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PLA-S-TECH: PLA Sustainable Technology

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Introduction

At the L3Harris Student Design Center (L3HSDC) at Florida Tech, there are many 3D printers active at any given time to complete print requests from students and faculty. The L3HSDC requested a machine to recycle 3D printing material in order to minimize plastic waste and reduce their material costs from 3D printing, as prints often require wasteful support structures or may fail altogether.

Reducer

- Shredder – 36 stainless steel blades powered by a CIM motor and heavy-duty reduction gearbox produce 230 N-m (170 ft-lb) of overall torque
- Filter – Double-layered vibration table with access door to remove material larger than 3mm
- Storage – Funnel container with volume enough to store up to 2.5 kg of shredded PLA plastic
- Feeder – Motorized gears transfer a constant volume of plastic into the extruder mechanism

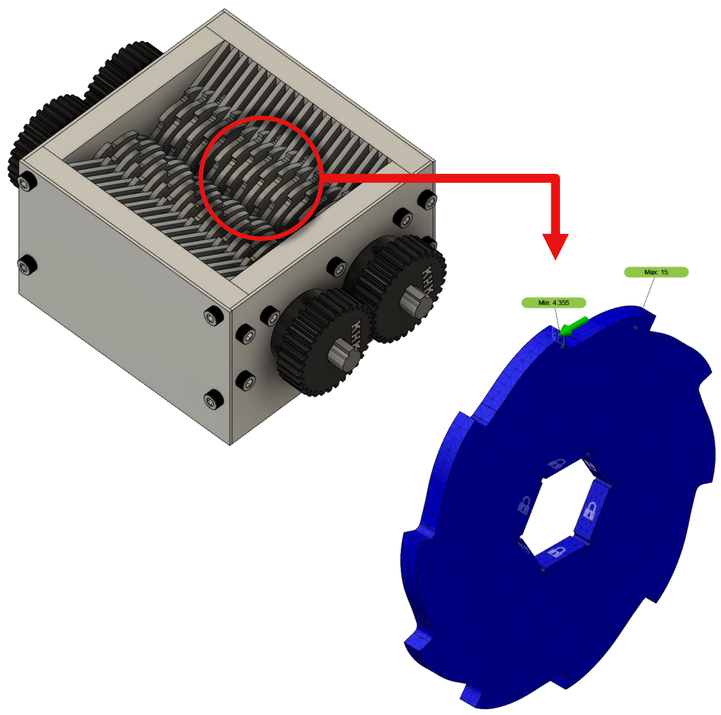

Figure 2: Shredder Assembly & Blade Analysis

Objectives

1. Design, build, and test a machine capable of:
   - Breaking PLA plastic into smaller pieces
   - Filtering and storing the broken down plastic
   - Melting plastic into recycled filament
   - Ensuring filament diameter is 1.75mm
   - Wrapping recycled filament on a standard spool
2. Design the machine with customer requirements:
   - Relatively small footprint (3’ x 3’ x 6’)
   - Comprised of commercially available parts
   - Accessible components for easy maintenance
   - User-friendly and safe to operate

Producer

- Extruder – Nitrided steel injection mold pipe melts plastic at 220°C and uses a three-stage compression screw to extrude the new filament
- Tolerancing – Standard 3D printer extruder gears drive the filament towards the spool while using a filament sensor to keep diameter at 1.75mm
- Spooler – A dual-stepper lead screw and limit switch assembly receives and spools the filament

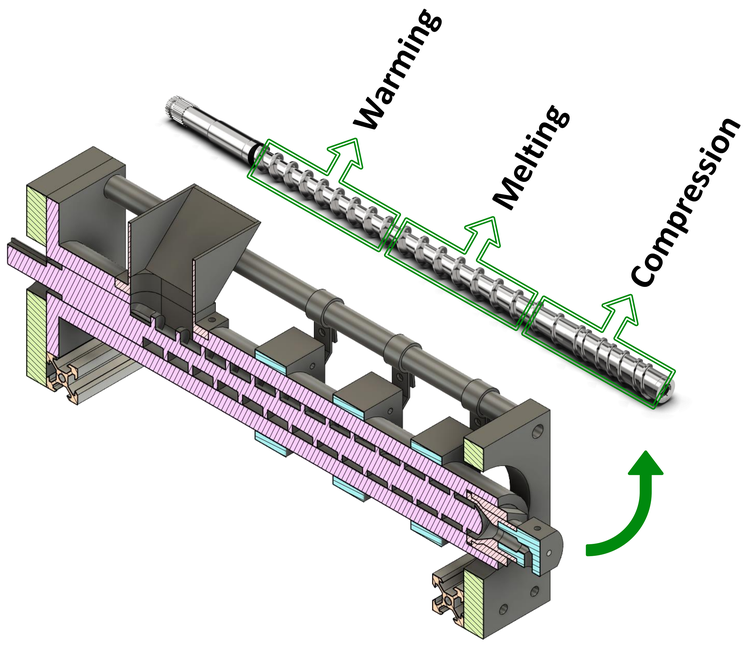

Figure 3: Section Cut of Extruder Mechanism

Final Design

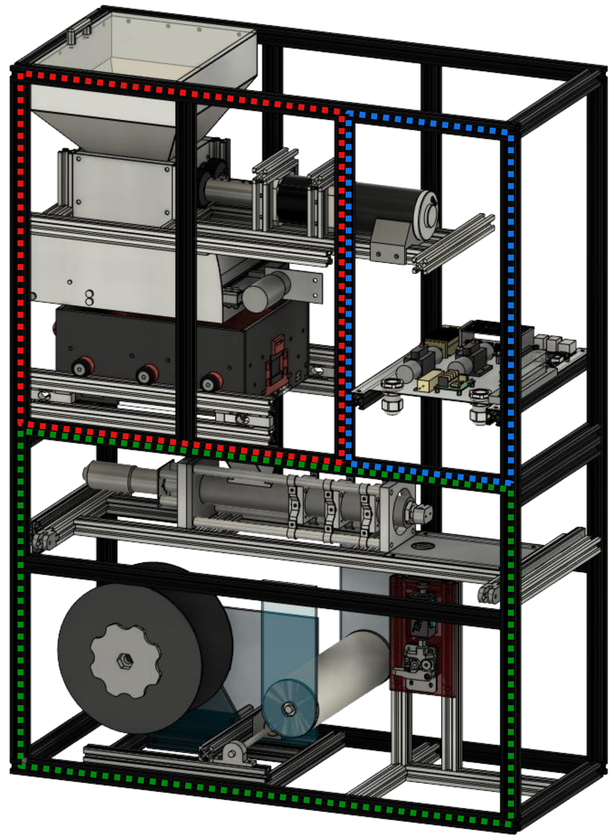

Figure 1: Recycler Assembly (Uncovered)

Automation & Controls

- Automation – Raspberry Pi uses Python code to communicate with serial devices via I2C & UART
- Controls – PID control loops read thermistor and encoder data for extruder heating and spooler motion, respectively
- Safety – Current sensing, circuit breakers, and an emergency stop button ensure safe operation

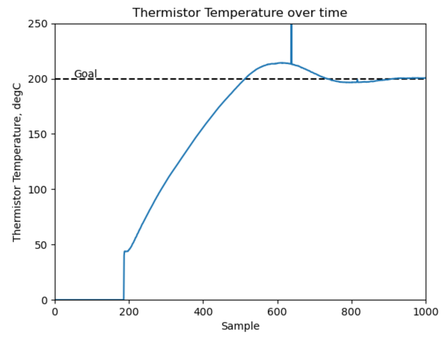

Figure 4: Heat Block Temperature Control