Pellet Fed 3D Printer for Direct Polymer Extrusion

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Problem Statement

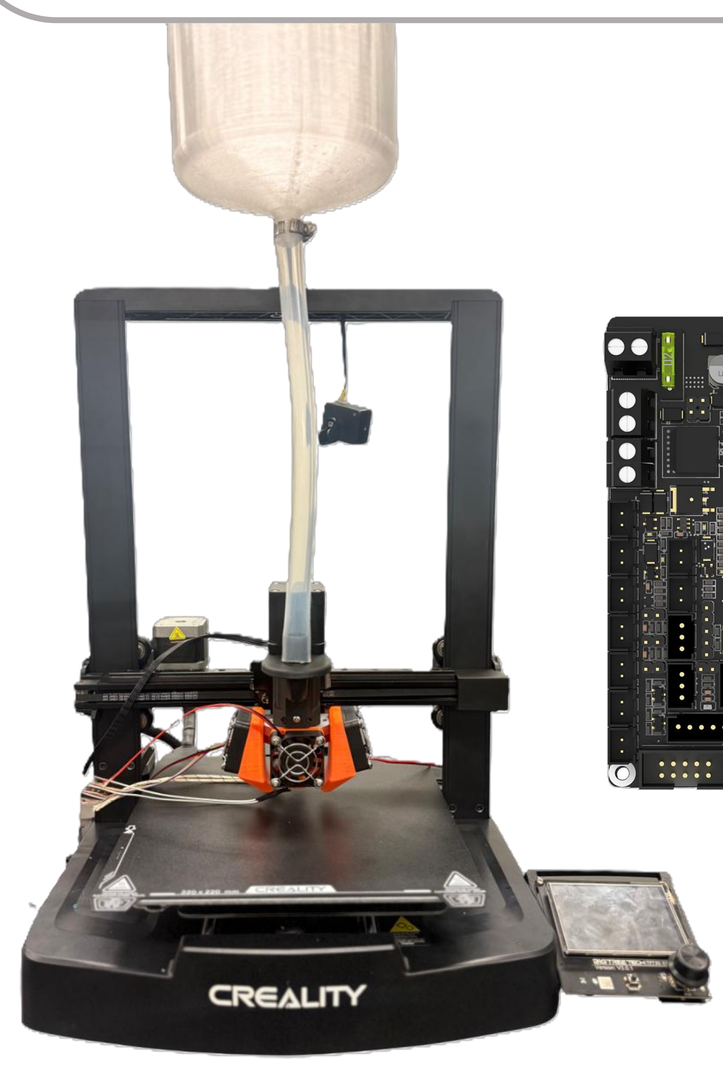
- Commercial filament is widely used in desktop FDM printing, but material cost remains a major barrier for students, hobbyists, and researchers.
- Raw thermoplastic pellets are cheaper, but most pellet extrusion systems are too bulky for desktop use, creating a need for a compact pellet-fed system with reliable print quality and thermal stability.

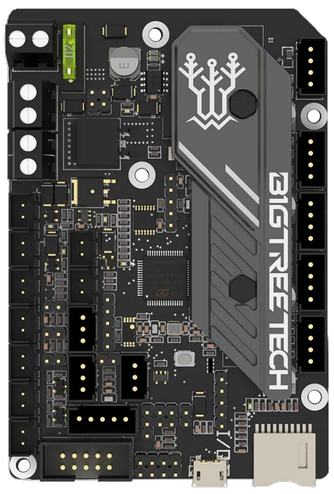
Background

- Pellet-based additive manufacturing can reduce material cost by eliminating intermediate filament production.
- However, compact pellet-fed systems must still manage screw-based material transport, thermal control, and mechanical integration, since most existing pellet extrusion systems are too large for desktop FDM platforms.

Project Objectives

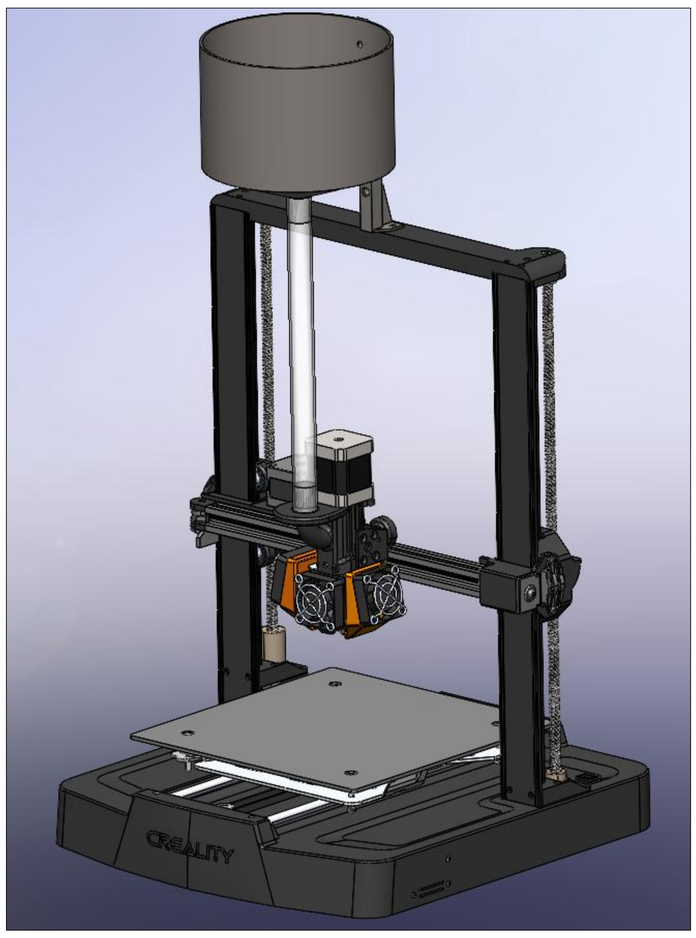
- Develop a compact pellet-fed extrusion system for desktop FDM integration while reducing material cost by 30–50% relative to commercial filament.
- Maintain safe and manufacturable operation by targeting ±0.2 mm dimensional accuracy, 180–260°C operation with ±5°C thermal stability, and a toolhead mass below 1.5 kg.

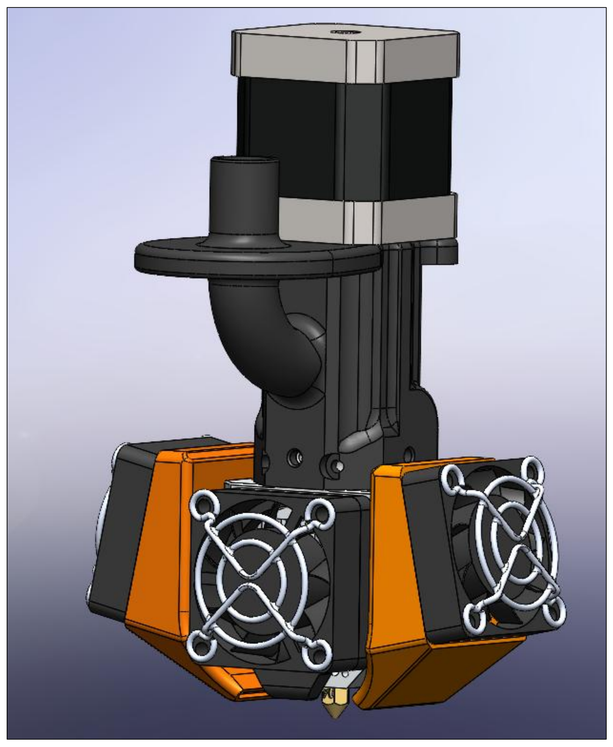


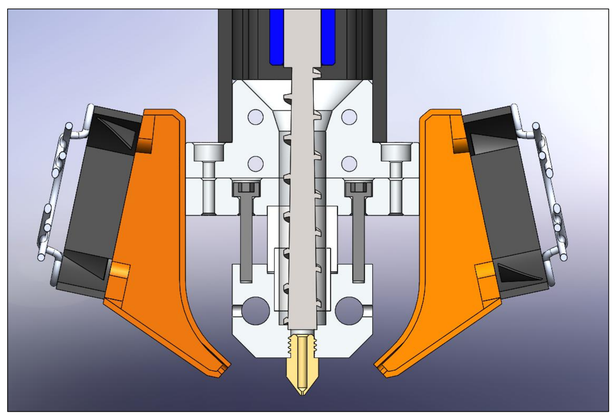


Control System

- SKR Mini E3 V3.0 controls the heater, thermistor, and extrusion system.
- It regulates temperature and extrusion during printer operation.
- The BigTreeTech TFT35 E3 display provides user control and live setting adjustment.







Design & Justification

- Remote hopper + tube feed supplies pellets to the toolhead.
- A screw extruder melts and deposits pellets through the nozzle.
- The system integrates with a desktop FDM printer using controlled heating.

Reduces moving mass on the toolhead
Improves serviceability and pellet changeover
Provides a practical path for desktop printer integration

System Workflow

Pellet Hopper → Tube Feed → Extrusion Toolhead → Heated Nozzle → Print

Findings

- The pellet-fed extrusion system has been fully designed, manufactured, and successfully integrated onto the desktop FDM printer.
- The selected remote hopper + tube feed architecture provided an effective solution by reducing moving mass, improving serviceability, and enabling practical desktop integration.
- The remaining work focuses on optimizing print material performance and improving print quality through testing, calibration, and process refinement.

Next Steps

- Optimize screw geometry for consistent extrusion.
- Enhance thermal management to prevent heat creep and uneven melting.
- Test and compare pellet printing vs filament printing performance.
- Synchronize extrusion rate with printing speed.

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