**Objective**

Feedback via Targeted Surveys and In-Person Interviews (74 customers contacted)

"We save all of our waste plastic in Ziploc bags hoping that a good system will pop up, and the pile is growing!"

"My local Maker-space would be very interested in a reasonably-priced recycler."

**Concept Generation**

**Plunger Concept**

**Vertical Concept**

**PolyForm Solutions: Proteus Filament Extruder**

**General Need For Product**

Multiple iterations of prototypes and misprints cause expensive filament to go to waste.

**Estimation of Market Size**

- $3 Billion Industry by 2018
- 14% Annual Growth for the next 5 years
- Target Market: Do-It-Yourself Innovators with consumer printers under $4000 (100,000+)

**Engineering Characteristics**

- Extrusion Rate
- External Temperature
- Material Density
- Ultimate Strength
- Melting Temperature
- Total Weight
- Pellet Size
- Desktop-Sized
- Simple to Clean
- Other Materials
- Filament Diameter
- (1.75/3 mm)

**Customer Requirements**

- Maintains Material Properties
- Filament Diameter
- Color Filament

**Design**

**Operation of Product**

1. Material enters through the hopper into the pipe [8]
2. Material travels down the pipe due to the rotating auger screw[1] that is powered by a wiper motor[9]
4. The material is then extruded through the nozzle to the appropriate diameter, so it may be processed by a 3D printer

**Prototype and Testing**

**Testing Procedures**

Extruder and Material Testing:
- Machined custom pipe, bearing, and nozzle
- Extruded ABS filament with raw ABS pellets
- Fed filament back through printer to create testing specimens for tensile testing

Automatic Spooler:
- Strain gauge sensor for filament slack

**FEA Testing**

- Temperature gradient for sizing band-heater

**Test Results and Future Work**

**Test Results**

**Stress vs. Strain**

- Pure ABS
- Re-extruded ABS

**Future Work**

- Manufacture custom parts
- Prototype grinder
- Refine auto-spooling subsystem
- Ziegler-Nichols tuning method for PID controller

**Key Functionality**

- Desktop sized device that accepts ground up plastic or pellets and converts the material into the dimensions required by 3D printers

**Trade Offs**

- RPM
- Pressure
- Extruder Rate
- Power Requirements
- Structure Stress
- Heating Rate
- Over shoot Temperature
- Filament Properties

**Temperature Control**

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<thead>
<tr>
<th>Characteristic</th>
<th>Alt Value</th>
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<tbody>
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<td>PID</td>
<td>0.3904666</td>
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<td>Arduino</td>
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<tr>
<td>Hard Wired</td>
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**Grinder Placement**

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<tr>
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<th>Alt Value</th>
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<tbody>
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<td>On Hopper</td>
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<tr>
<td>On Side</td>
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<tr>
<td>Detached</td>
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</table>

**ENME472 - Integrated Product and Process Design and Development**

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