GREEN ELLIPSIS

Senior Design 2023-2024

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Problem Statement

WHO:

Green Ellipsis, the sponsor of the project, processes 2-liter plastic bottles and upcycles them into usable filament for 3-D printing. They are a small company working to create a full process that can be used by community level groups to promote recycling and contribute to limiting pollution.

WHAT:

Currently the process costs more to complete than you can sell the end product for, and is therefore not appealing for a group to take on.

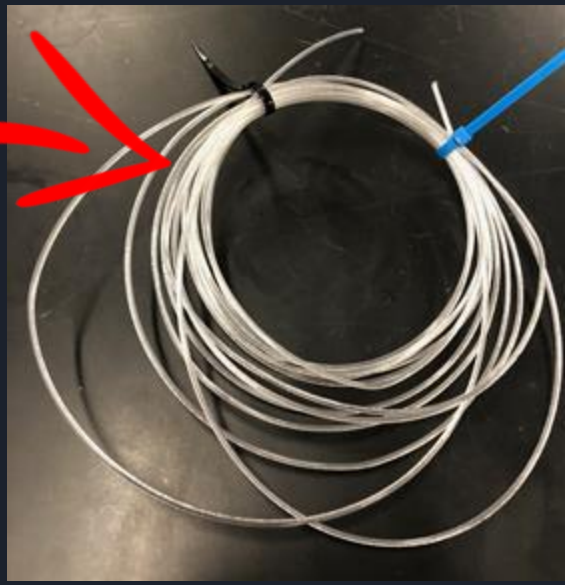
WHY:

Without the incentive of being able to sell the produced filament for a profit, the cost, upkeep, and use of the rig is not worth it to a community.

Process

- Bottles prepped and cleaned
- Bottle cut into strips
- Pulled through nozzle to turn into filament
- Wound on the spool
- Taken off spool for repackaging

Current End Product



Requirements

- Process uses all portions of the plastic bottle with minimal waste
- Bottles used are Pepsi branded
- The filament must be cheaper to produce than the cost it can sell for
- Filament withstand stress of spooling and 3-D printing
- The size of the processing machine must not be too big
- Budget of <$1000
- All design components must use the metric system of measurements

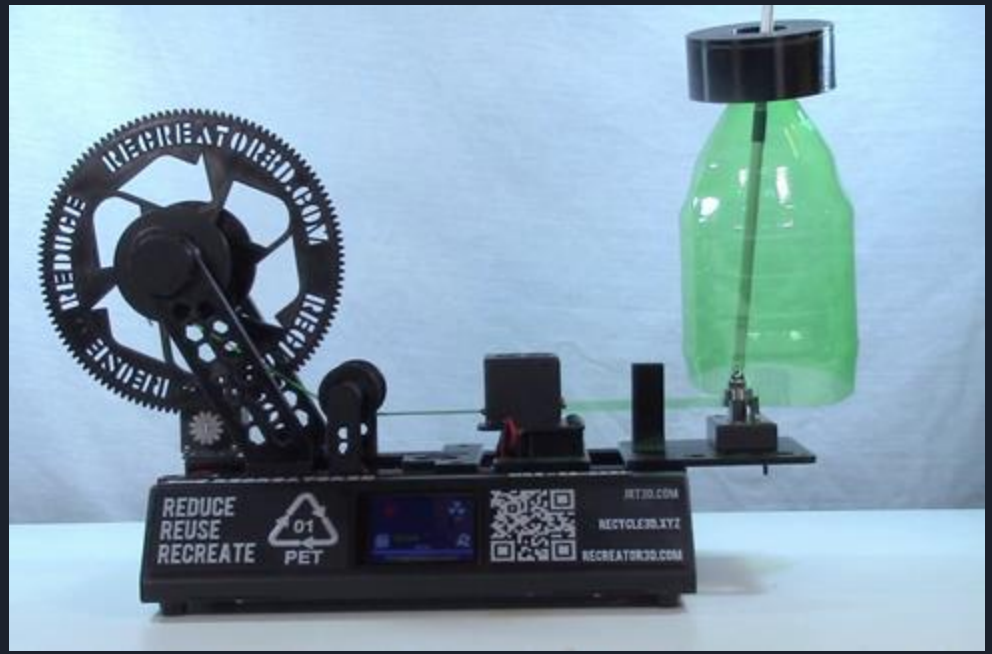
Constraints

- The raw materials are sourced from used plastic bottles
- The process must be environmentally friendly with a net positive impact
- The process must be safe and usable by an average person
- The process must be low cost to build so the average consumer can afford to repeat it
- Filament must be usable with any standard 3-D printer: 1.75mm +/- .1mm
- The filament cannot break or become jammed during the pultrusion process
- Any power requirements must be available from a standard outlet: 120V

Concept Selection

First round of dowselection:

- Bottle cleaning and prep
- Pultrusion initiation
- Winding/Packaging
- Coloring the filament
- Splicing pieces of filament together



Cleaning and Prep

What is cleaning?

- The bottles must be delabeled and cleaned of residue before they can be used.

Why cleaning?

- Prepping the bottles for cutting is time consuming and labor intensive.

Winding/Packaging

What is winding/packaging?

- Filament must be taken off of machine and neatly wound.

Why winding/packaging?

- Currently, the machine must be stopped so the filament can be respooled.

Coloring

What is coloring?

- Add color pigment to filament

Why coloring?

- Increases value of product

Problems?

- PET doesn't easily accept color

Splicing

What is Splicing?

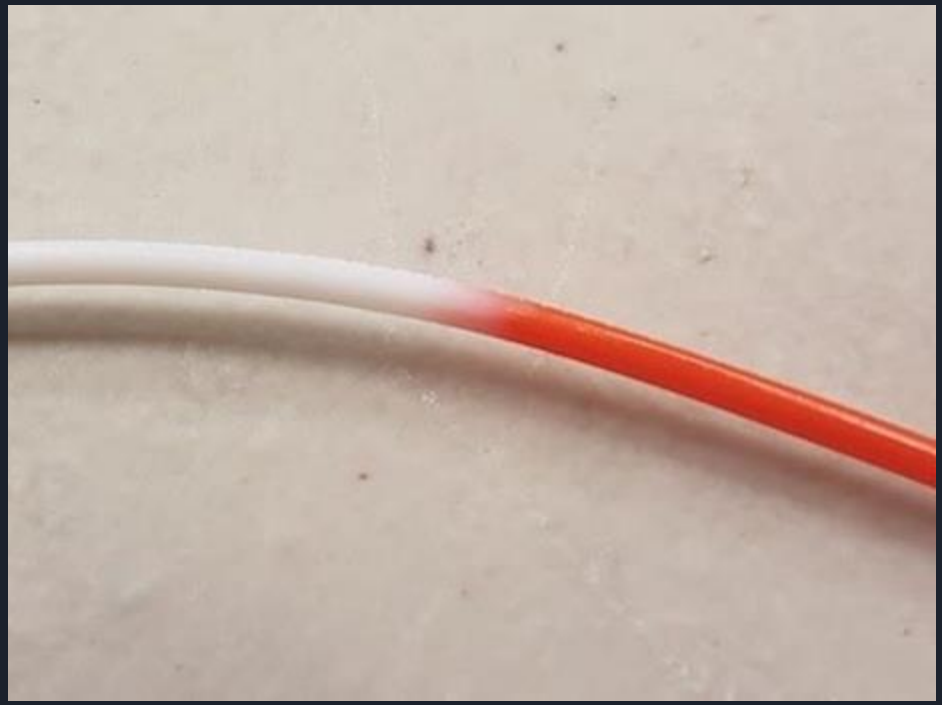
- Joining or connecting of two strands of material.

Why Splicing?

- Increase the amount of filament available per spool of material.

Problems?

- PET can recrystallize very easily, causing the filament to become brittle either breaking or jamming in the nozzle or the 3D printer.



Concept Selection

Pugh Matrix							
Critical Quality	*Weight 1-5*	Cleaning/ Prep	Pultrusion	Winding/ Packaging	Coloring	Splicing	
Difficulty	1	1	-1	0	1	-1	
Team Knowledge	2	0	1	1	-1	-1	
Time Saved	3	1	0	1	0	0	
Sponsor Preference	4	1	0	-1	-1	1	
Benefit	5	0	-1	0	0	1	
Maintenance	2	-1	1	0	-1	1	
Cost to Reproduce	2	0	-1	0	1	0	
Safety	3	0	1	1	1	0	

Summary Table						
Total "1s"	3	3	3	3	3	
Total "0s"	4	2	4	2	3	
Total "-1s"	1	3	1	3	2	
Total	6	-1	4	-2	8	

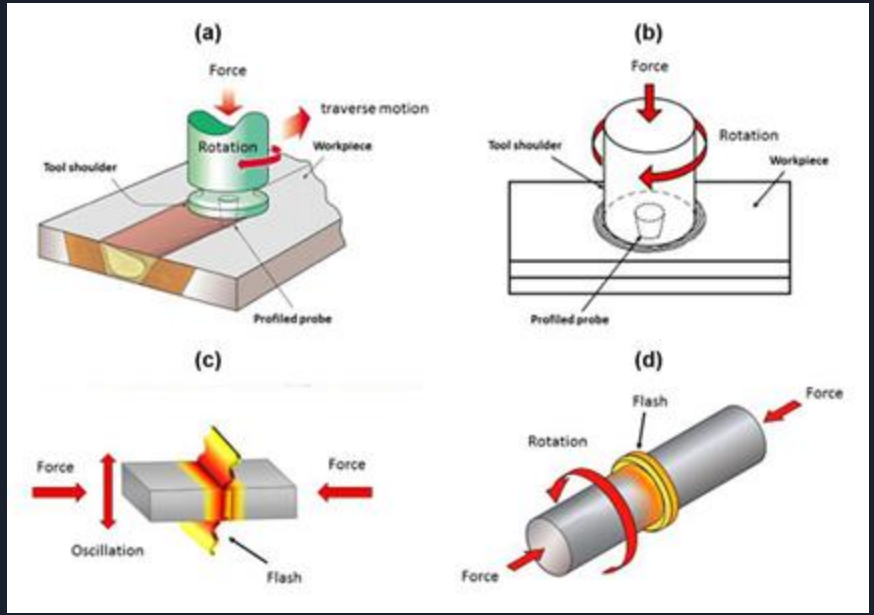
Mosaic Palette pro 2

- Current option used by hobbyists and recommended by others but is $700
- Heats, compresses, and cools the filaments to splice them together automatically. [5]
- Trying to figure out a cheaper way to achieve this.

Mechanical Methods

With splicing selected, the following Mechanical ideas are being considered:

- Friction Welding (Ribbon)
- Hook and Loop or Zip Tie Design (Ribbon)
- Cutting and Gluing Techniques



Heating and Welding Methods.

Alternatively, these heating methods are another area to experiment with:

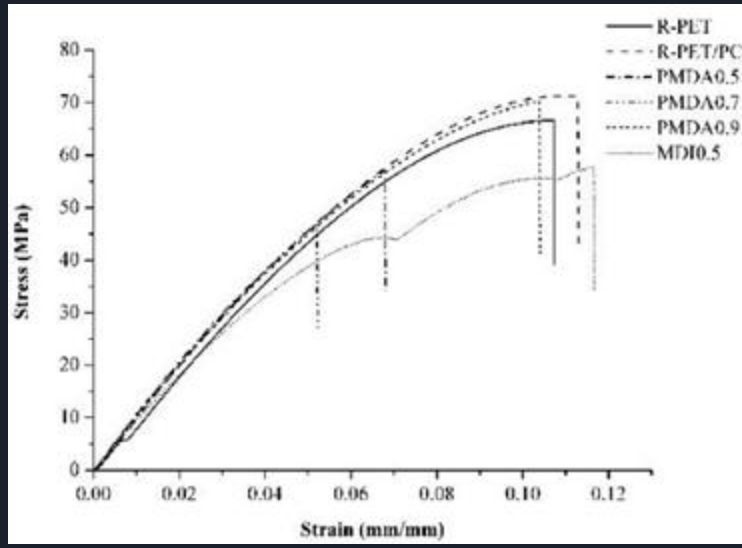
- Ultrasonic Welding
- Traditional Soldering
- Heated Air (Heat Gun)

Designs and Testing

Designs

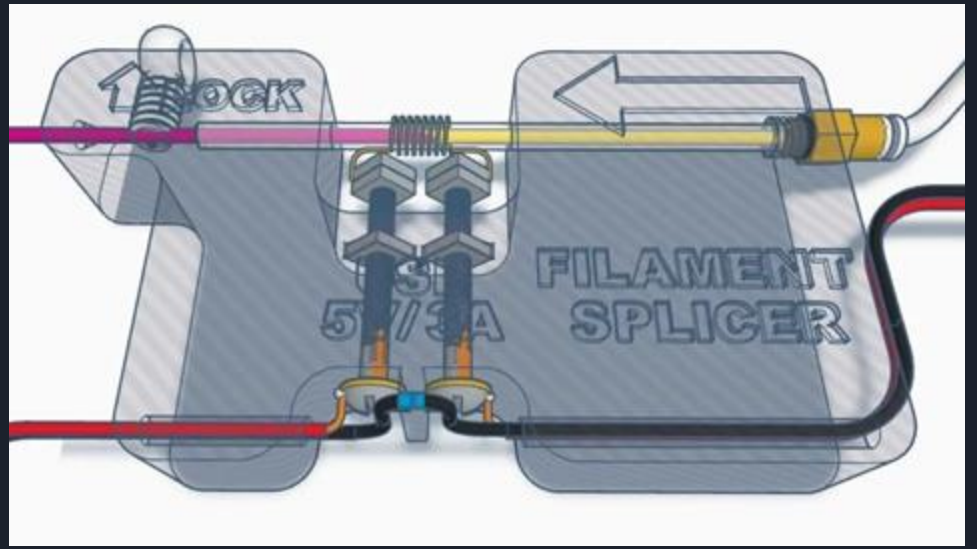
Testing

- Tensile strength
- Brittleness
- Spooling
- Print quality



Possible Automation

- Selected Process
- Design a device for automation
- Human assistance
- No human assistance

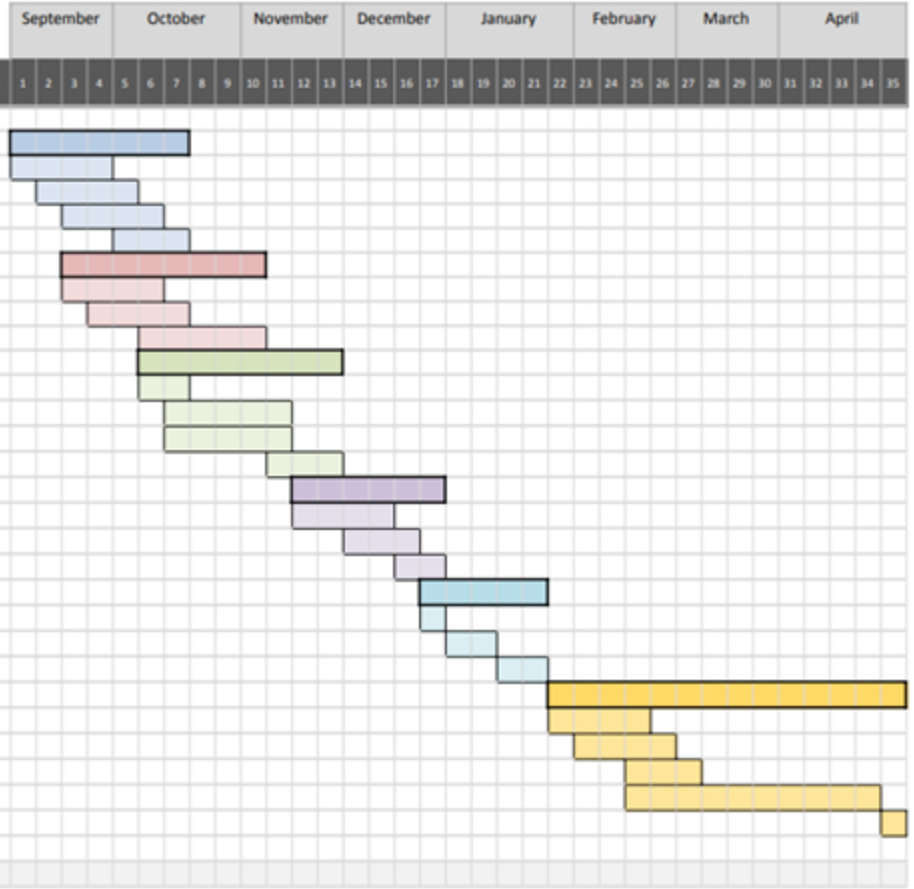


PET Filament Splicing

Green Ellipsis
UNF Senior Design

Project Start:	Mon, 9/4/2023
Project End:	Tue, 4/30/2024
Current Week	5

TASK	PROGRESS	START	END
Brainstorm	33%	9/4/23	10/20/23
Problem Assessment	70%	9/4/23	9/29/23
Idea generation	40%	9/11/23	10/6/23
Concept Exploration	10%	9/18/23	10/13/23
Concept Downselection	10%	10/2/23	10/20/23
Research	15%	9/18/23	11/3/23
Current Processes	25%	9/18/23	10/13/23
Material Properties	10%	9/25/23	10/20/23
Methodology	10%	10/9/23	11/3/23
Experimentation	0%	10/9/23	12/1/23
Process testing	0%	10/9/23	10/23/23
Filament Splicing	0%	10/16/23	11/10/23
Ribbon Splicing	0%	10/16/23	11/10/23
Quality Testing	0%	11/13/23	12/1/23
Design	0%	11/20/23	12/29/23
Manual Process Design	0%	11/20/23	12/15/23
Automated Process Design	0%	12/4/23	12/22/23
FEM testing	0%	12/18/23	12/29/23
Production	0%	12/25/23	1/25/24
Parts Purchasing	0%	12/25/23	12/29/23
Manufacture Design	0%	1/1/24	1/12/24
Integrate electical components	0%	1/15/24	1/25/24
Testing/Iteration	0%	1/29/24	4/30/24
Product Usage Testing	0%	1/29/24	2/23/24
Filament Testing	0%	2/5/24	3/1/24
3D Print Testing	0%	2/19/24	3/8/24
Design Iteration	0%	2/19/24	4/19/24
Finalize Product	0%	4/22/24	4/30/24



What’s Next?

- Finalizing experiment ideas
- Finalize budget and order all necessary parts
- Recreate available commercial and hobbyist jigs
- Design experiments to test splice joints
- Begin experimentation

References

[1] "Tension rod-less Recreator3D with runout detection", YouTube, Jul 12, 2022. Available: https://www.youtube.com/watch?v=w-EAWBNNP8s
[2]"3D Printing Filament Splicing Jig", Youtube, May 29, 2022. Available: https://www.youtube.com/watch?v=UgFf3n4iQ6wslide 15
[3]"PET Bottle Recycling: Waste to 3D Printing Filament", Youtube, Sep 16, 2023. Available: https://www.youtube.com/watch?v=1yle1Pp_Nrg 8[1]
[4]" 3 Dprinter filament joiner welder connector", Youtube, Feb 10, 2022. Available: https://www.youtube.com/watch?v=guGbnYIyfu4 slide 15[1]
[5] Mosaic Manufacturing, Palette 2 & Palette 2 Pro: Filament Production Speeds, and Maximum Recommended Print Speeds, https://www.mosaicmfg.com/pages/palette-2-filament-production-speeds#:~:text=Palette%202%20and%20Palette%202,of%20filament%20during%20a%20print.
[6]"PET - Polyethylene terephthalate," Ensinger Plastics. https://www.ensingerplastics.com/en-us/shapes/engineering-plastics/pet-polyester (accessed Sept. 29, 2023).
[7] BotCan, "AUTO FILAMENT SPLICER" Printables, https://www.printables.com/model/524622-auto-filament-splicer-afs-v1-using-your-3d-bowden-

Questions?