

# Development of a Small-Scale Plastic Recycling Assembly

## Team Members:

Paul Calderon

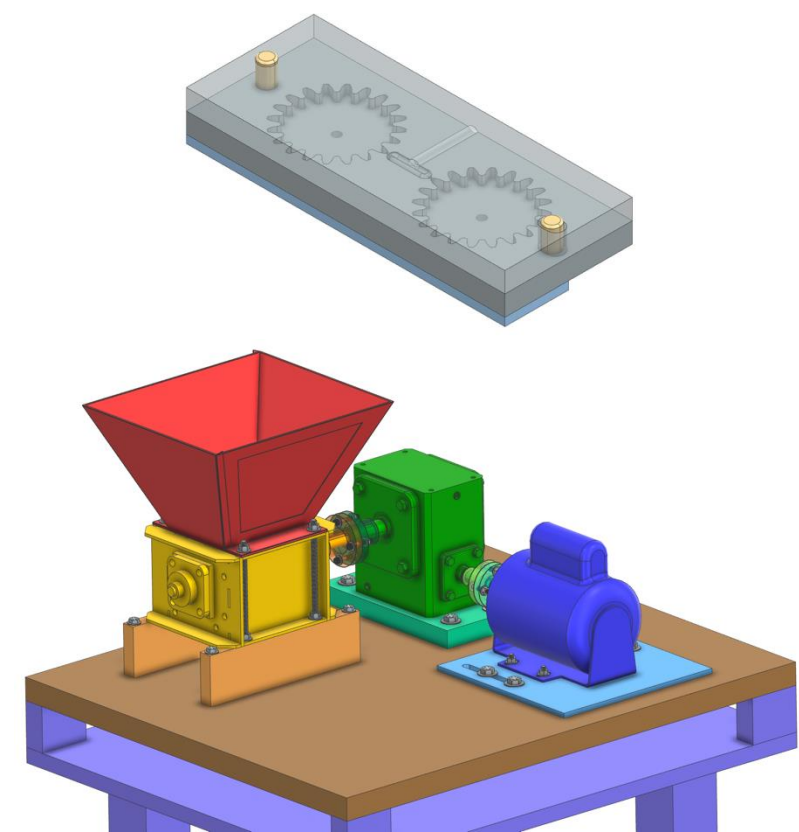
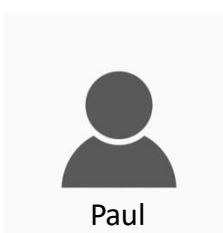
Taryn Langtry

Morgan Ransom

Cece Vassallo

## Customer:

Christopher Muir



## Project Overview

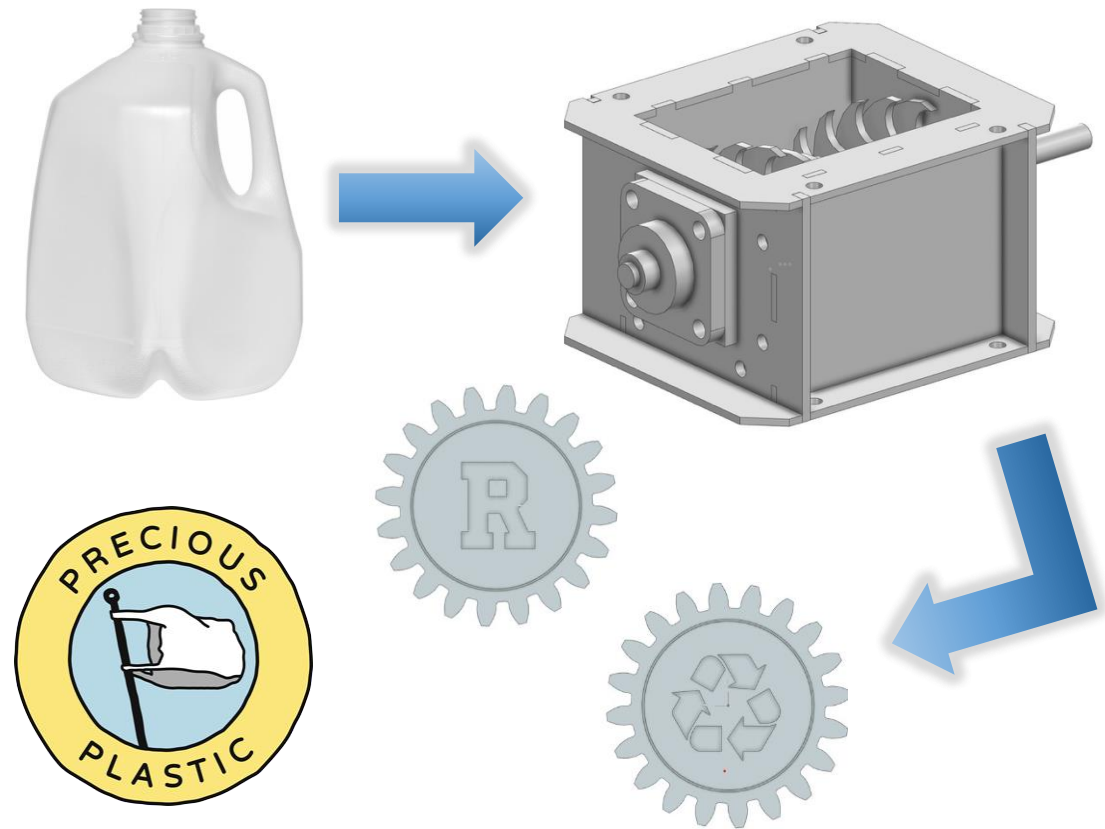
This project utilizes a motorized shredding machine and injection molding equipment to recycle and repurpose high-density polyethylene (HDPE) milk jugs used by the on-campus Starbucks.



## Problem Statement

Plastic waste generated on campus at the University of Rochester is substantial, with a sizable portion originating from single-use plastic containers at coffee shops like Starbucks. The creation and application of small-scale recycling equipment can repurpose these single-use plastics to prolong their useful life before going to a final waste disposal system.

This assembly can raise awareness about plastic usage and disposal on college campuses and help empower smaller communities/individuals in addressing the problem of plastic waste.



# Deliverables, Requirements and Specifications

## Deliverables:

- Prototype device (assembly)
- Technical report with test data
- 1000 plastic items
- Theory of operations manual

## Requirements:

- Plastic must come from on campus
- Standard injection molding protocols will be followed
- All collected plastic must be recyclable in a similar manner (similar melting points, etc.)
- Safety protocols will be recognized and evaluated by appropriate safety staff
- Molded pieces will be formed in one shot based on the injection molder's shot capacity
- Mold material should support the quantity of units specified
- Mold must contain vents to prevent plastic from burning

## Specifications:

- 1000 items produced by May 4th
- 24 hours max. spent injection molding
- Shredded particle size must be no greater than 5/16 in
- Injection molder must be used within a temperature range of 440°F to 490°F



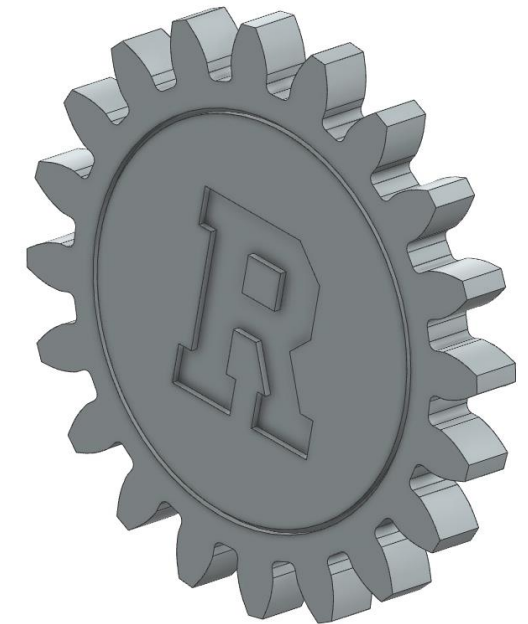
## Current Project Status - Concepts

### Motor Speed Reduction – Concept Selection

	Belt and Pulley	Chain and Sprocket	Worm Reducer
Ease of Design	0	0	+2
Ease of Fabrication	0	0	-1
Safety	0	-2	+1
Compactness	0	0	+1
Cost	0	-1	-2
<b>Total</b>	0	-3	+1

### Injection Molded Item – Concept Selection

	Baseline (Dice)	Standard Poker Chip	Involute Gear Chip	Chip Clip	Ruler
Meets Requirements of Machine	0	-1	+1	0	-1
Ease of Manufacture	0	+1	0	-1	0
Cost	0	0	0	-1	0
<b>Total</b>	0	0	+1	-2	-1



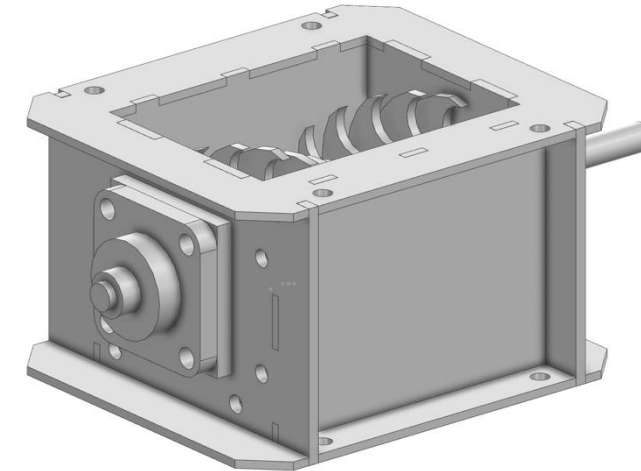
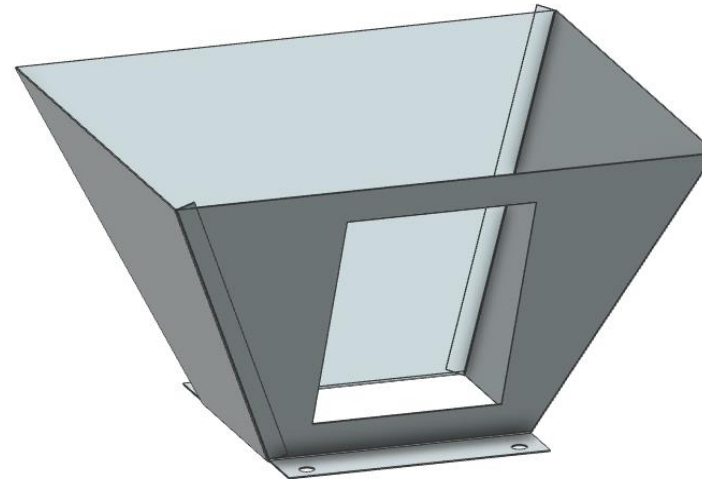
## Current Project Status – Assembly Design

### Bought/Inherited Components:

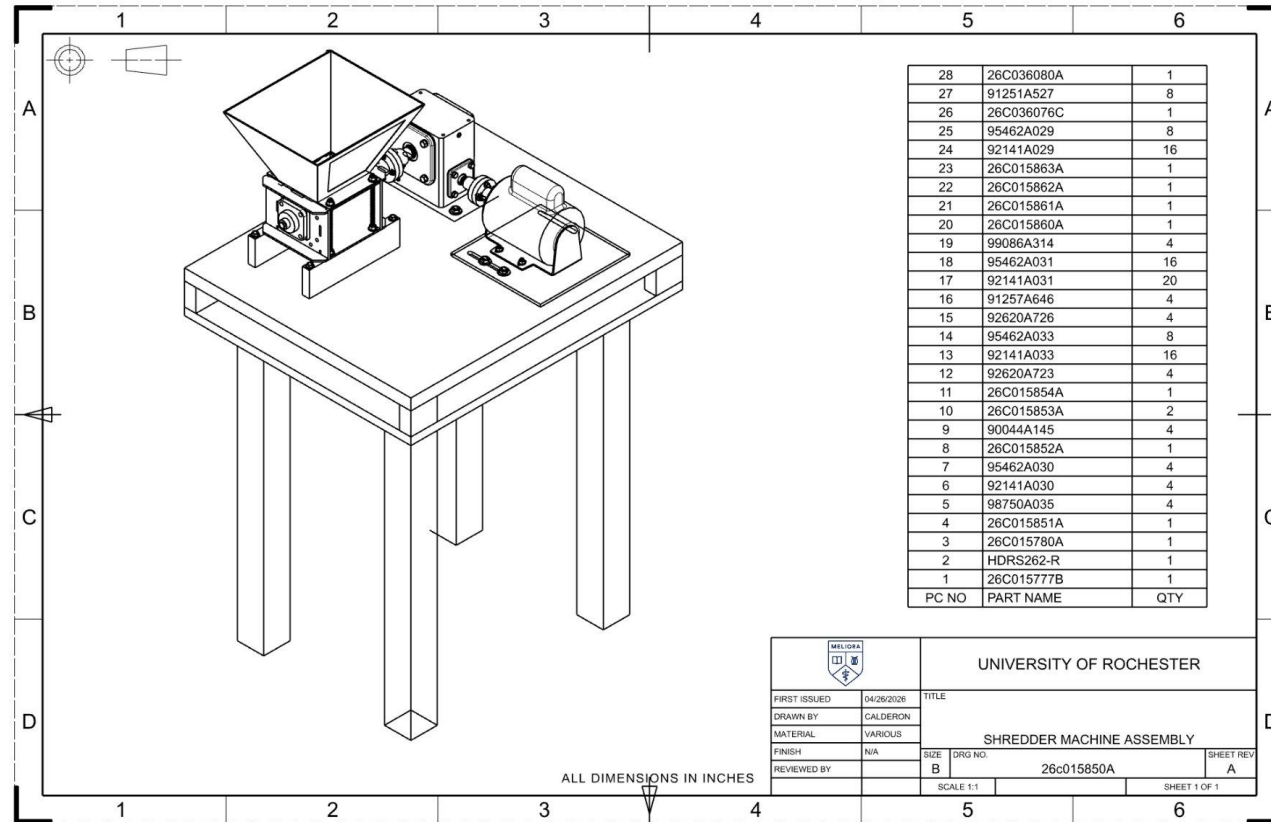
- Motor
- Gearbox
- Shredder

### Manufactured Components:

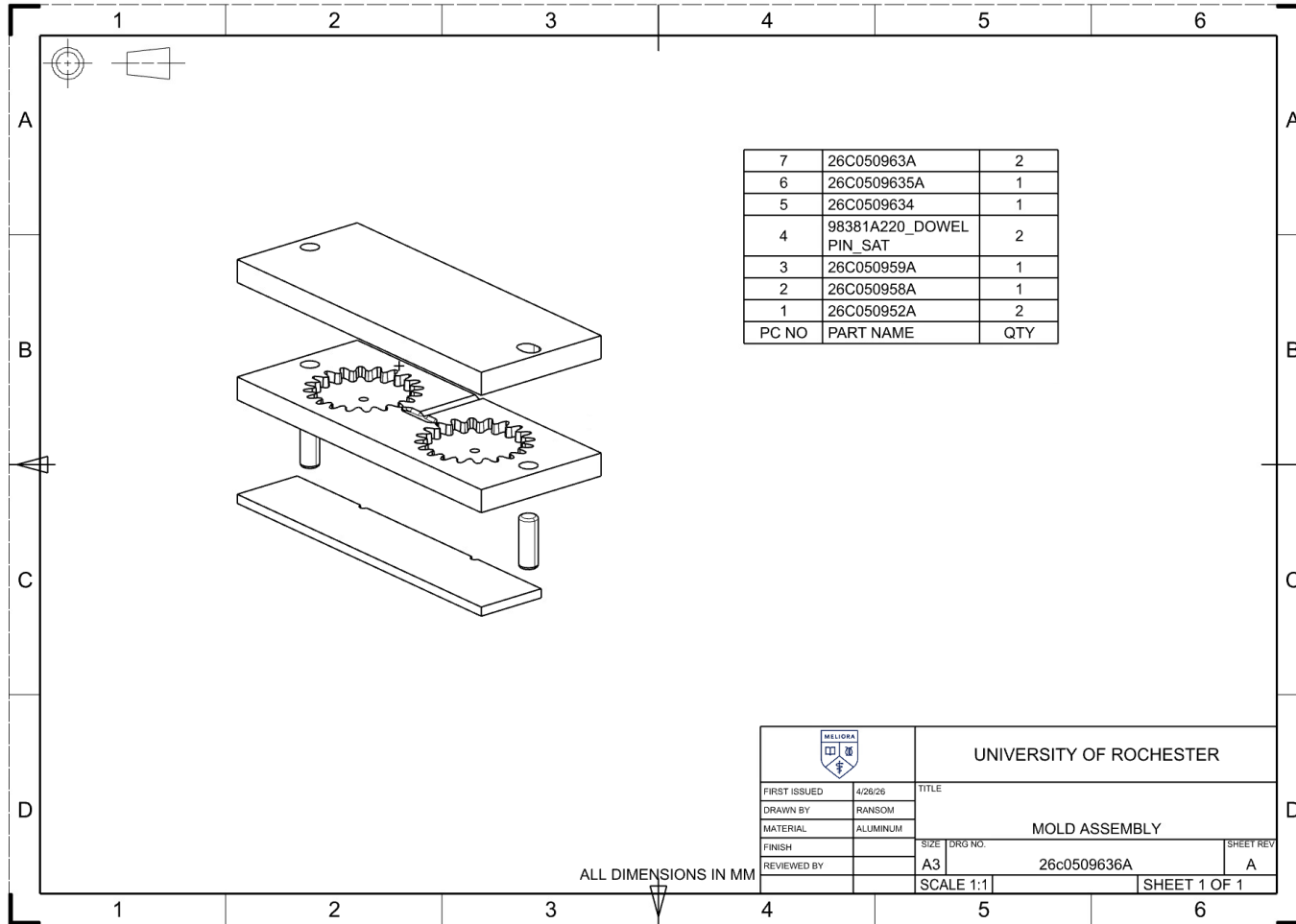
- Bearing block spacers
- Hopper
- Alignment plates/risers
- Couplers
- Basket
- Mold
- Plywood base




# Current Project Status – Final Assembly Drawing and Image



# Current Project Status – Final Assembly Drawing and Image



		UNIVERSITY OF ROCHESTER	
FIRST ISSUED	4/26/26	TITLE	
DRAWN BY	RANSOM	MOLD ASSEMBLY	
MATERIAL	ALUMINUM	SIZE	DRG NO.
FINISH		A3	26c0509636A
REVIEWED BY		SCALE 1:1	SHEET 1 OF 1

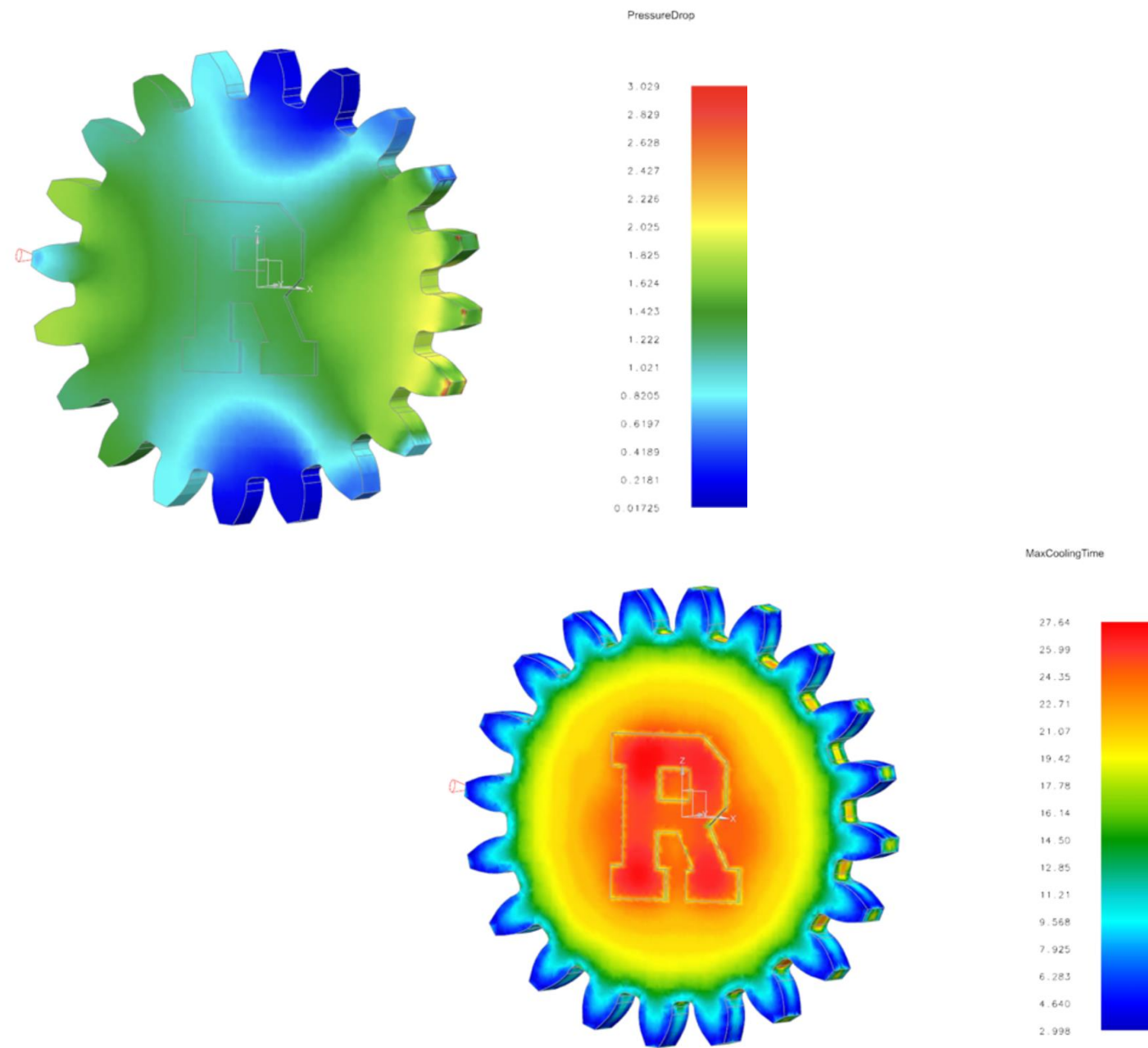
ALL DIMENSIONS IN MM



# Current Project Status - Analysis

## Mold Fill Analysis

- Material used: HDPE
- Highest pressure drop on opposite side of gate entrance
  - Air vent placement
- Greatest cooling time occurs at center of gear chip



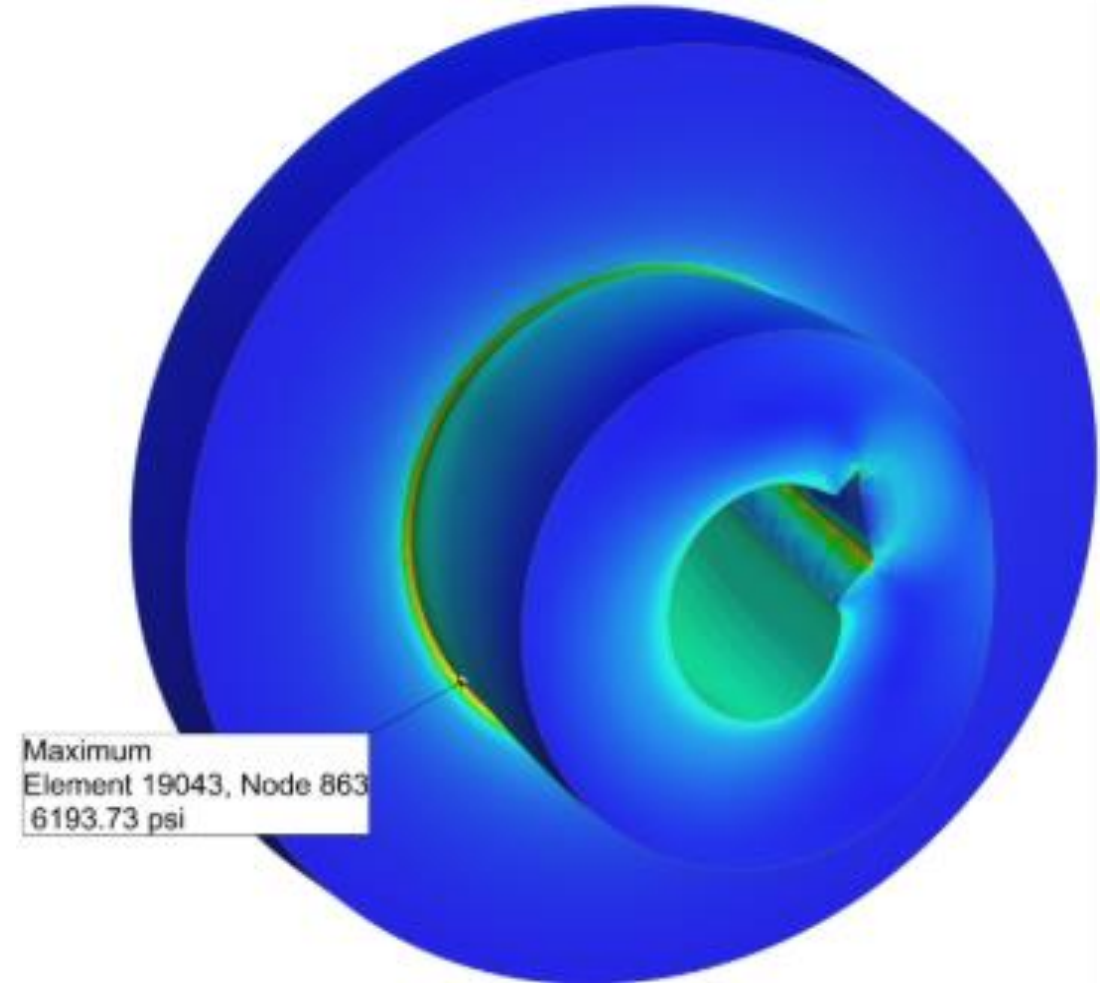
## Current Project Status - Analysis

### Solid Mechanics Analysis of Couplers

- Peak stress in keyway
- Peak stress lower than estimated 6061 AL yield strength in shear (20,000 psi)

### FEA of couplers

- Problematic due to 90-degree angle at flange; stress would have diverged to infinity
- Relied on solid mechanics analysis



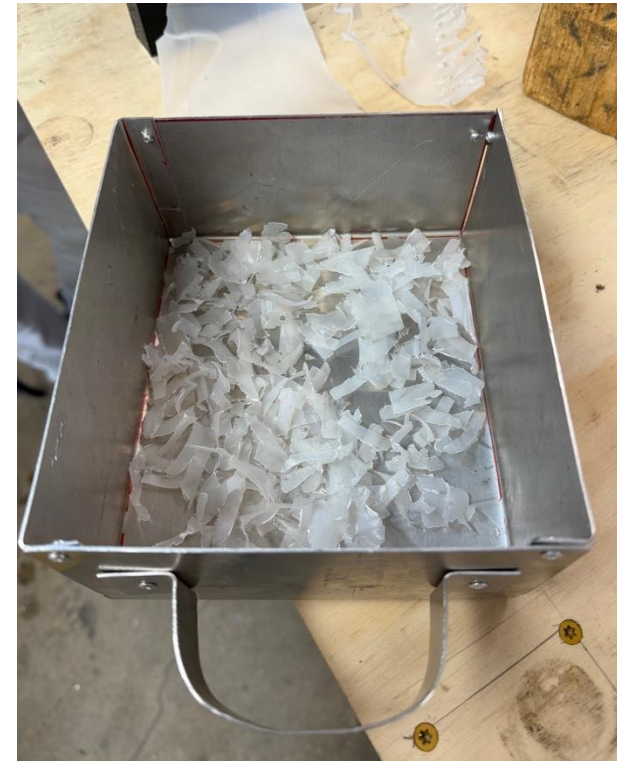
# Current Project Status - Test Results

## Testing of Shredder:

- First run through with entire assembly were able successfully shred plastic
- Pieces larger than target size and will need to be cycled through until requirement is met

## Testing of Mold:

- Initial test of hand-cut HDPE injected into mold showed slight shrinkage and flash
- After flattening the mold, second test was conducted using polypropylene
  - Significantly improved results



### Shredder box challenges

- Severe tolerance stack-up issue in rotating blade assembly
- Better solution would be to manufacture new blades and spacers or to machine a new rotating blade assembly out of a single piece of material

### Assembly mounting surface challenges

- Plywood is organic and non-homogeneous
- More rigid and homogenous material could be used for assembly's mounting surface to mitigate alignment issues

### Milk jug pre-processing challenges

- Relatively small size of shredder box and limited maximum torque made pre-processing the milk jugs necessary
- Milk jugs could be cleaned more efficiently with a hose or a solution bath
- An extruder would make assembly easier to integrate with automatic injection-molders

**Despite these challenges, this project has thus proved the viability of small-scale recycling.**

*The team would like to acknowledge Dr. Christopher Muir, Matthew Hook, Chris Pratt, Jim Alkins, Bill Mildenberger, Paul Osborne, and Samantha Kriegsman. We greatly thank them as their assistance to this project was both immense and invaluable.*