



Reuse Plastic for 3D Printing

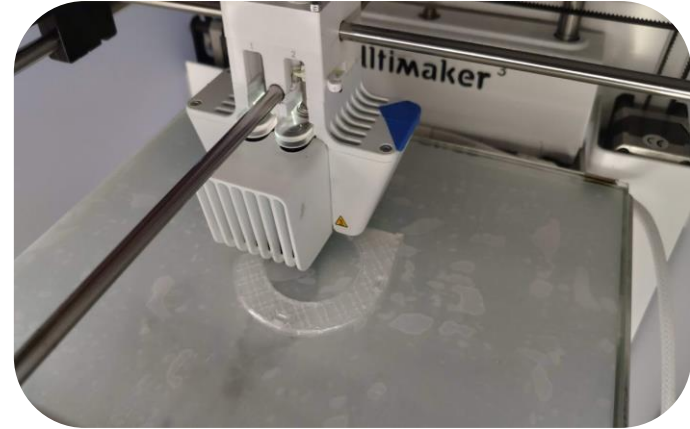
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WPI

Rapid Prototyping at WPI

Rapid prototyping technology, such as 3D printing, has become an essential part of many projects at Worcester Polytechnic Institute (WPI).



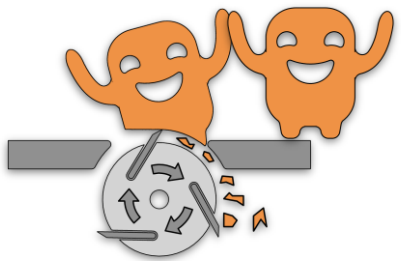
Across campus, there are many areas that allow access to 3D printers, a popular location being the Foisie Innovation Studio Makerspace.

Project Goal

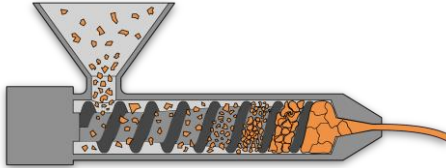
The Makerspace does not have an effective means of recycling plastic waste and the majority of them end up in landfill.



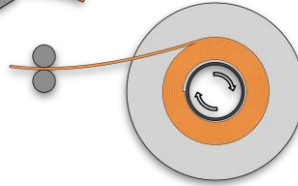
To reduce the amount of plastic waste produced, the team has developed a **proof-of-concept system** that **repurposes waste PLA into printable filament.**



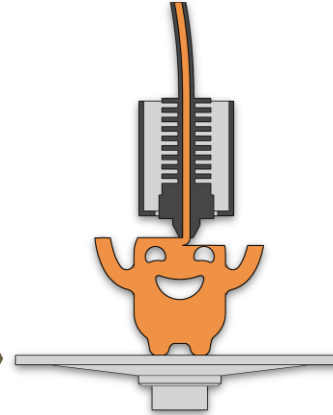
Shredding



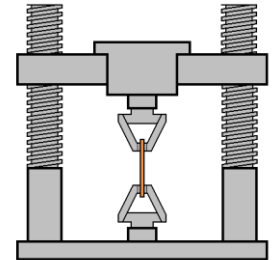
Extrusion



Winding



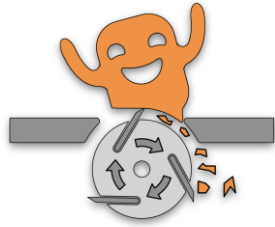
3D Printing



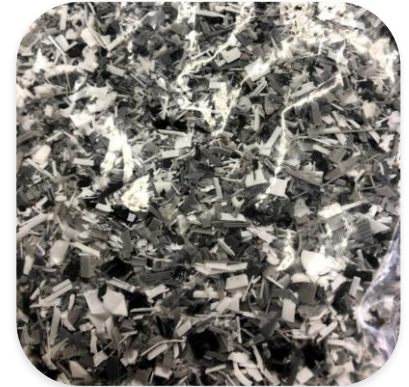
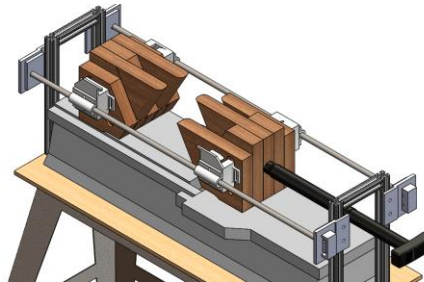
Tensile Testing

Approach

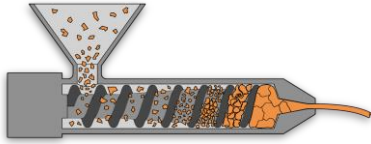
Shredding



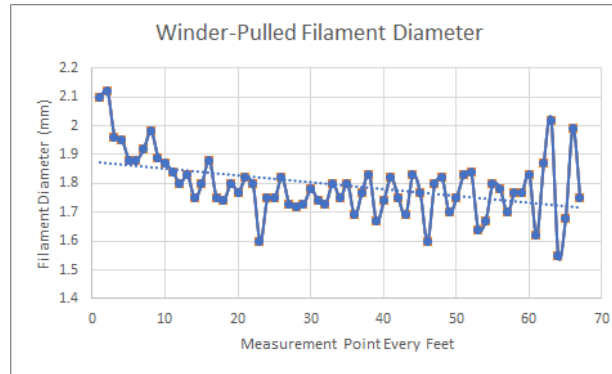
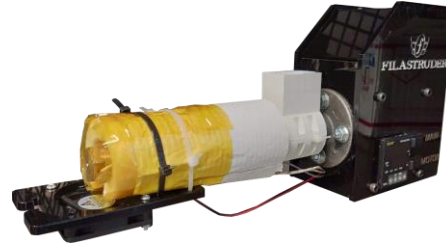
- Enclosed shredding mechanism implemented around a wood jointer and micro-cut paper shredder
- Pushers grip and move plastic repeatedly across high-speed rotating blades to shred chips
- Jointer chips falls into a micro-cut paper shredder to further refine chip size
- Output chips are <math><10\text{ mm}</math>



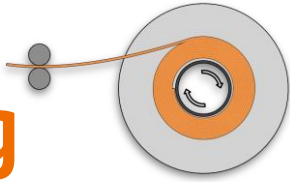
Extrusion



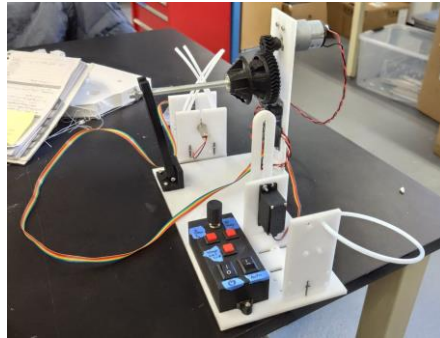
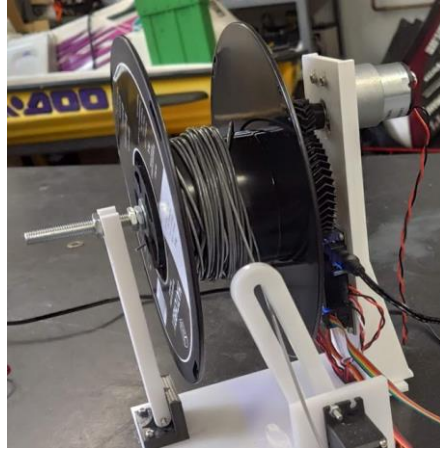
- Filastruder filament extruder was purchased and modified
- A heated barrel and screw melts the chips from the hopper and presses the plastic through a round die to produce filament
- Average filament diameter was 1.75 ± 0.1 mm
 - Commercial filament average is 1.75 ± 0.02 mm



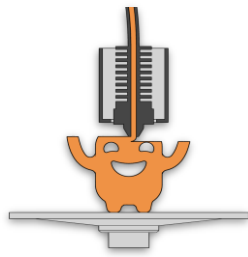
Winding



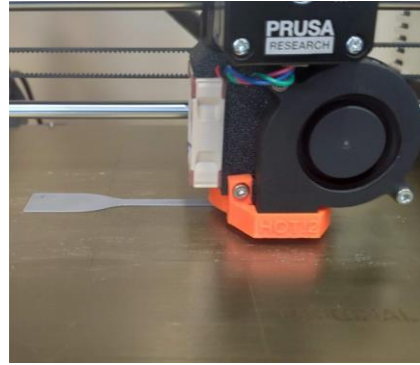
- Filawinder winder was purchased
- Winder uses sag sensor, motorized spool holder, and filament guide to wind filament at a constant tension
- Winder reduced spool tangles and filament diameter variance



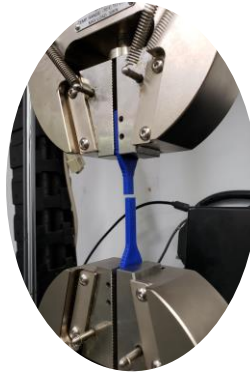
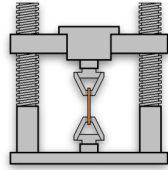
3D Printing



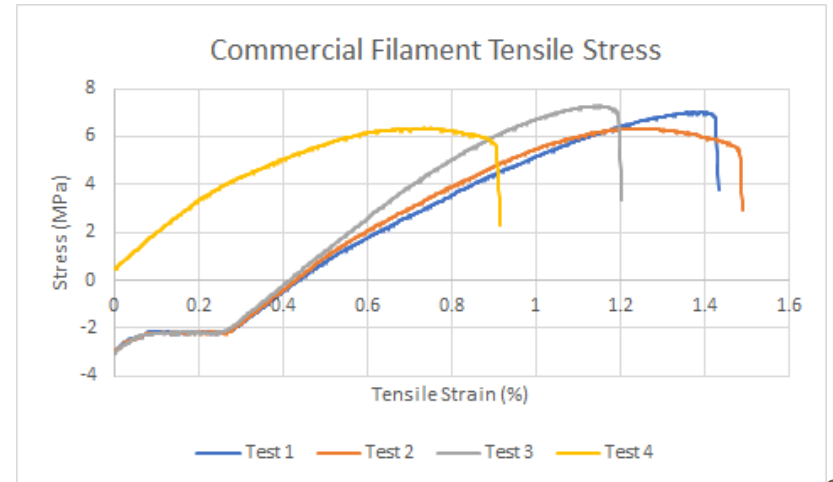
- Tested filament on Prusa i3 Mk3 3D printers
- Adjusted slicer settings to accommodate filament diameter variance and reduce nozzle jamming
- Printed simple and complex shapes for testing and showcasing



Tensile Testing



- Test specimens were printed based on ASTM standards
 - Compared to Hatchbox True Blue 1.75 mm PLA
- Compare commercial and recycled filament properties
 - Young's Modulus
 - Ultimate Tensile Strength
 - Yield Strength
- Unable to test recycled filament specimens due to COVID-19



Recommendations

Shredding

Adjust clearance of enclosure
→ Reduce chip volume loss

Automate motor/belt
→ Reduce manual labor

Noise dampening insulation
→ Reduce noise during operation

Helical cutterhead
→ Provide finer and more uniform chips and reduce noise

Extruding

Independent power control
→ Modular and versatile extruder functions

Improve part quality
→ Improve material flow

Weld steel hopper
→ Eliminate PLA hopper warping

Winding

Vertical mount to simplify path
→ Decrease diameter variance

Light cover over sensor or alternative diameter sensor
→ Minimize sensor disruptions

Conclusion



The team completed a proof-of-concept recycling system that produced filament comparable to commercial filament.