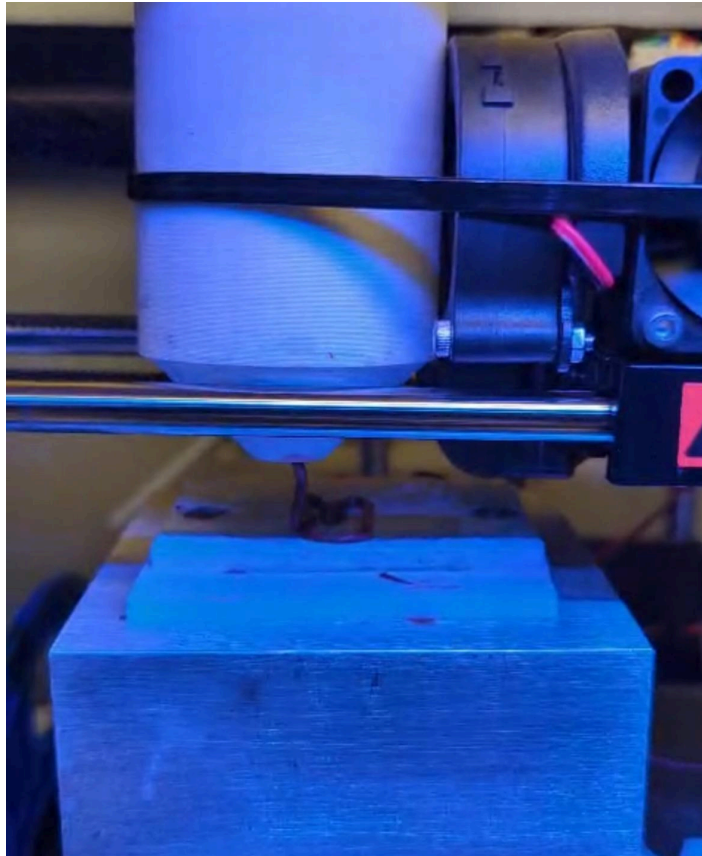


ChocBot: Retrofitting Extruder for Chocolate Design

MIE12 - ME397: Senior Design II



**Ibrahim Ahad
Jamye Brothers
Neil Rasmussen
Qasim Rizvi
JJ Sebastian**

Spring 2025

Accomplished from February 2025 to EXPO Day

- **Initial LEGO plunger concept:** Began with a syringe-style design inspired by Amazon chocolate pen methods, but trials showed it lacked the necessary force for our application.
- **Developed mechanical gearbox:** Ibrahim designed a custom gearbox to improve torque and control for the plunger system, though force was still insufficient.
- **Transition to pump-based extrusion:** Switched to 6V and later 12V pumps after testing revealed higher force was needed to push chocolate through tubing.
- **Adapted baking tip nozzle:** Modified a baking tip into a sealed nozzle, allowing chocolate to fill and build pressure before extrusion for smoother flow
- **Integrated heating and cooling system:** Ensured chocolate remained liquid all throughout transfer and solidified quickly upon deposition using a heated tube and cooled print bed.
- **Prepared custom print files:** Created chocolate-compatible designs, sliced using Dremel software, and uploaded via SD card for automated printer operation.

Over the course of the semester, we explored multiple extrusion mechanisms, starting with a syringe-based approach similar to the Chocolate Pen bought from Amazon, before shifting to motorized pumps better suited for the viscosity of melted chocolate. We also developed a sealed baking tip nozzle that allowed pressure to build more effectively, improving extrusion quality. Each design brought new insights, and by EXPO Day, we had successfully integrated heating, cooling, and digital modeling to enable reliable chocolate 3D printing (**See ‘Appendix’ for more details**)

Future Recommendations

- **Implement temperature control system:** Maintain the chocolate within a narrow temperature range to avoid nozzle clogging or poor extrusion.
- **Add flow and pressure sensors:** Monitor chocolate movement in real time to ensure consistent and reliable prints.
- **Regulate flow rate:** Essential for successful multi-layer printing and maintaining consistent layer thickness.
- **Add side-cooling mechanisms:** Help solidify layers evenly and eliminate the need for manually flipping the print during the process

Throughout this project, we discovered how sensitive chocolate printing is to factors like temperature, flow, and cooling. Using more advanced controls and automation to regulate these factors will significantly improve performance and consistency. We hope our work provides a solid foundation for future teams to refine and build upon (**See ‘Appendix’ for more details**)

Purchased Items

Amazon

Chocolate Pen Real Cooking: **\$26.85 [NOT USED ON PROTOTYPE]**

AdaFruit

Electric Heating Pad: **\$5.95 (x3) [2 USED ON PROTOTYPE]**

Electric Cooler Module & Heatsink Assembly: **\$34.95**

3.5v - 12.8v Adjustable Power Supply: **\$17.50 (x3)**

6v DC Powered Liquid Pump w/ Silicone Tubing: **\$24.95 [NOT USED ON PROTOTYPE]**

12v DC Powered Liquid Pump w/ Silicone Tubing: **\$24.95 (x2) [1 USED ON PROTOTYPE]**

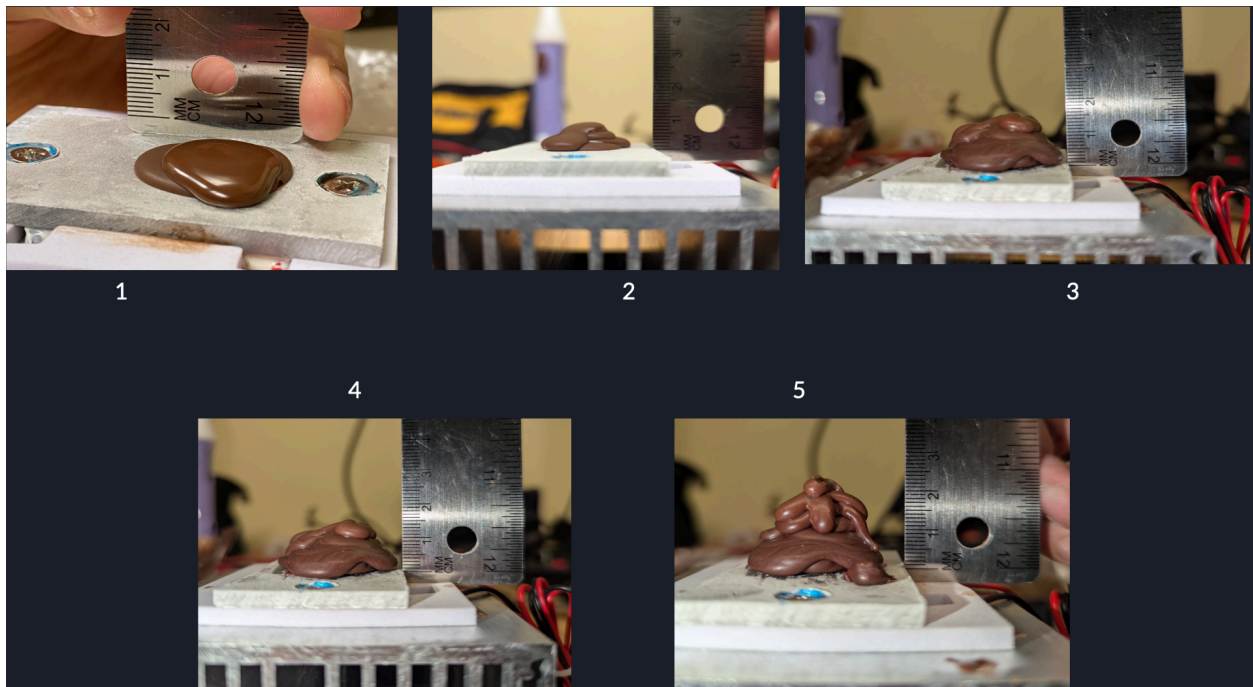
2.1mm DC Barrel Jack to Alligator Clips: **\$1.95 (x3)**

Total Spent: **\$212.85**

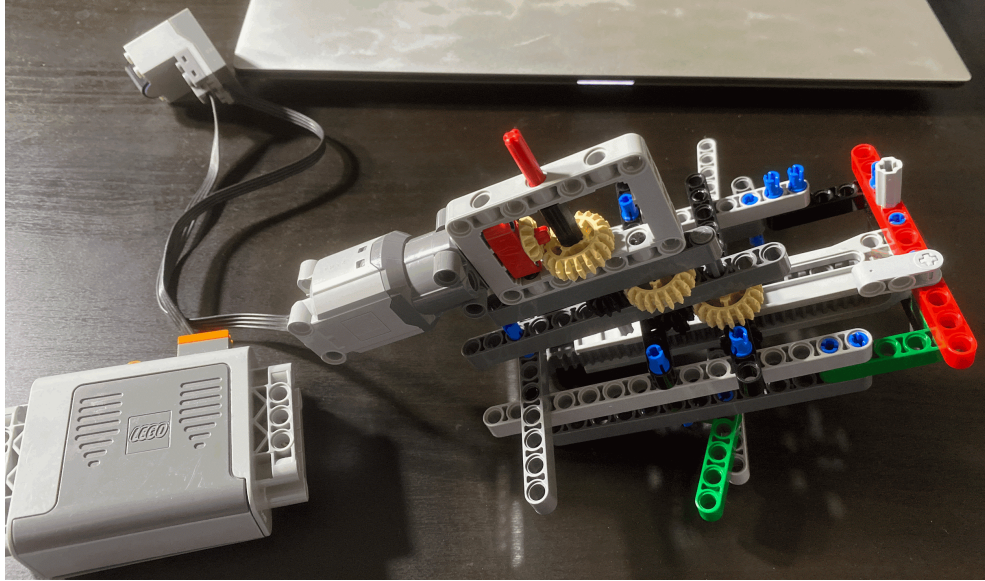
Equipment Used on Prototype: **\$130.15**

Remaining Balance: **\$95.07**

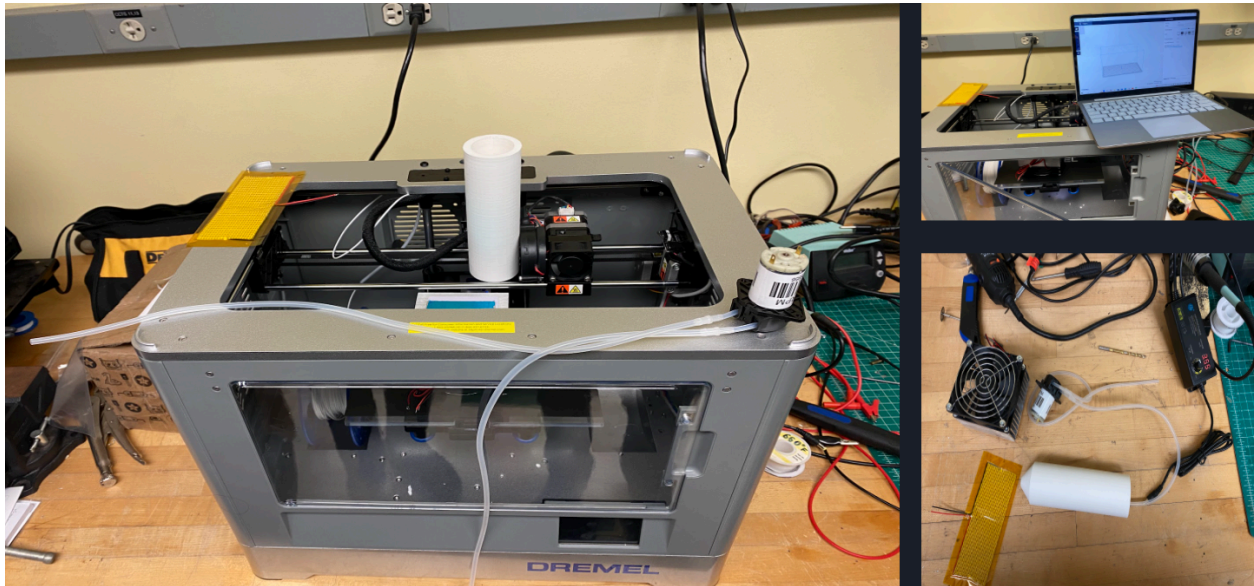
Appendix



Early extrusion trials showing chocolate hardening behavior during layering. Used to test layer height limits and solidification timing for optimal print quality (Feb. 2025)



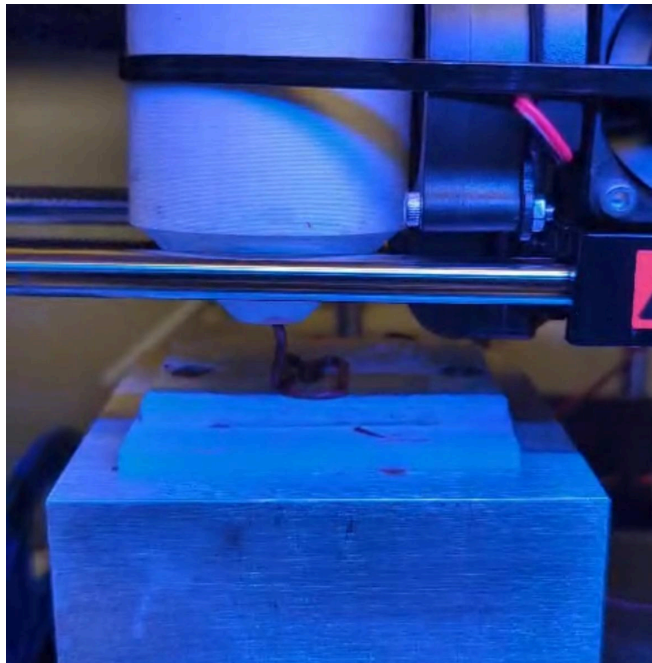
Early design featuring the Lego plunger with attached gearbox regulator, inspired by Real Cooking's chocolate pen. Later scrapped due to insufficient extrusion force, leading to the adoption of pump-based system **(Feb. 2025)**



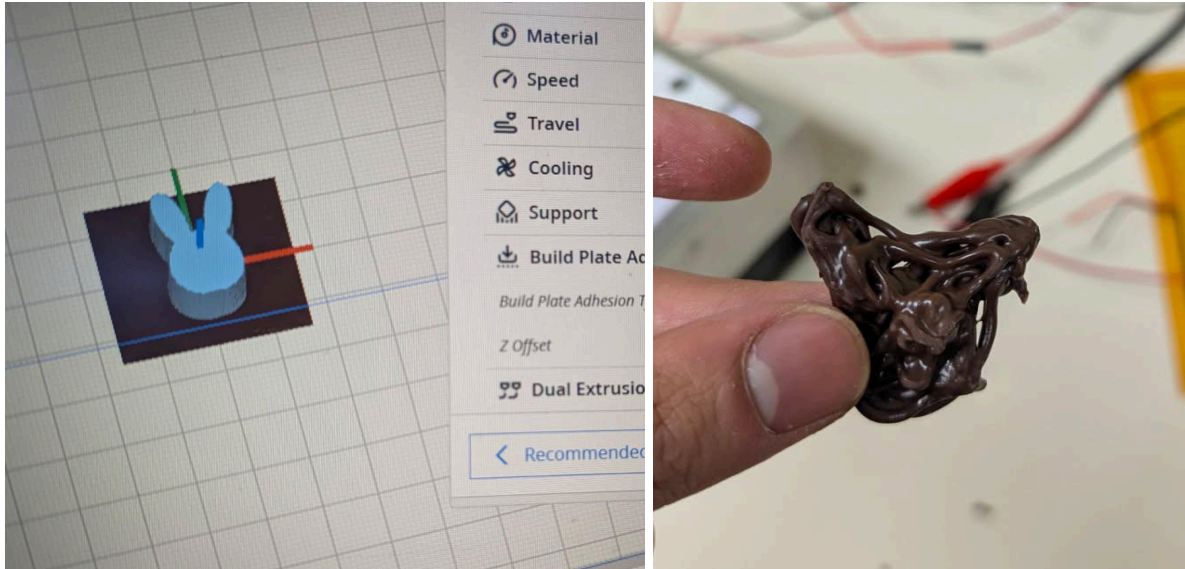
Initial setup during pump-based extrusion trials, outlining the proposed setup for integrating the peristaltic pump with the printer system **(Mar. 2025)**



Team members holding an early iteration of the nozzle system to push chocolate through the white housing. Later versions improved materials, tighter seals, and heating (**Mar. 2025**)



Screenshot from a milestone test showing the extruder successfully depositing and cooling chocolate onto the print plate proving functionality of the full system (**Apr. 2025**)



Side-by-side of the “bunny head” model in Dremel slicing software and its printed result. This test confirmed successful custom file uploads and helped refine optimal flow rate, temperature, and cooling conditions (**Apr. 2025**)



Early successful multi-layer prints, a solid shape and a hollow cube, achieved by pausing between layers to allow cooling (~30 sec–1 min), manually flipping, and continuing the print, marking a breakthrough in the layering process (**Apr. 2025**)



(Left to right): Ibrahim Ahad, Dr. Michael Brown, J.J. Sebastian, Neil Rasmussen, Jamye Brothers, Qasim Rizvi (UIC Engineering Expo — April 25, 2025)



(Left to right): Qasim Rizvi, Jamye Brothers, J.J. Sebastian, Dr. Pranav Bhounsule, Ibrahim Ahad, Neil Rasmussen (UIC Engineering Expo — April 25, 2025)

*We would like to express our appreciation to **Dr. Michael Brown & Dr. Pranav Bhounsule** for their support, mentorship, and encouragement throughout the course of this project. Their guidance and expertise were key to our progress, and it was an honor to present our work alongside them at the Expo.*