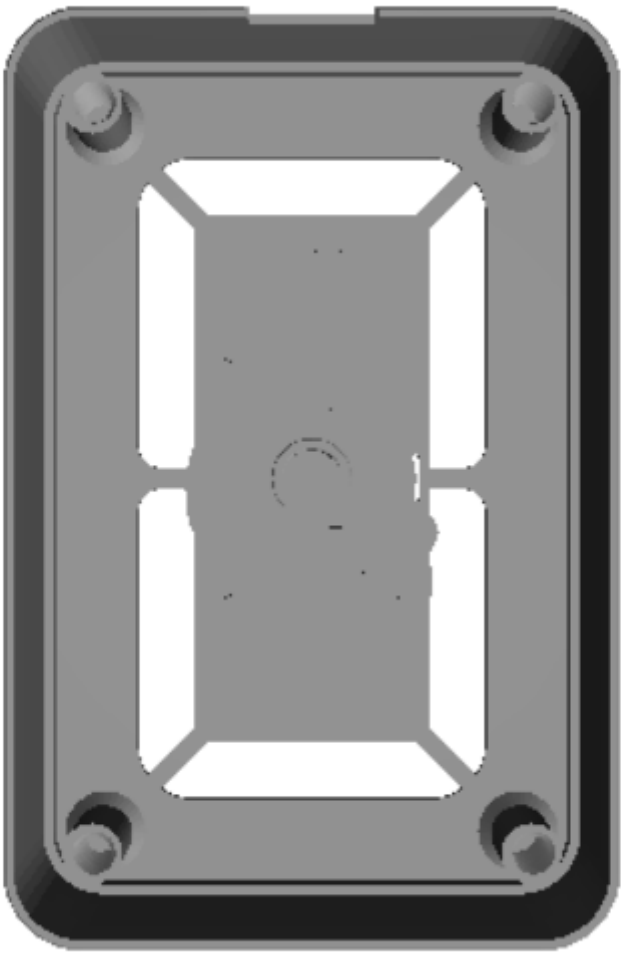
	A1	A2	B1	B2	C1	C2	D1	D2
0							CLEARANCE	
1							CLEARANCE	
2							CLEARANCE	
3							CLEARANCE	
4							CLEARANCE	
5							CLEARANCE	
6							CLEARANCE	
7							CLEARANCE	
8							CLEARANCE	
9							CLEARANCE	

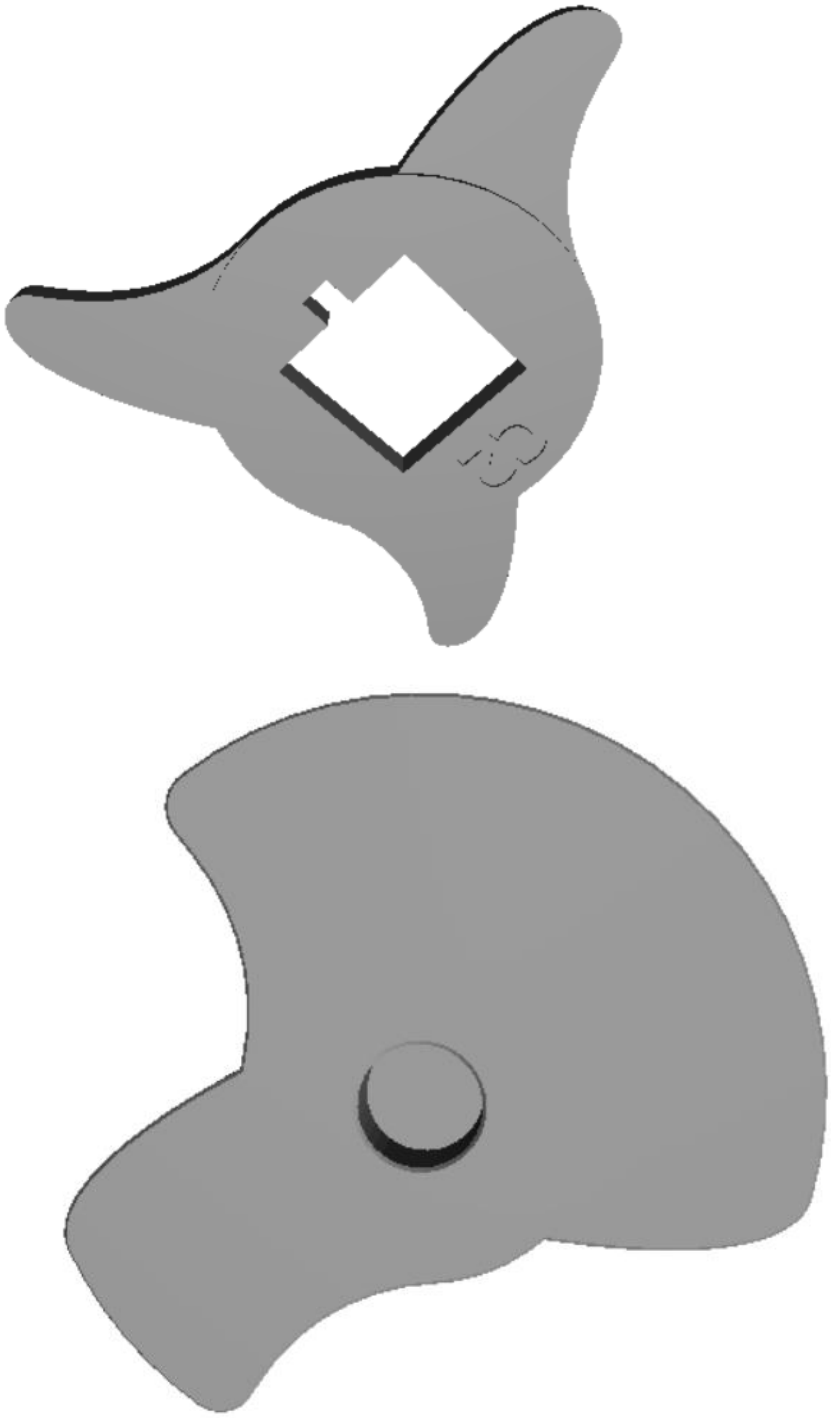
3. Cam design selection-

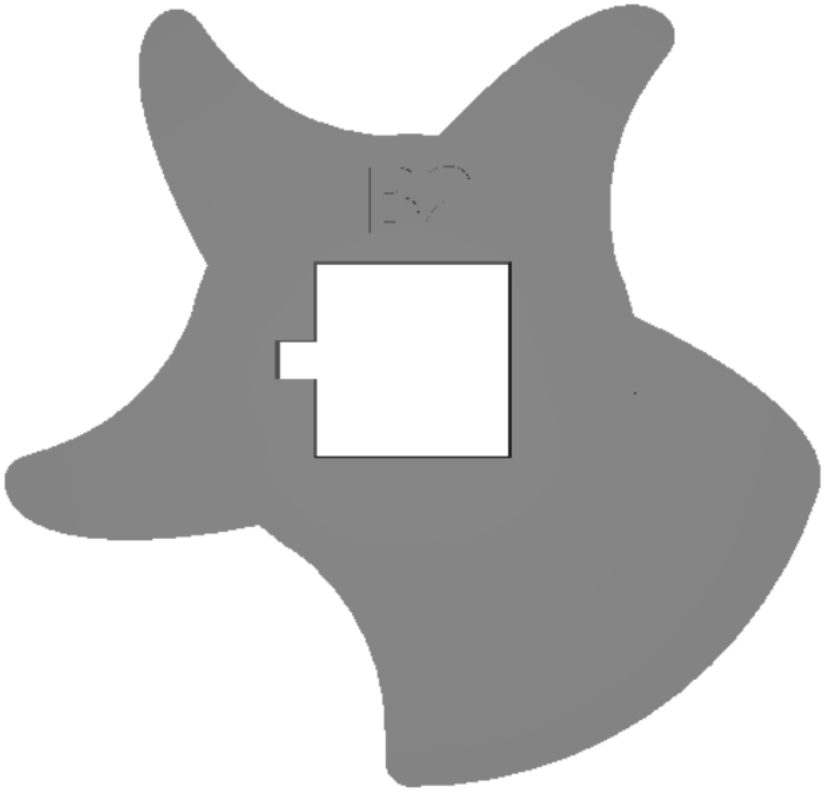


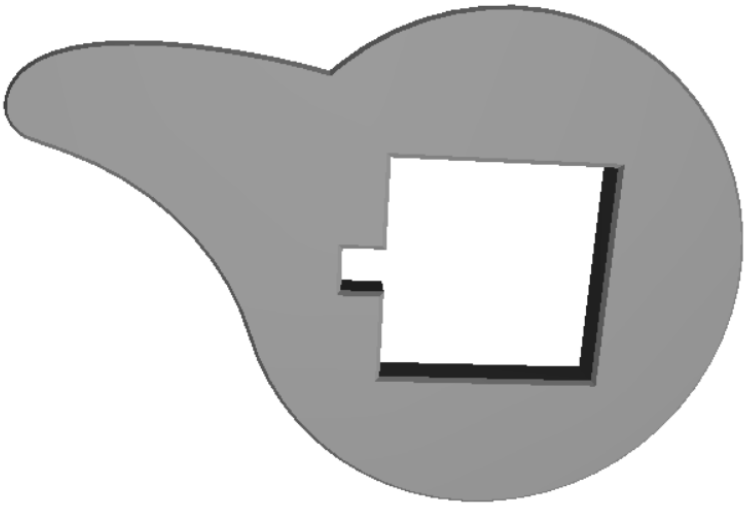
The protruded part represents OFF state which in this case represents digits 3,4,5.

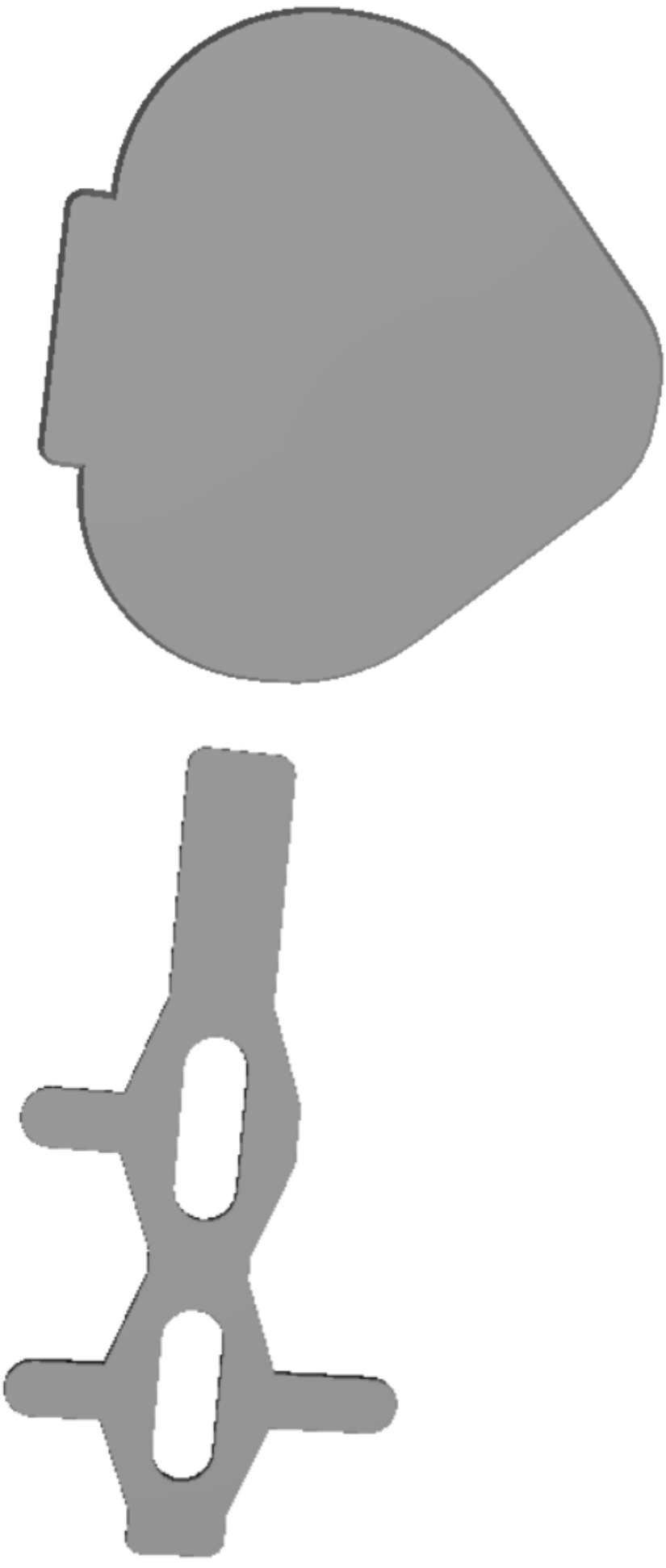
Parts (cams) Created in Solidworks:

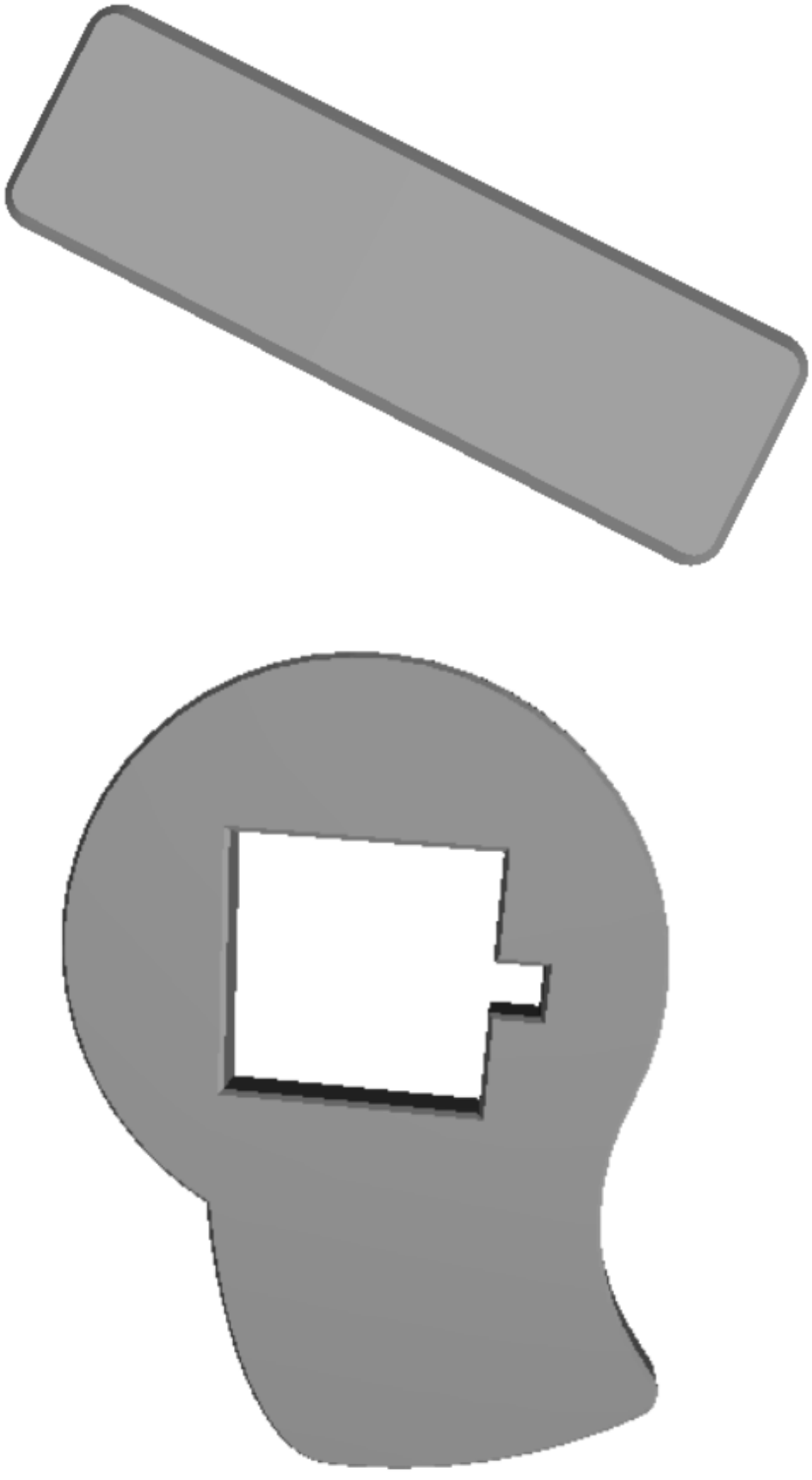


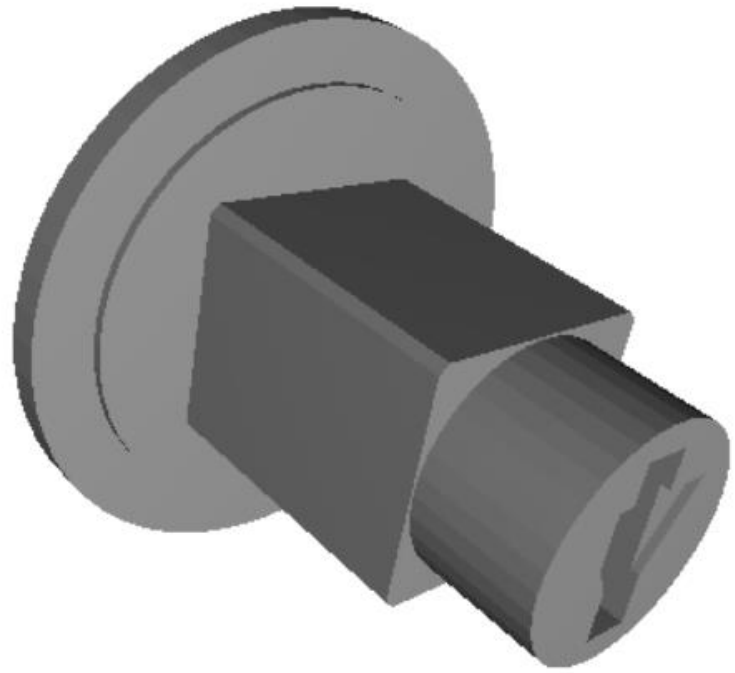


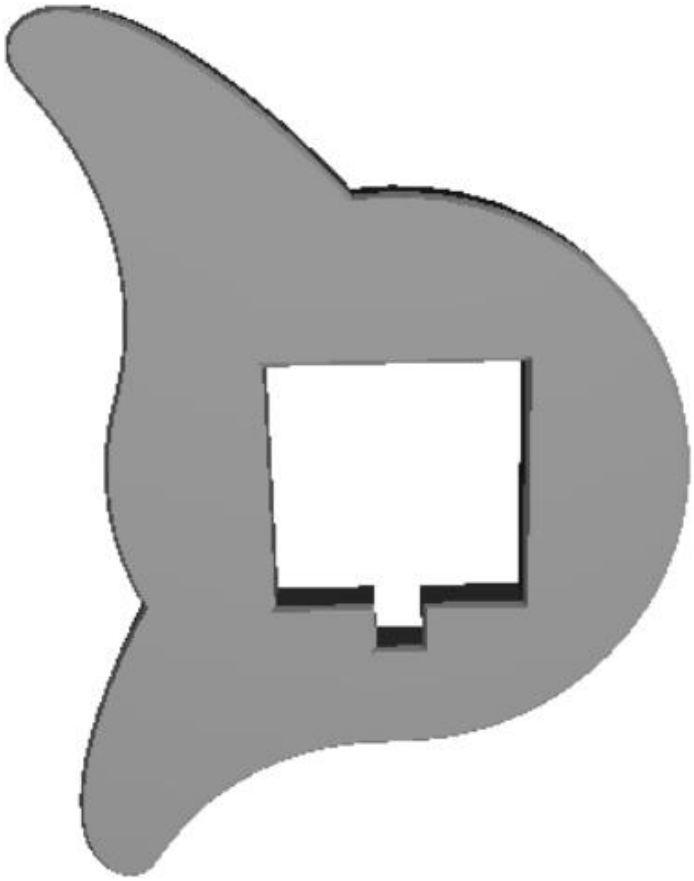


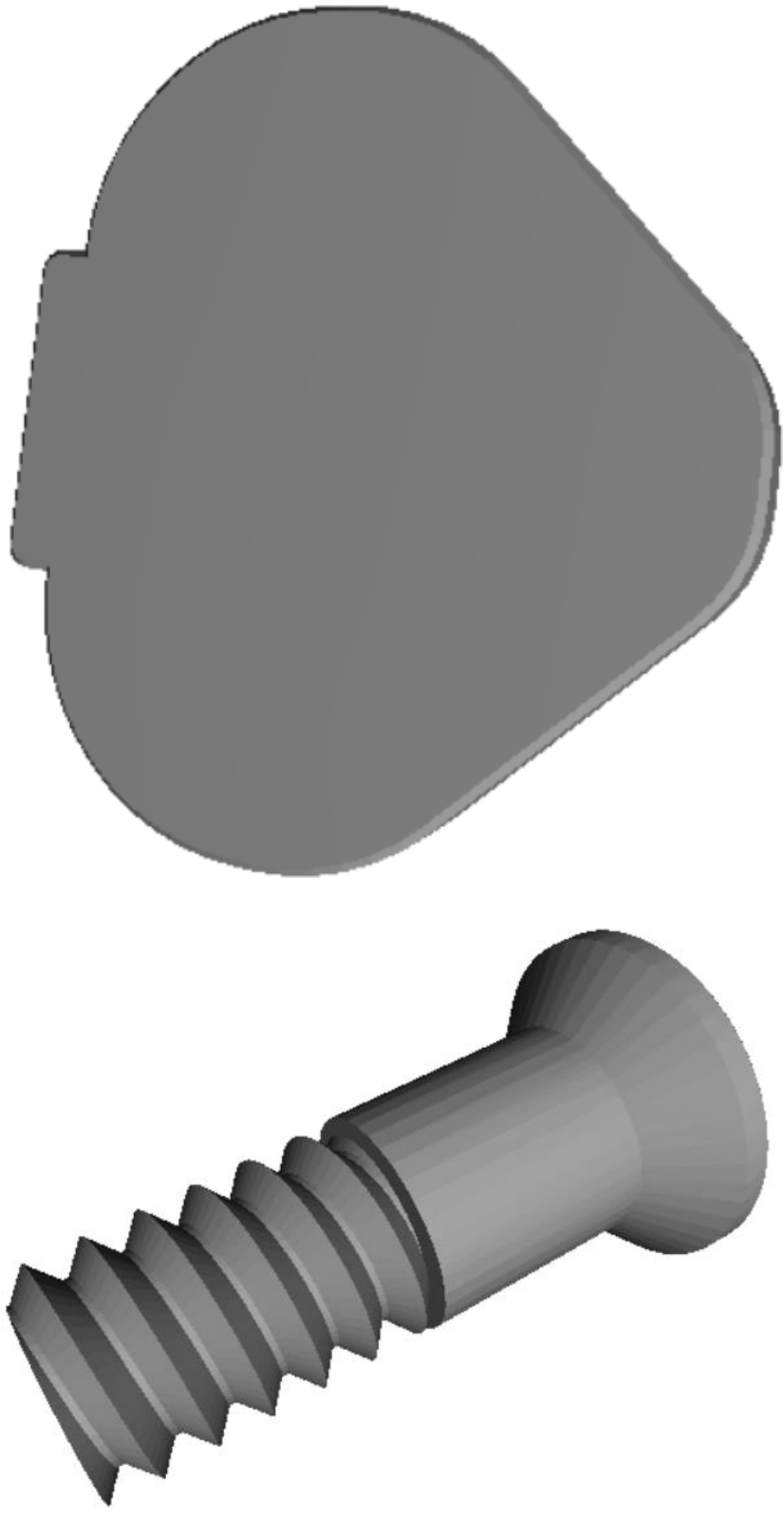


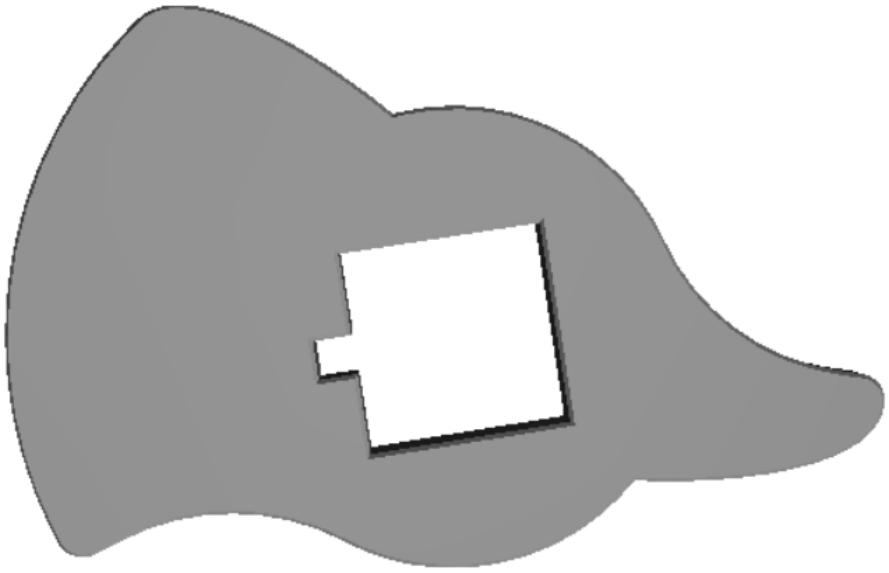


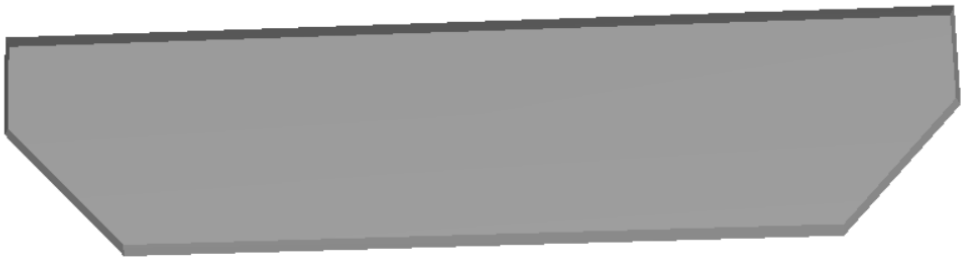


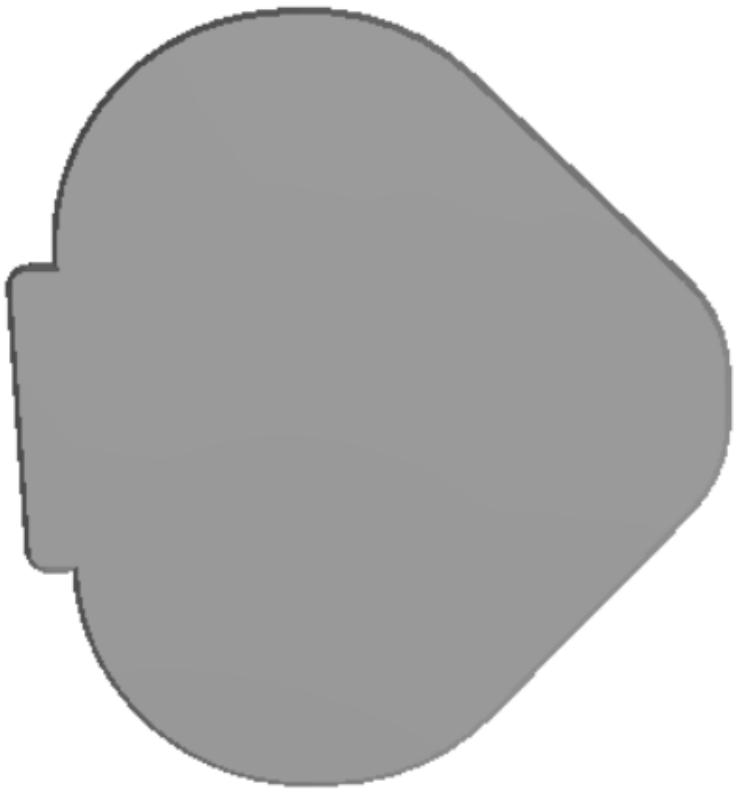


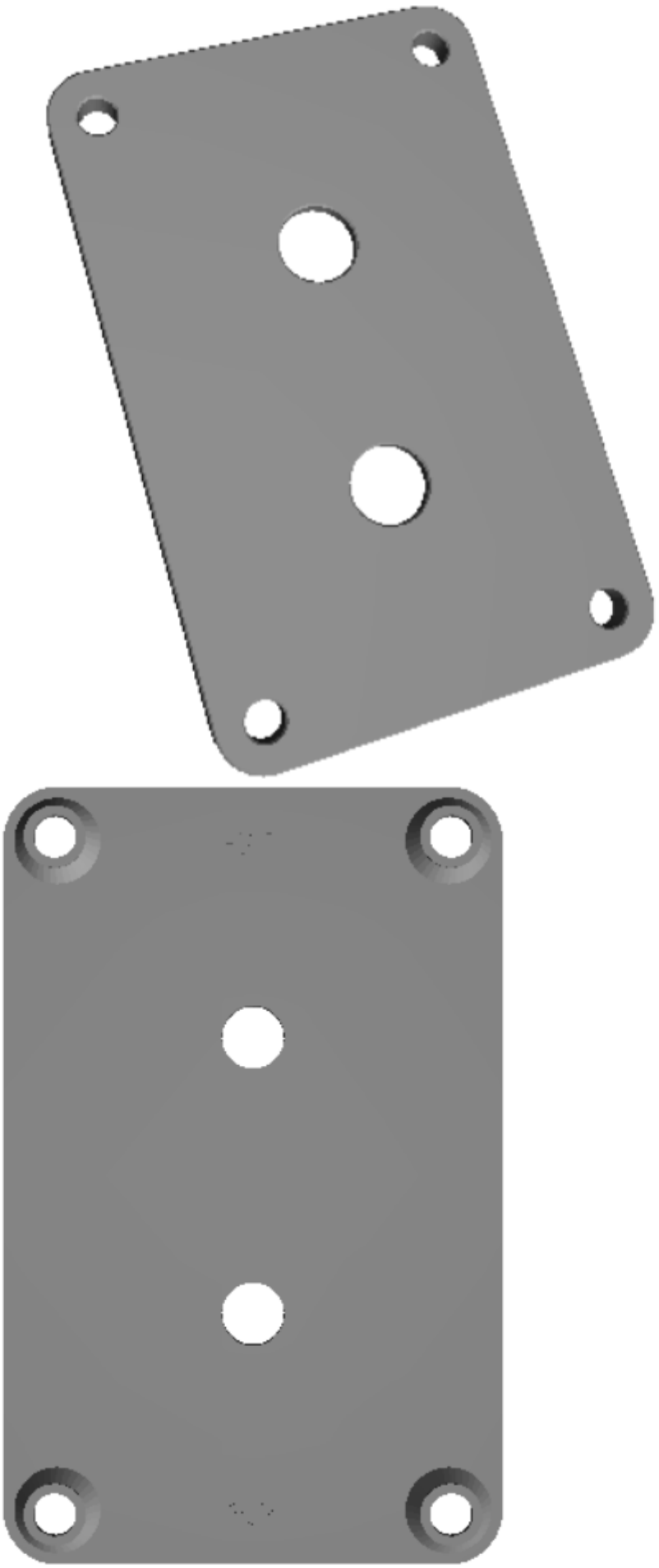


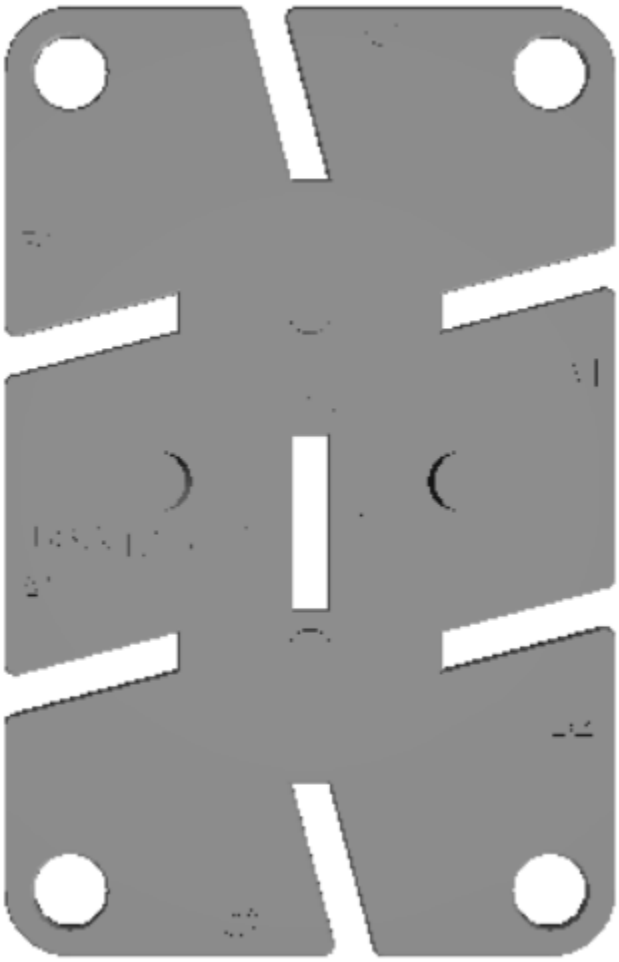


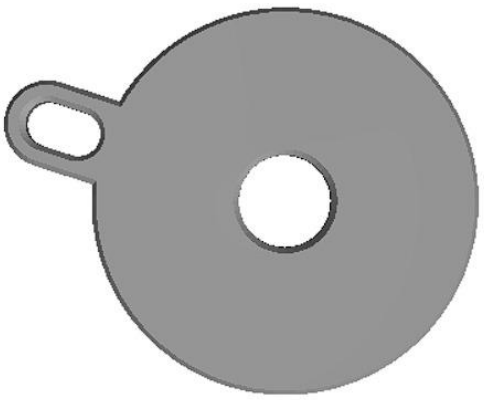


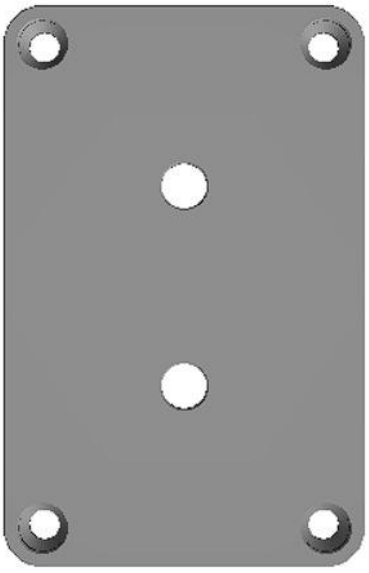




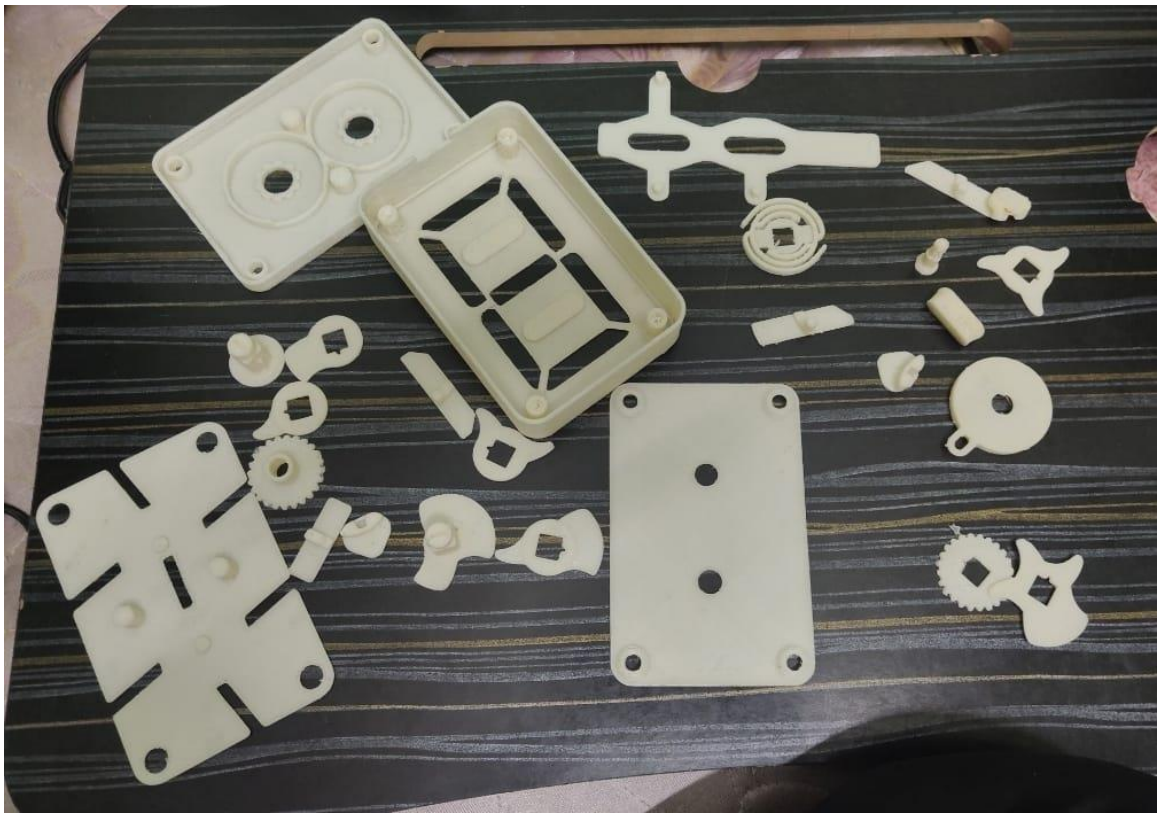




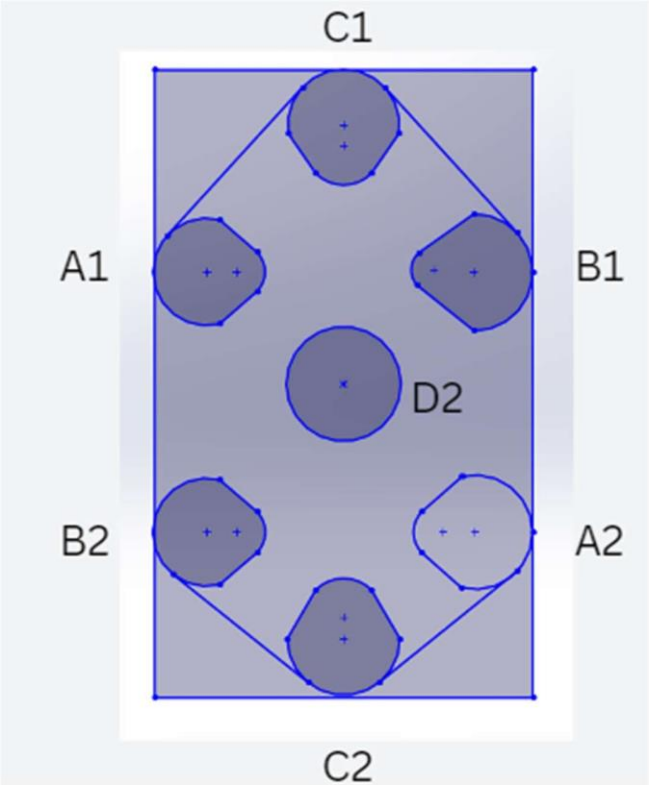




3-D PRINTED MODELS:

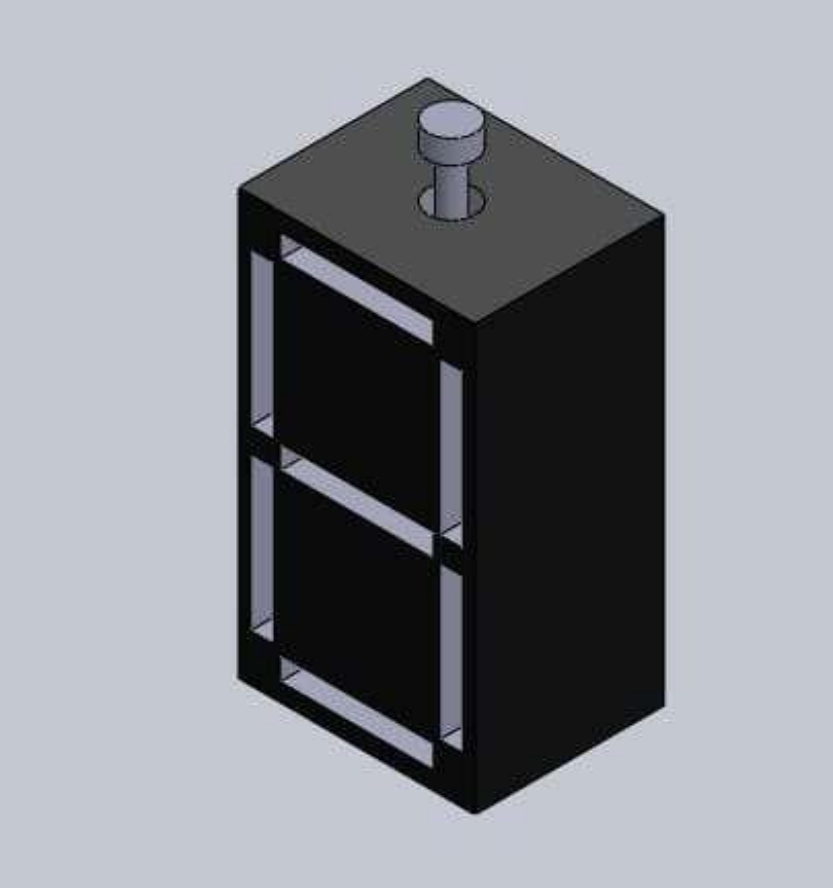


2-D Design of Model-



These cam followers would house the 7 segments that would be used to display digits.

3-D Design of Model-



Innovation and Application:

- Since the push button is the trigger involved here, we can use different types of sensors corresponding to varying physical conditions which will activate it.
- Some of the sensors involved are electric, heat, and proximity sensors.
- This allows us to use the counter without manual labour or in extreme physical situations where human intervention is difficult.
- Mechanical processes such as hammering, pressing, and punching, which helps to monitor the number of impacts.
- High-pressure environments, such as the deep sea to keep track of equipment usage or structural monitoring.
- In nuclear reactors to detect and measure radiation or particle flux for monitoring, safety, and operational control.
- In high temperature and magnetic fields to measure radiation and particle flux in environments like fusion reactors and accelerators with designs to withstand extreme conditions.

Optimization:

- Size optimization: A compact design reduces the size of parts while keeping the display clear, using smaller parts and segments to take up less space.
- Fewer moving parts: Reduce the number of mechanical components involved in segment movement, making the system simpler and easier to operate.
- Use of rubber bands instead of multiple springs for the cam return mechanism.

Future goals:

- Enhancing practical usability by integrating sensors
- Drive product commercialization
- Convert to a multi-digit format