Anti-ooze Valve System for Pellet-based, Highflow Extrusion 3D Printing

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ABSTRACT

This project is aimed at addressing a critical flaw in pellet-based 3D printing – the unwanted oozing of melted material through the nozzle during printing pauses. Due to the gravity-fed nature of the pellets, the material is unable to be retracted, resulting in the oozing and stringing of the melted pellets. There are currently no mechanisms on the market to tend to this issue, so the team set on designing a high temperature valve-system to redirect the flow of melted pellets during temporary stops in printing to a designated storage reservoir.

GOALS

Objective 1

Sustainable 3D printing; faster print speeds while minimizing waste

Objective 2

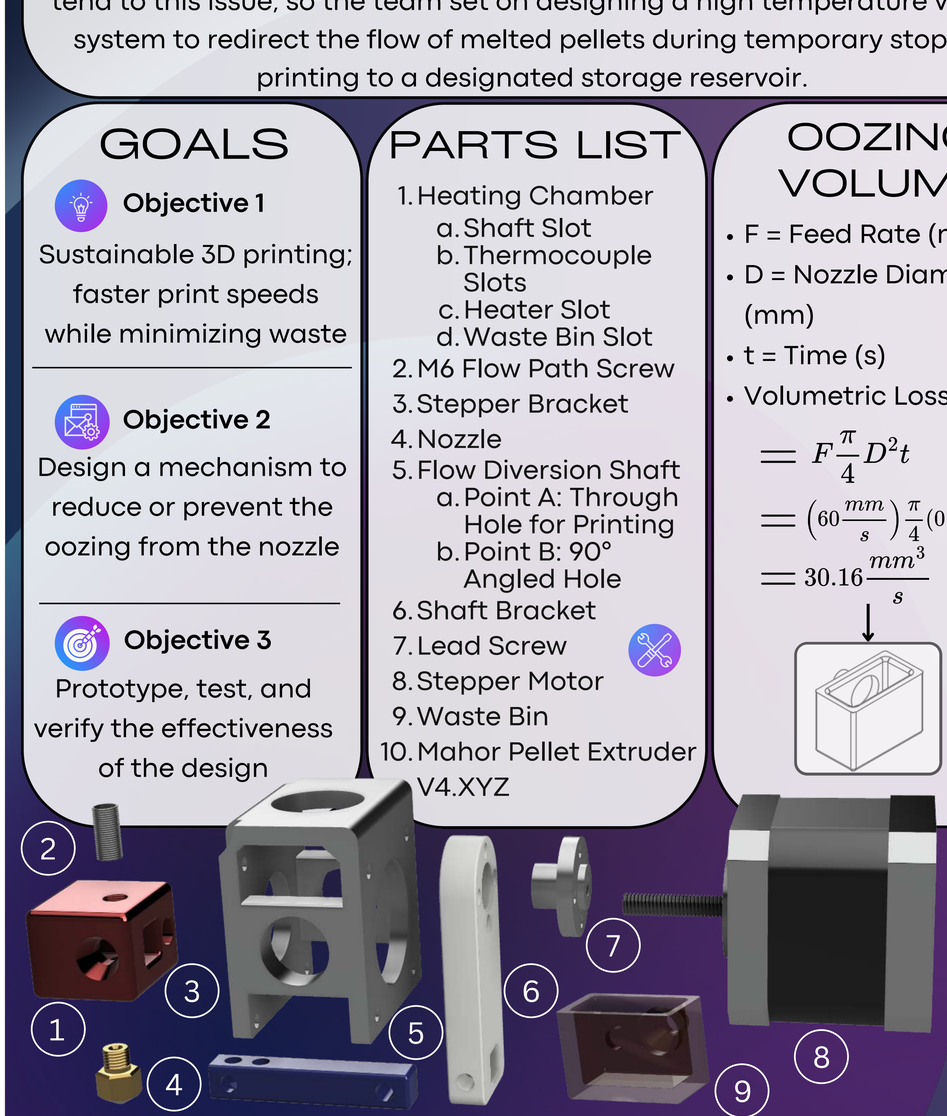
Design a mechanism to reduce or prevent the oozing from the nozzle

Objective 3

Prototype, test, and verify the effectiveness of the design

PARTS LIST

1. Heating Chamber
   a. Shaft Slot
   b. Thermocouple Slots
   c. Heater Slot
   d. Waste Bin Slot
2. M6 Flow Path Screw
3. Stepper Bracket
4. Nozzle
5. Flow Diversion Shaft
   a. Point A: Through Hole for Printing
   b. Point B: 90° Angled Hole
6. Shaft Bracket
7. Lead Screw
8. Stepper Motor
9. Waste Bin
10. Mahor Pellet Extruder V4.XYZ



OOZING VOLUME

- F = Feed Rate (mm/s)
- D = Nozzle Diameter (mm)
- t = Time (s)
- Volumetric Loss

$$= F\frac{\pi}{4}D^2t$$

$$= \left(60\frac{mm}{s}\right)\frac{\pi}{4}(0.8)^2\,(1s)$$

$$= 30.16\frac{mm^3}{s}$$

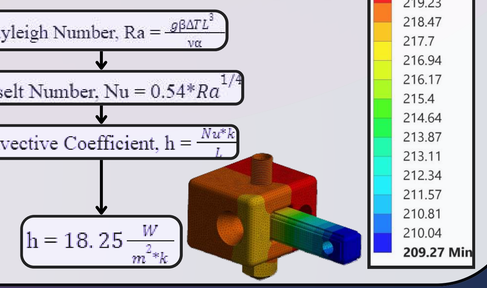
CONTROLS & AUTOMATION

- G-code is generated by slicing an object in Repetier-Host then modified manually
- Custom parameters are set for valving system, including 2 separate heating chambers, and an additional stepper
- Printer is tricked into believing there are 2 extruders to accommodate extra stepper

M163 S0 P0.0	M163 S0 P1.0
M163 S1 P1	M163 S1 P0
M164 S0	M164 S0
G1 F5000 E35.0; Move shaft to Point B from Point A	G1 F150 E50 ; Extrude 50mm of filament at a speed of 150mm/min

FINITE ELEMENT ANALYSIS

- Configured heating chamber to ~2.3 degree gradient to the end of nozzle and flow path to storage reservoir
- Displayed a 10 degree temperature gradient across flow control shaft
- Verified results during testing

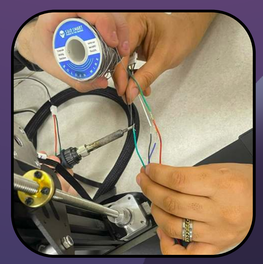


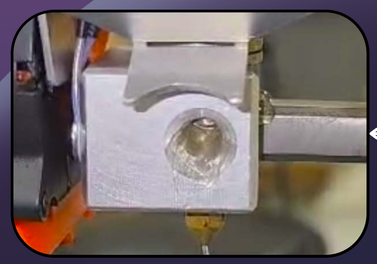
OUTCOMES

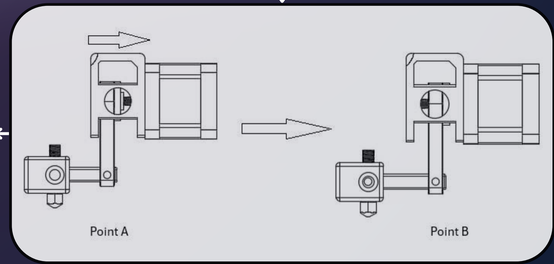
- Functioning prototype with variable design for different extruders
- Effectively able to redirect flow
- Higher quality print with less oozing
- Custom G-code allows for secondary stepper to act as an additional extruder

OPERATION

- Steel shaft slides in aluminum heating chamber.
- Stepper motor rotates to drive lead screw for linear motion.
- Lead screw, attached to bracket on the shaft, moves it from Point A to Point B.
- Point A: through hole for printing; Point B: Diverges flow to waste
- Stepper motor programmed in G-Code to divert excess flow into storage during printing pauses.
- Content in waste bin can be removed and recycled back into pellets







TDD CAPSTONE