Filament Respool System Project Portfolio

DEFINE THE PROBLEM

DESIGN BRIEF

Client

Hopewell Engineering Team
Hopewell High school
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11530 Beatties Ford Road

Designer

TopTechnologies
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Problem Statement

The Hopewell Engineering program needs a way to use old, cardboard, or small diameter 3D printing filament spools on their 3D printers and reuse depleted spools.

Design Statement

Engineers at TopTechnologies will design a Filament Respooling System that can transfer filament from a unusable spool, to a new spool that can fit on the 3D printers for the Hopewell Engineering Team.

Criteria / Constraints

- Implementation (ease of use)
- Speed (Time to transfer plastic)
- Compatibility (with different types of spools)
- Size/Storage/Reliability

Deliverables

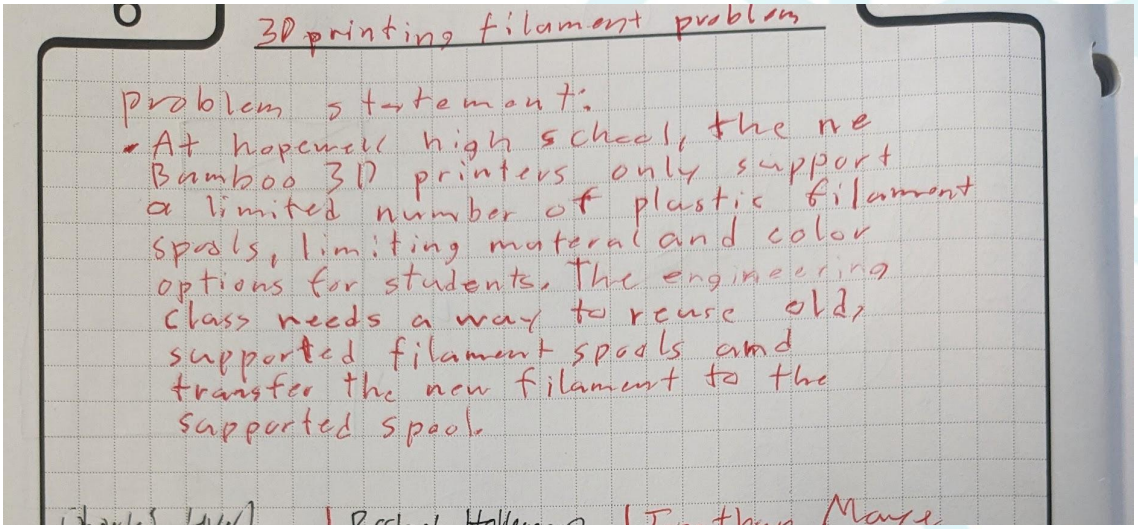
TopTechnologies will provide a working, respoolment system for the Hopewell Engineering Team that will help students reuse old, supported filament spools, to transfer the new unusable filament to the supported spool.

GENERATE CONCEPTS

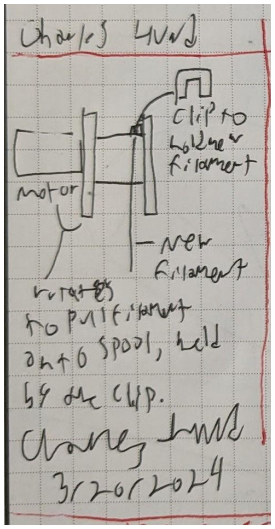
BRAINSTORMING

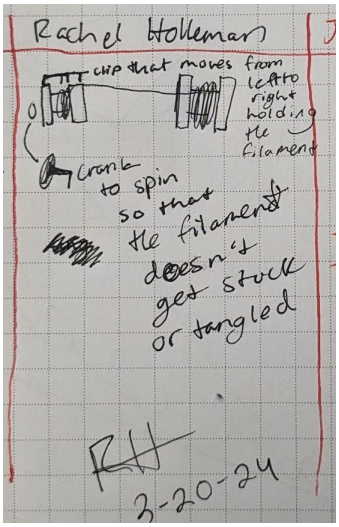
Sketches of Early Designs

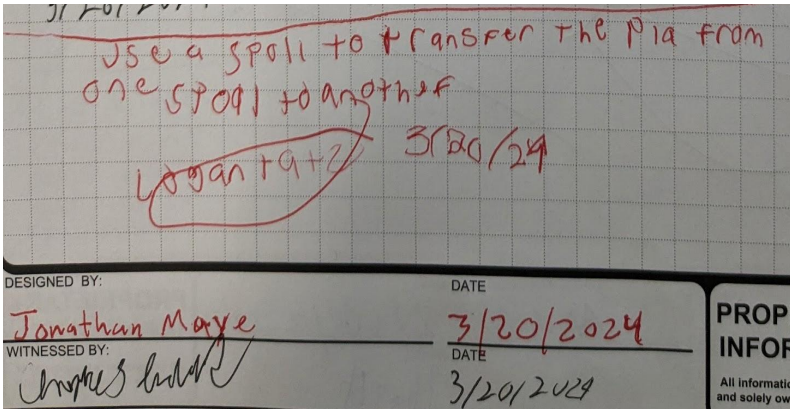
Initial problem statement



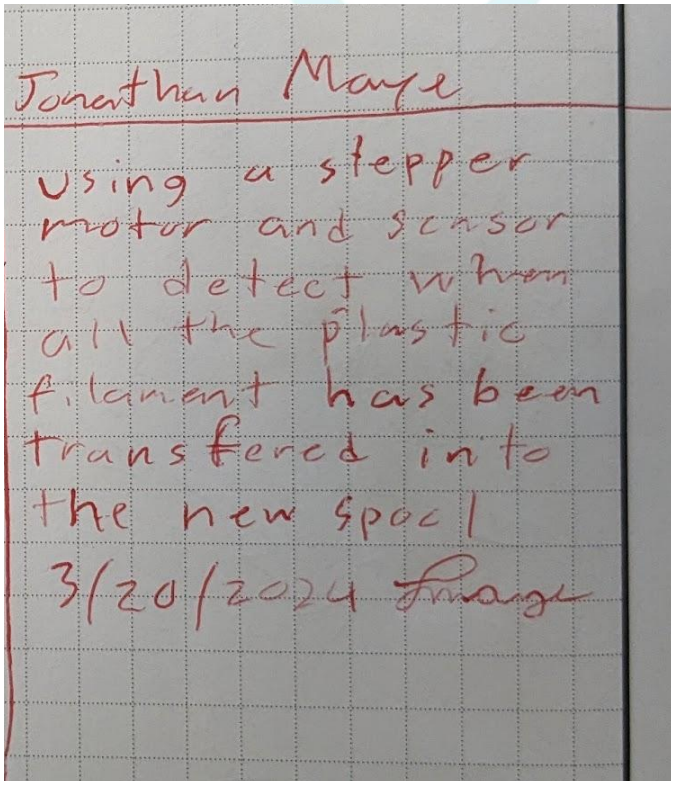
Talking to peers to find 3 possible solutions to the issue







Combining the best aspects of both Ideas



DECISION MATRIX

	Criteria and Constraints			
Ideas	Speed	Compatibility	Implementation (Ease of use)	Totals
Hand crank - type transfer system	1	3	3	7
Battery powered drill w 3D printed assembly/stand.	4	2	4	10
Programmable Brushless DC motor /w UI	5	2	4	11
Programmable stepper motor for precise control.	4	3	2	9

Scoring Scale	Lowest (Worst) - Highest(Best)
	1 - 5

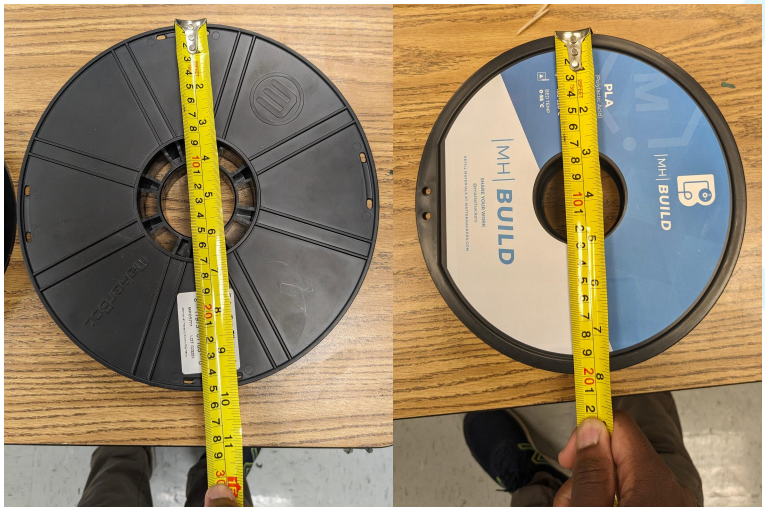
Summary of Findings / Reflection

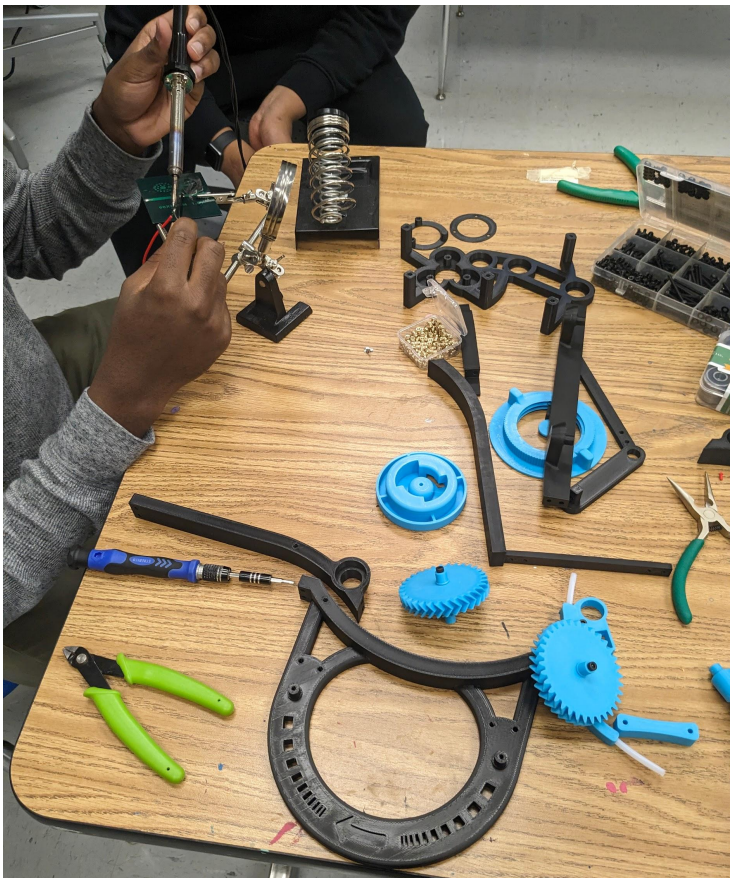
The Hopewell Engineering lab needs a system to automate the current manual process of transferring plastic wire/filament from one spool to a supported one, however implementation, speed and compatibility are the three main concerns. The systems has to be easy to program, activate, and use without a steep learning curve, and it needs to be both compatible with virtually all types of 3D printing spools. Therefore, designing an automated, and motorized system that an quickly and effectively transfer the filament between spools is the best, and most effective solution.

DEVELOP SOLUTION

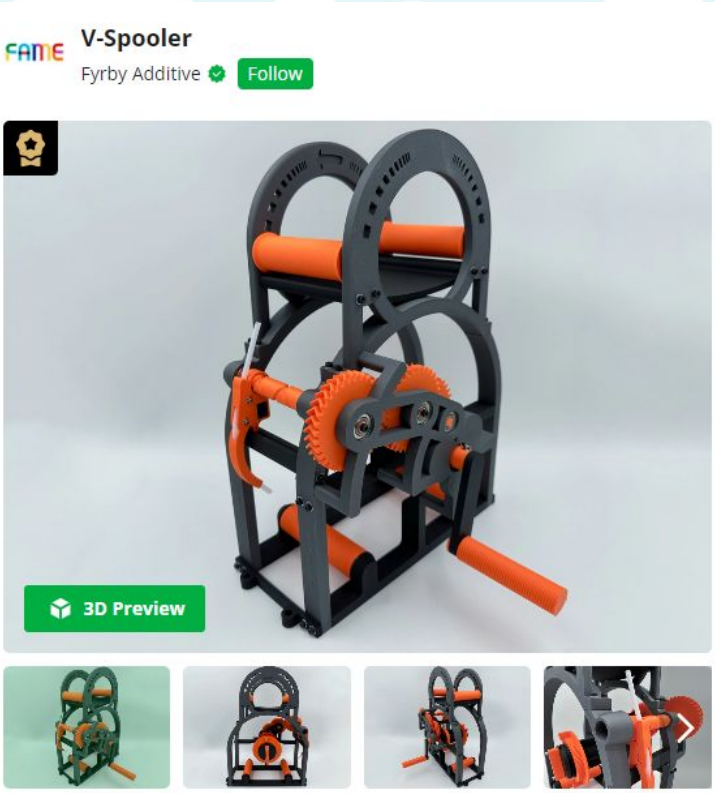
SOLUTION DEVELOPMENT

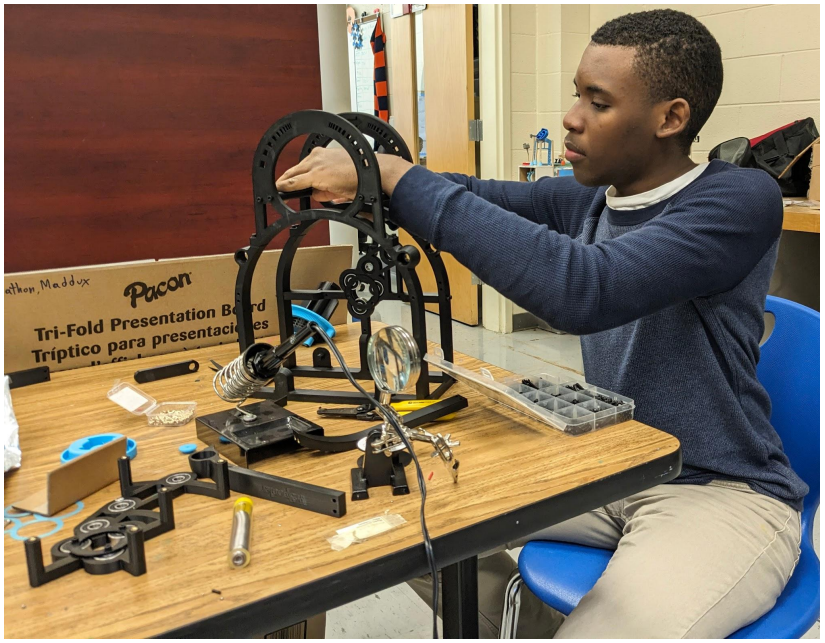
Spool on the left is too large for a standard 3D printer





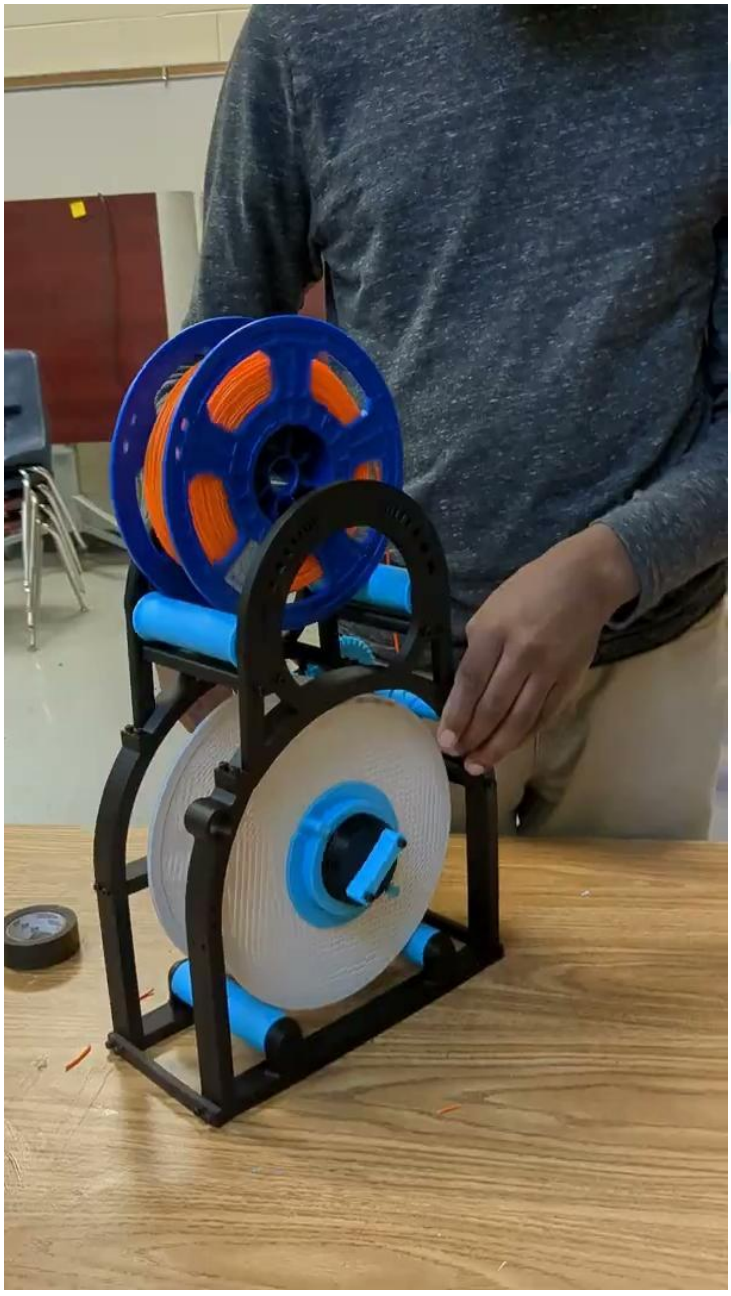
Found a working model for a **hand-cranked** Filament respooler by Fryby Additive.





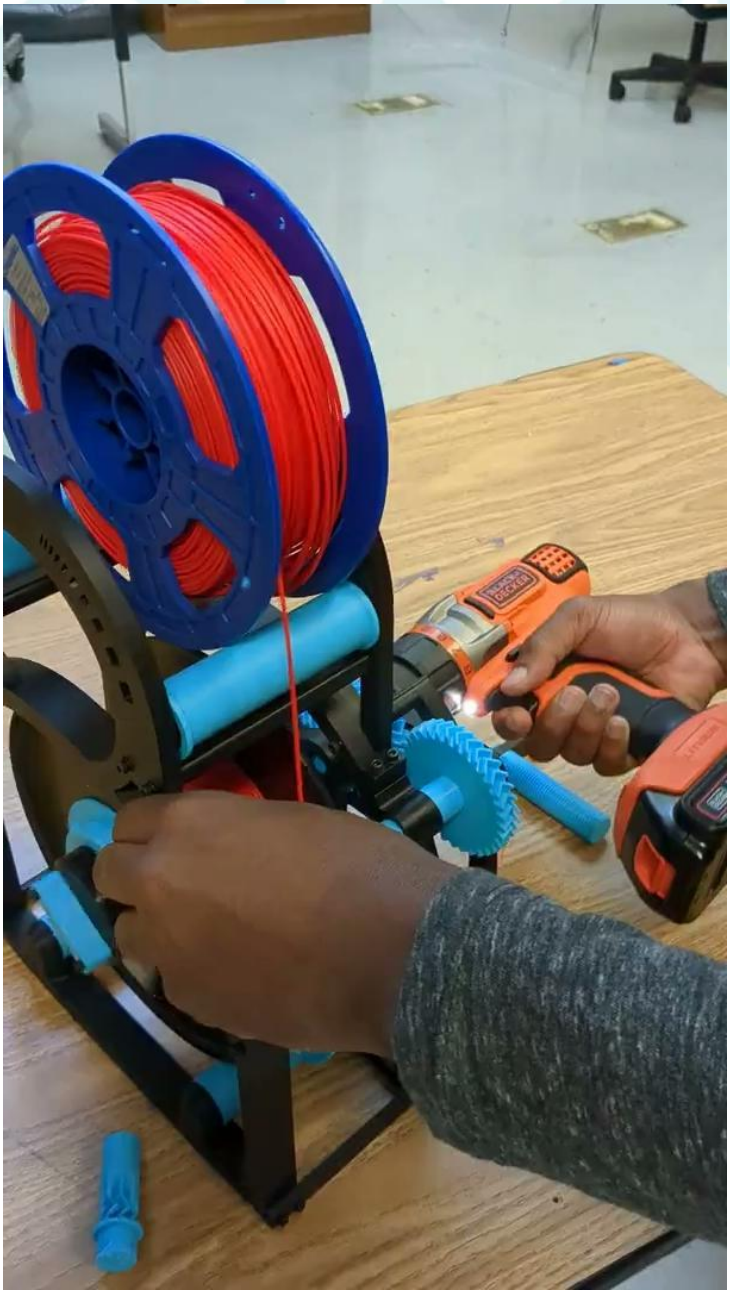
"Don't reinvent the wheel just realign it". So required materials were purchased, and some parts were 3D printed as well

SOLUTION DEVELOPMENT



^Video^

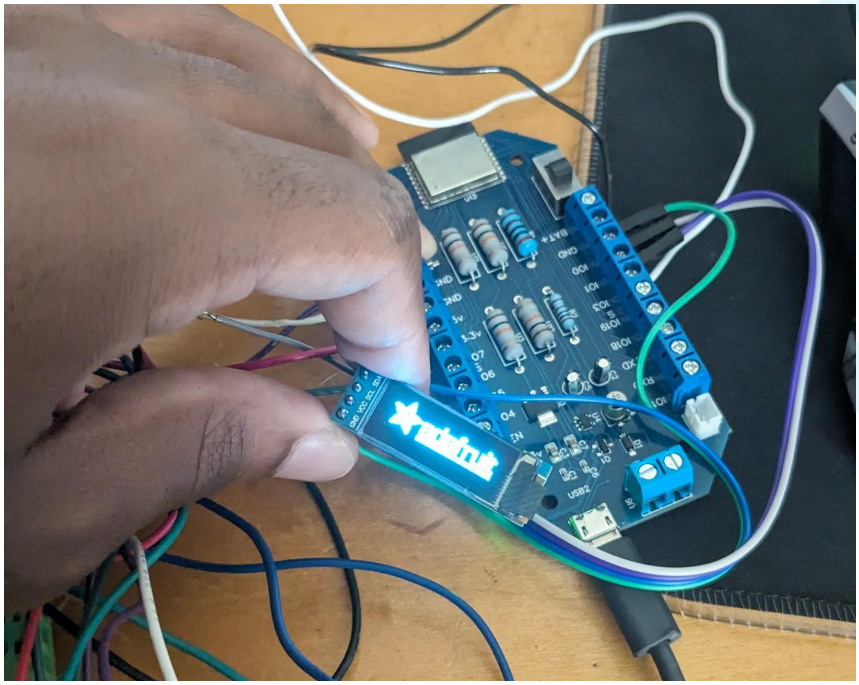
Base FRS working with hand crank



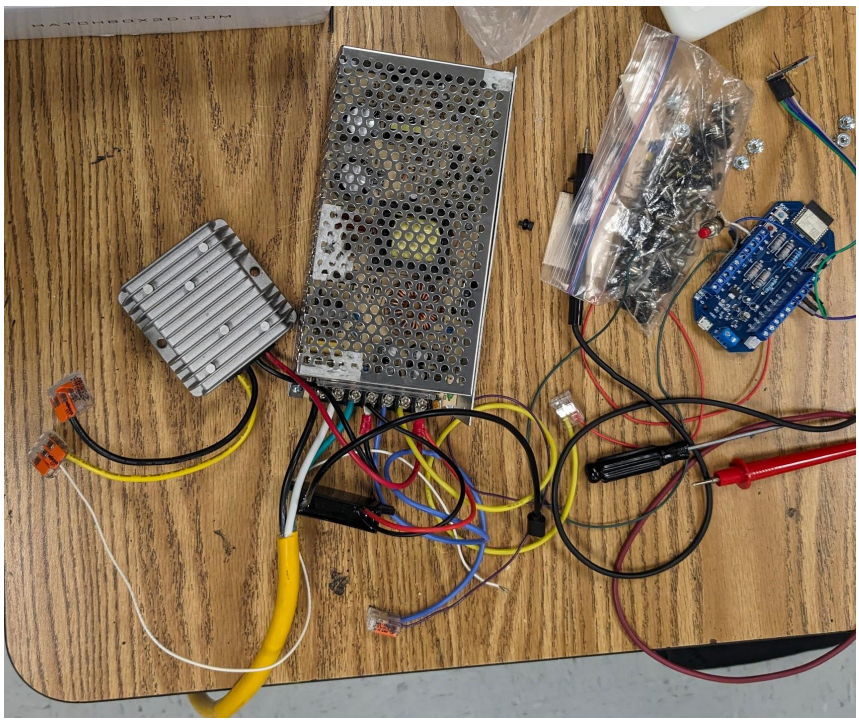
^Video^

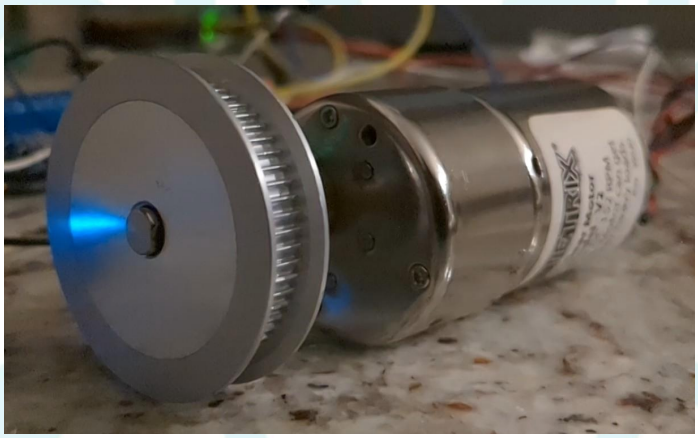
Base FRS working with a plastic drill attachment that TopTechnologies designed.

SOLUTION DEVELOPMENT

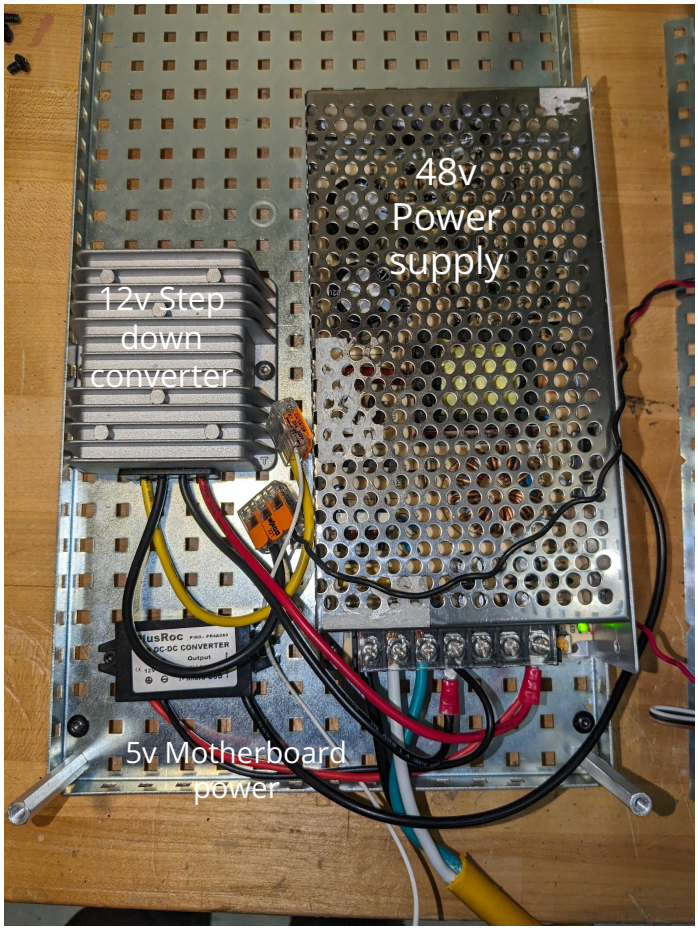


A custom electrical system was designed to deliver 12v to the DC motor, and a safe 5v to the motherboard/main controller.



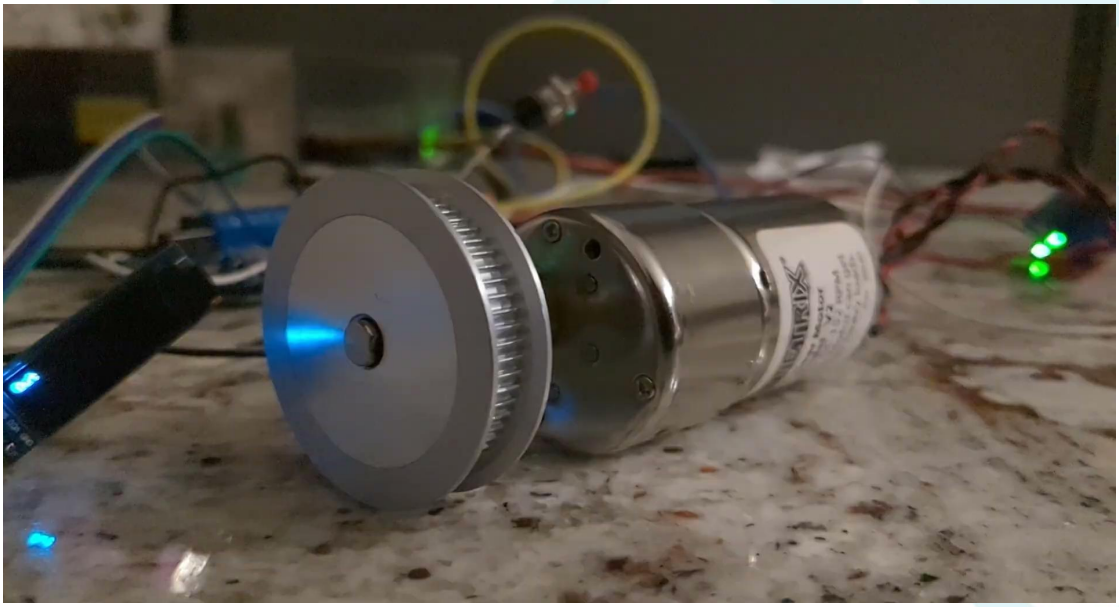


Instead of using a drill that is fatiguing to hold and unsafe to use at high speeds, It was decided to use a Brushless DC motor to drive the F.R.S



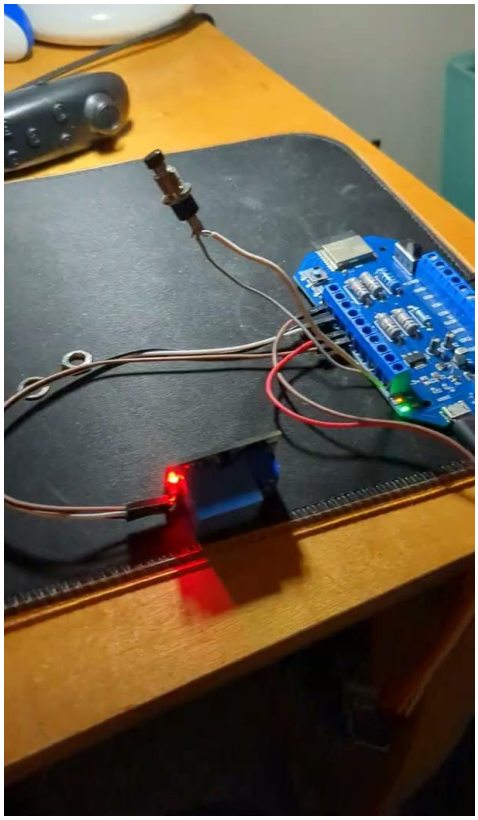
SOLUTION DEVELOPMENT

Using a custom designed PCB, a program was made to turn on/off the motor with a relay.

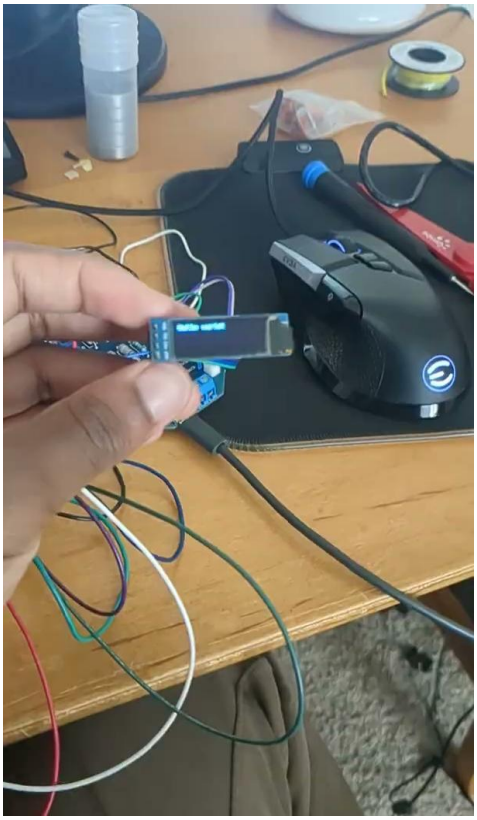


^Video^

A button error was found. Learned how to implement debounce into the code to solve this issue.



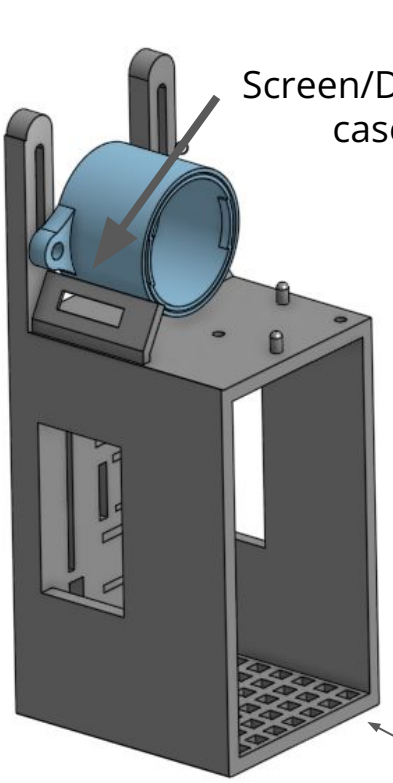
^Video^

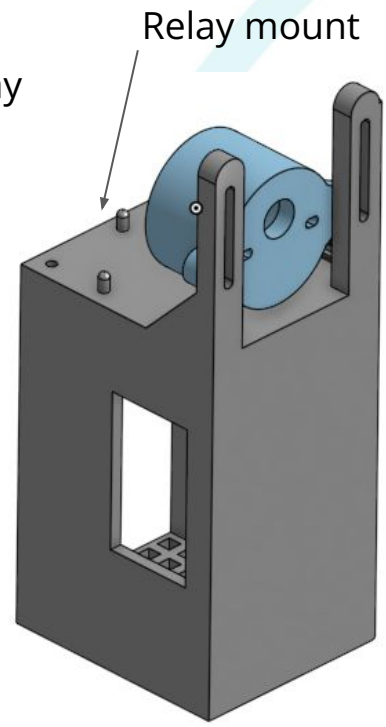


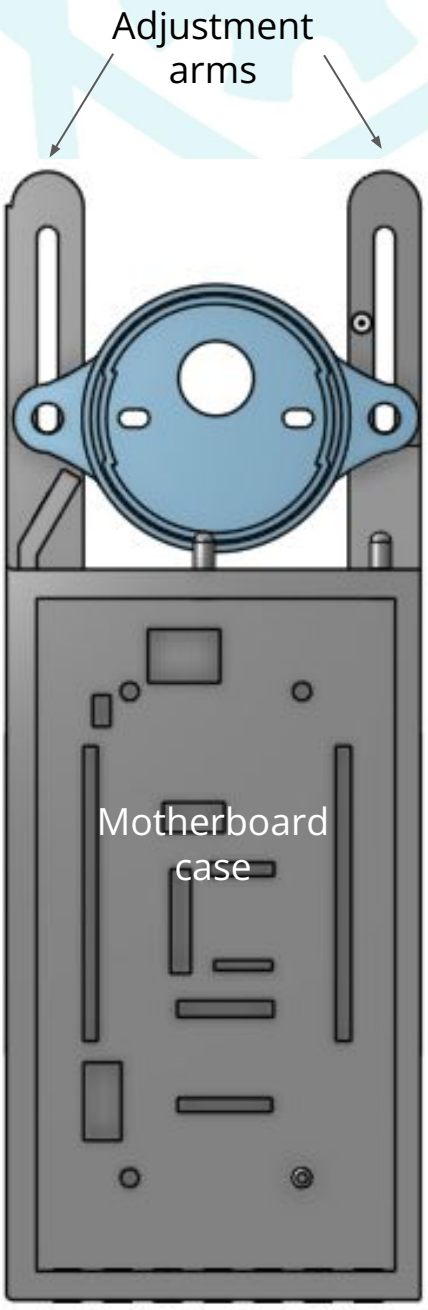
^Video^

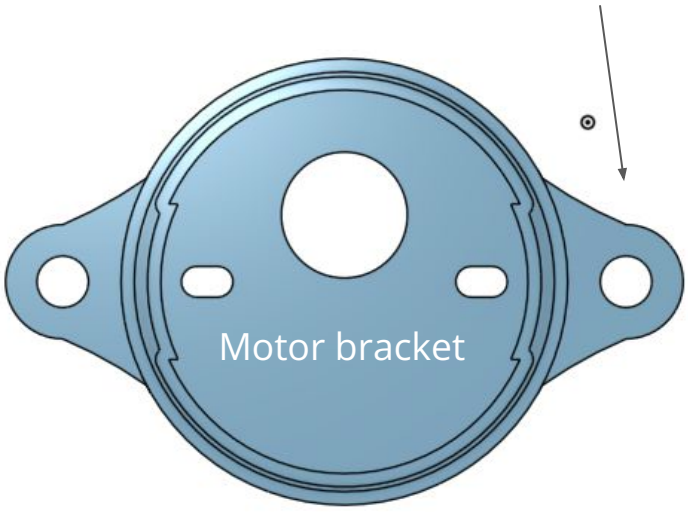
Working and interactive user interface with a small OLED screen over the IIC communication protocol

SOLUTION DEVELOPMENT

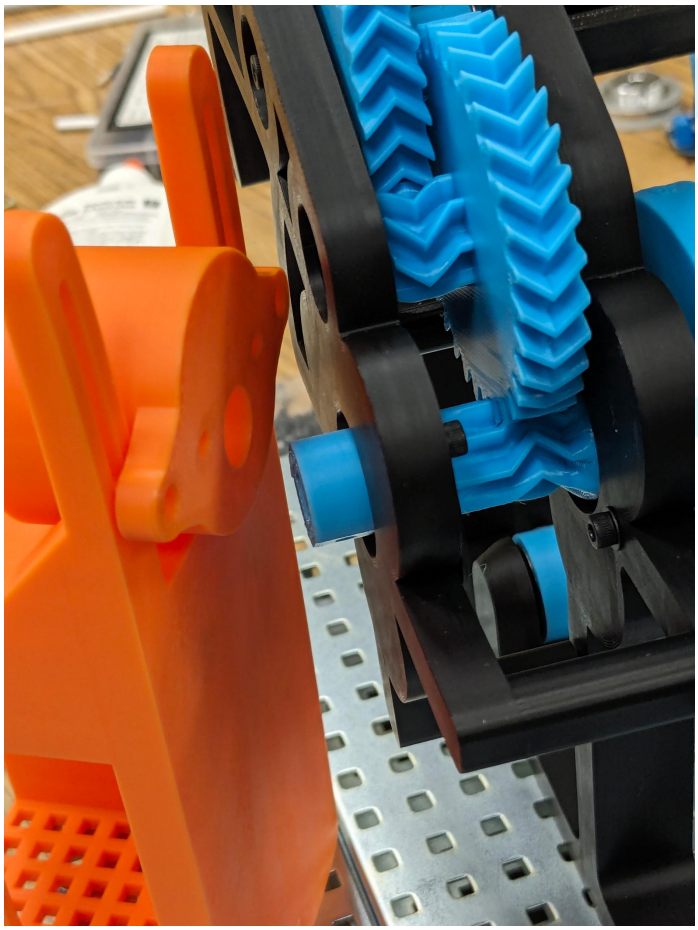




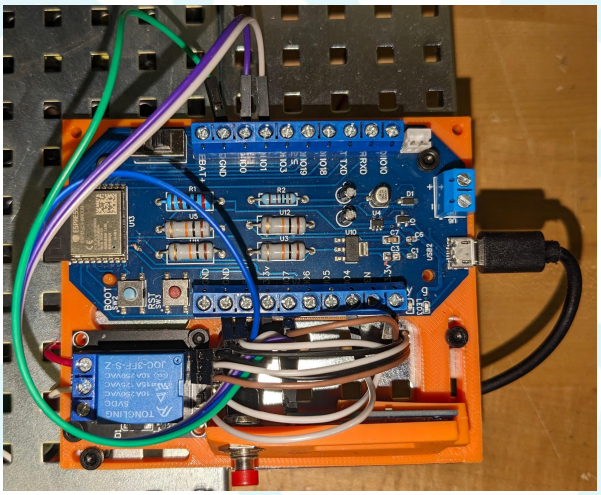




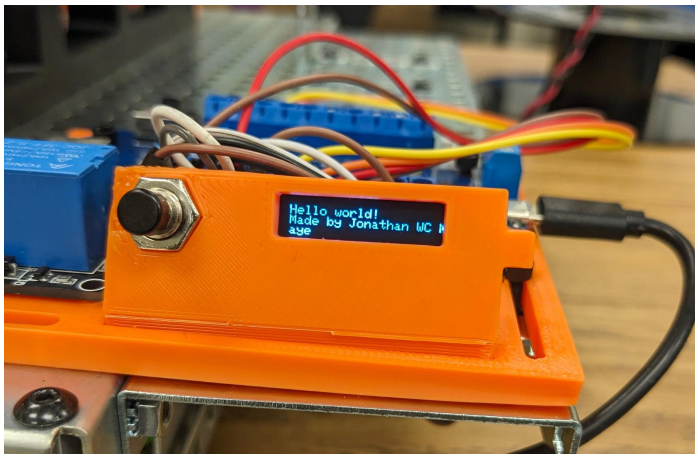
SOLUTION DEVELOPMENT

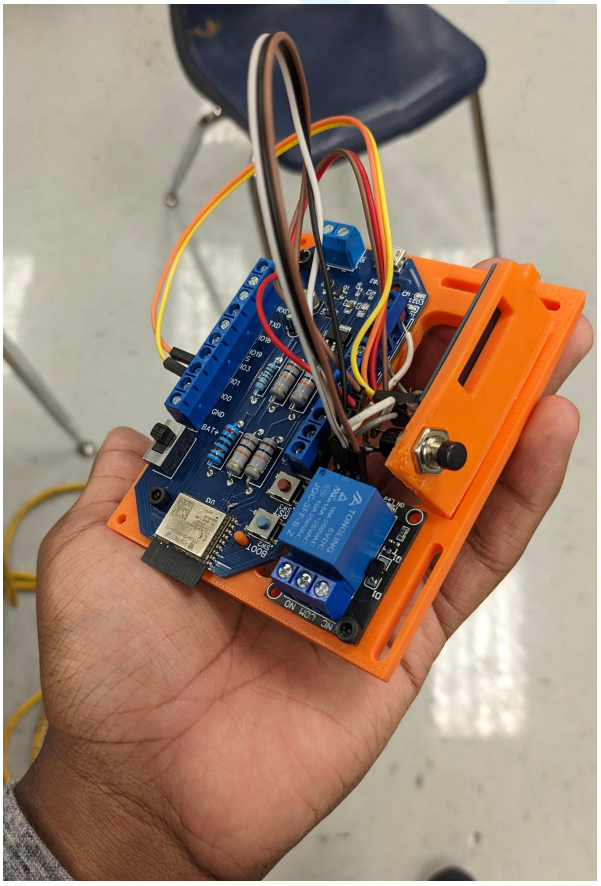


Motherboard/Motor Case had several design flaws, and took too long to print/prototype. Made of PLA which would also most likely break.



Designed a new motherboard case assembly. Incredibly easy to prototype and got a fully working design on the third print.



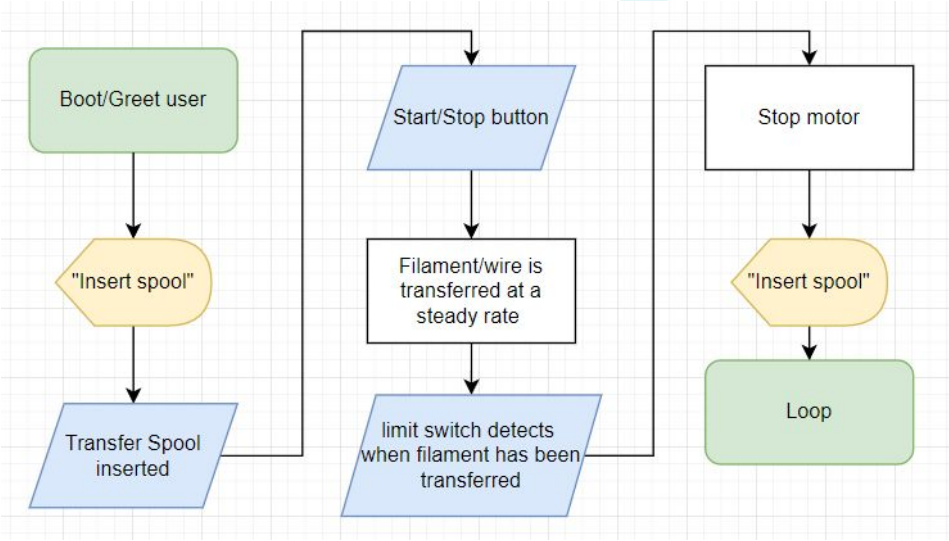


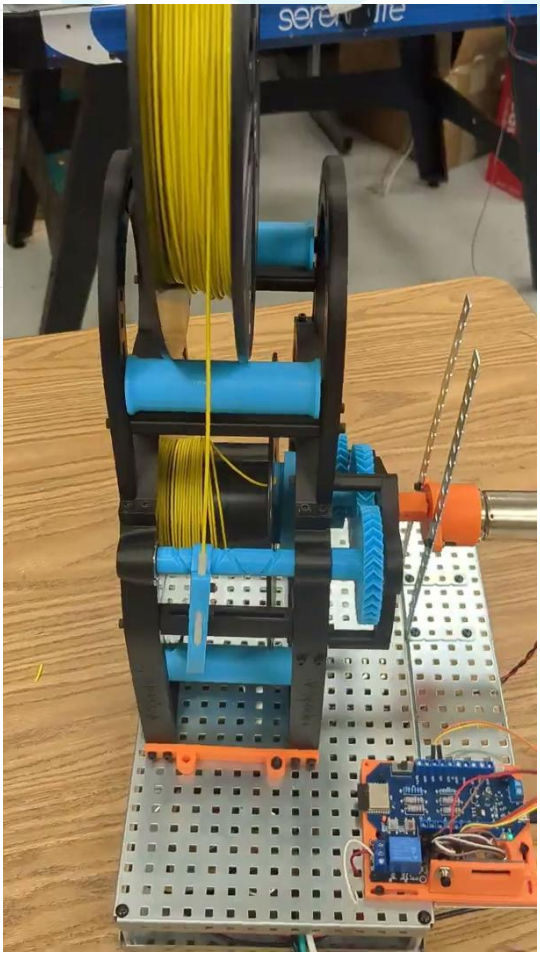
Motherboard assemble completed, with the PCB, relay, a UI/UX display paired with a button.

CONSTRUCT AND TEST

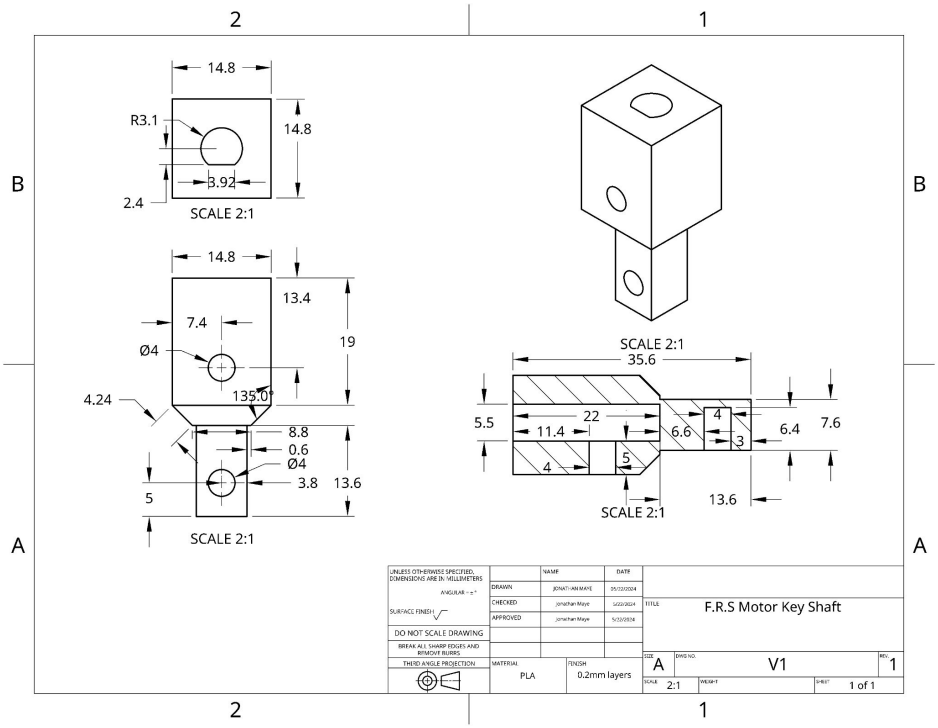
TESTING, MODELS AND/OR DATA

The Hopewell Engineering Team used to have to spend ~7 to 10 minutes to manually transfer filament from one spool to another by manually wrapping the filament in a circular motion. Now with the F.R.S can automatically do this process, and do it twice as fast! Averaging around 2 minutes and 30 seconds to transfer one 1KG spool of 1.75mm filament.



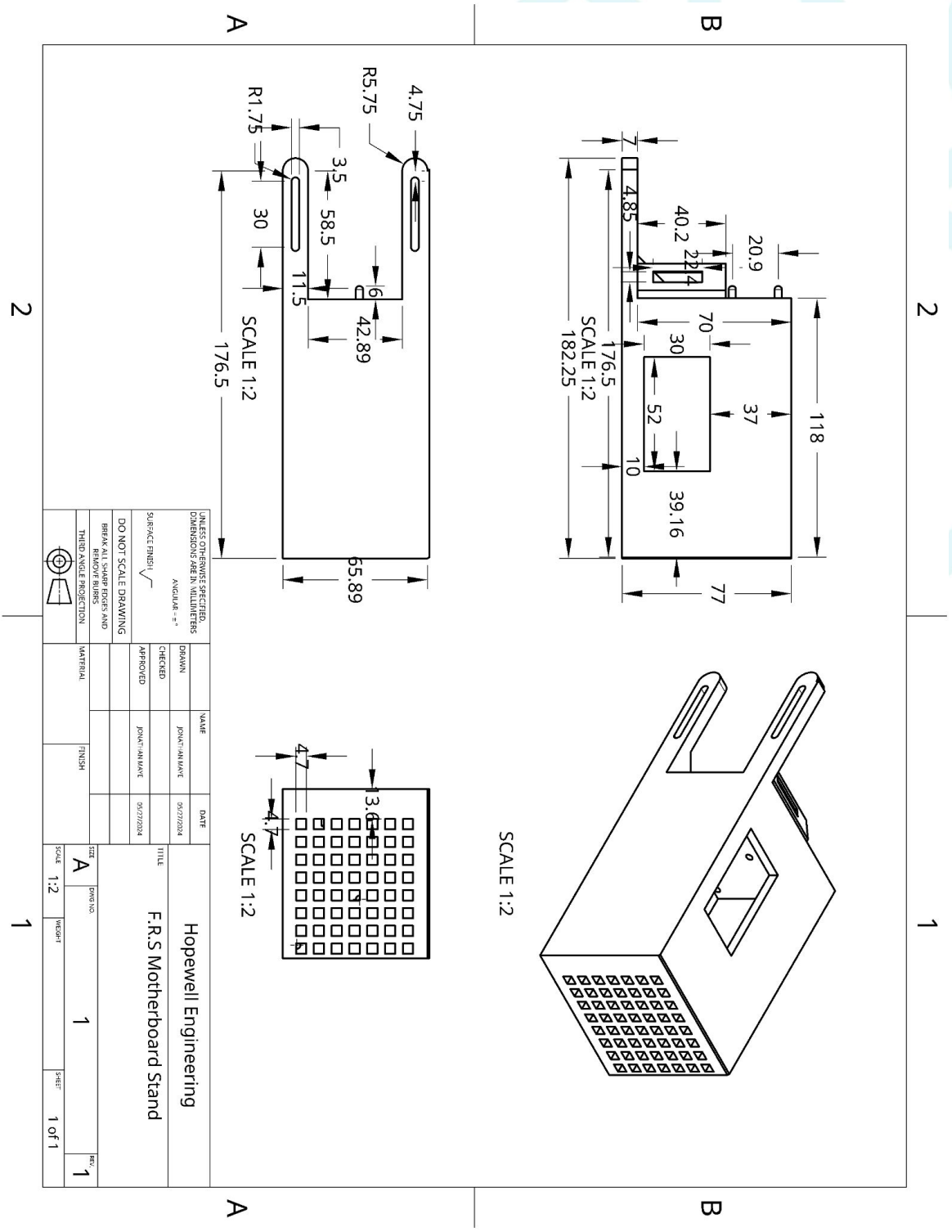


^Video^



Instruction Manual link.

TESTING, MODELS AND/OR DATA



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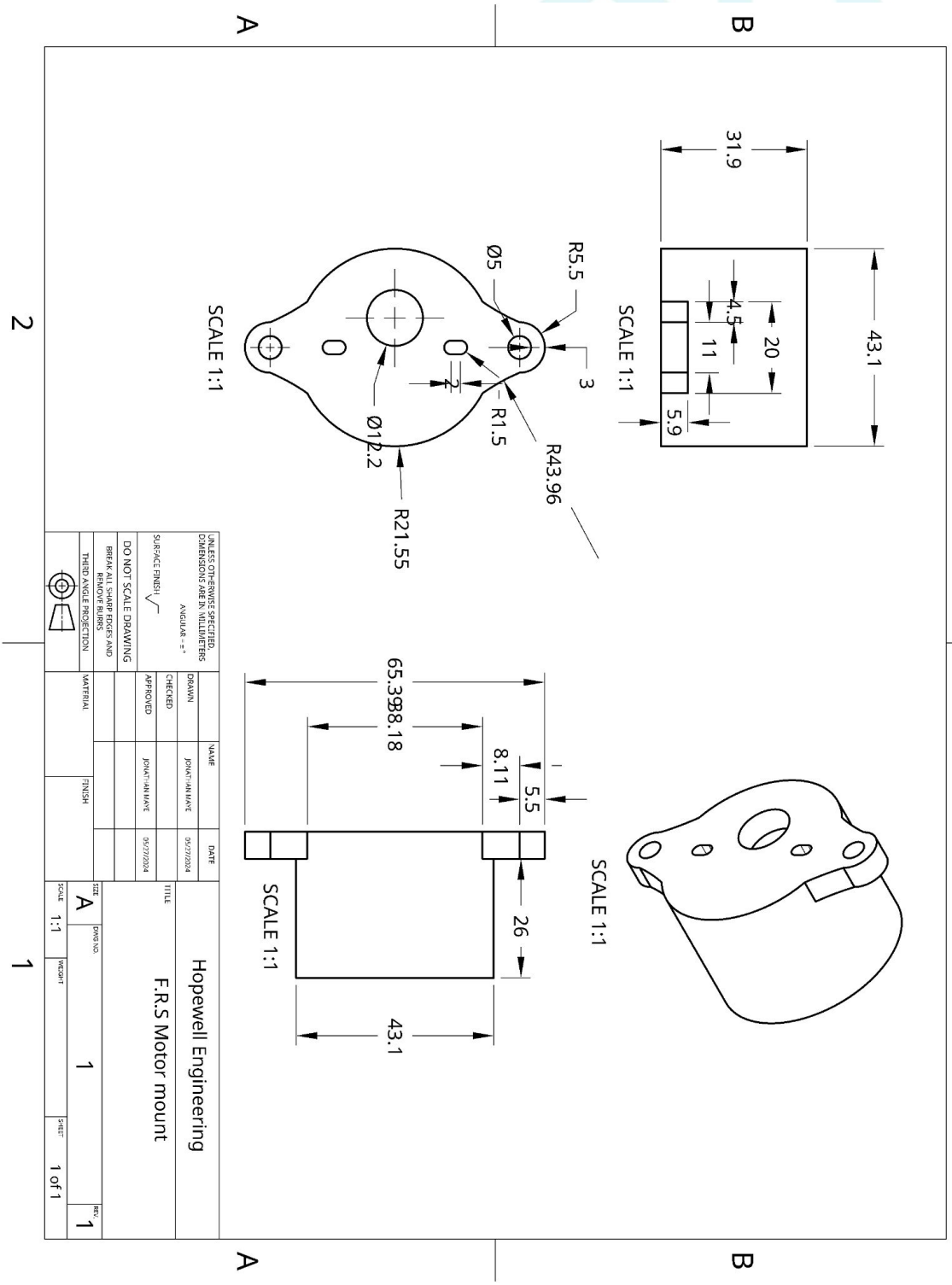

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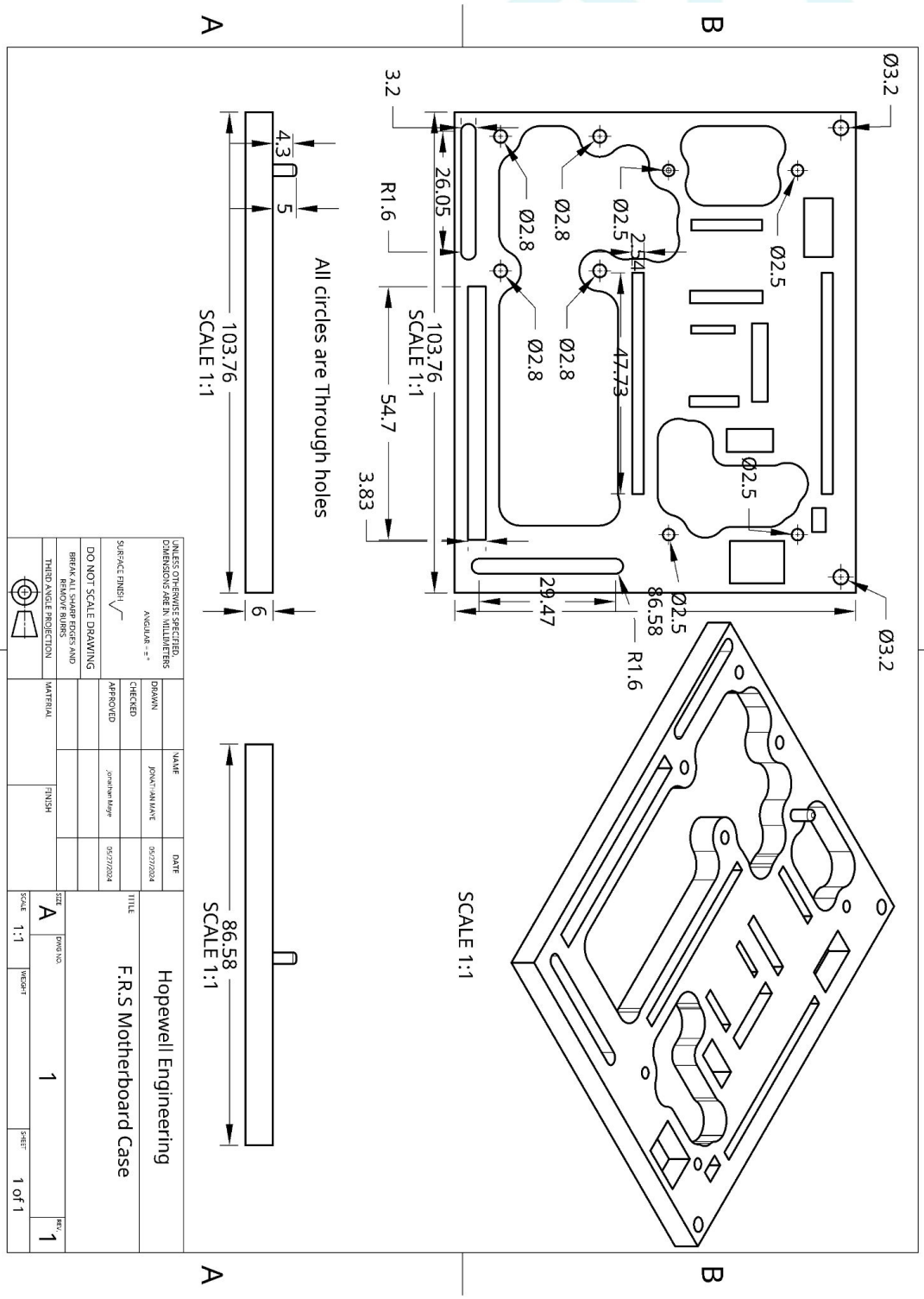
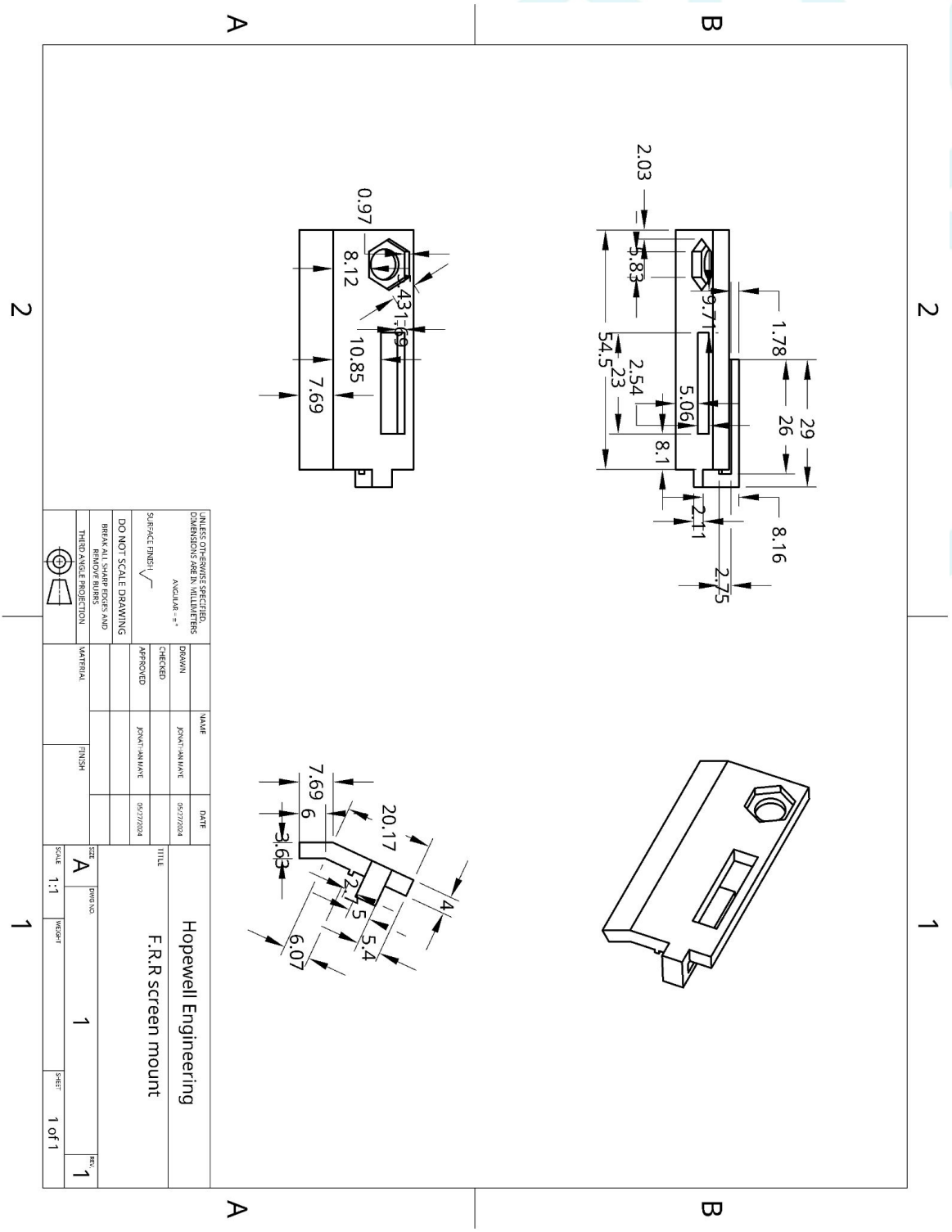


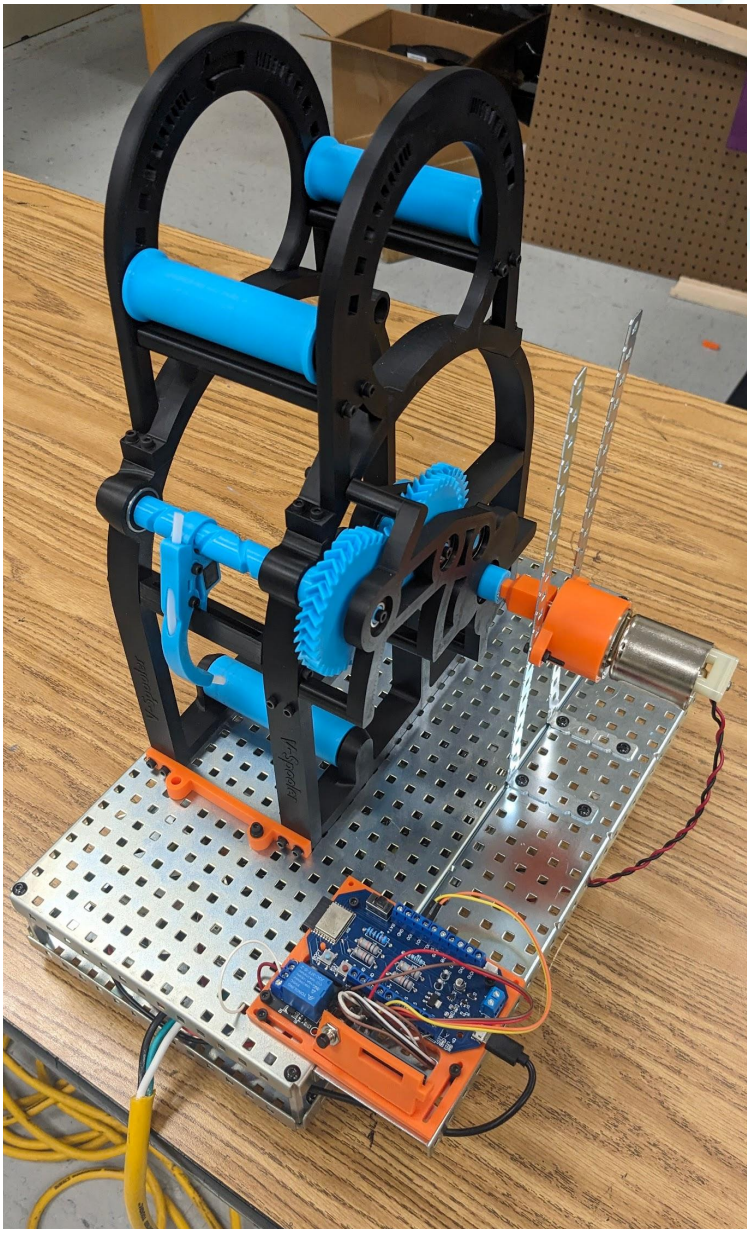
TESTING, MODELS AND/OR DATA

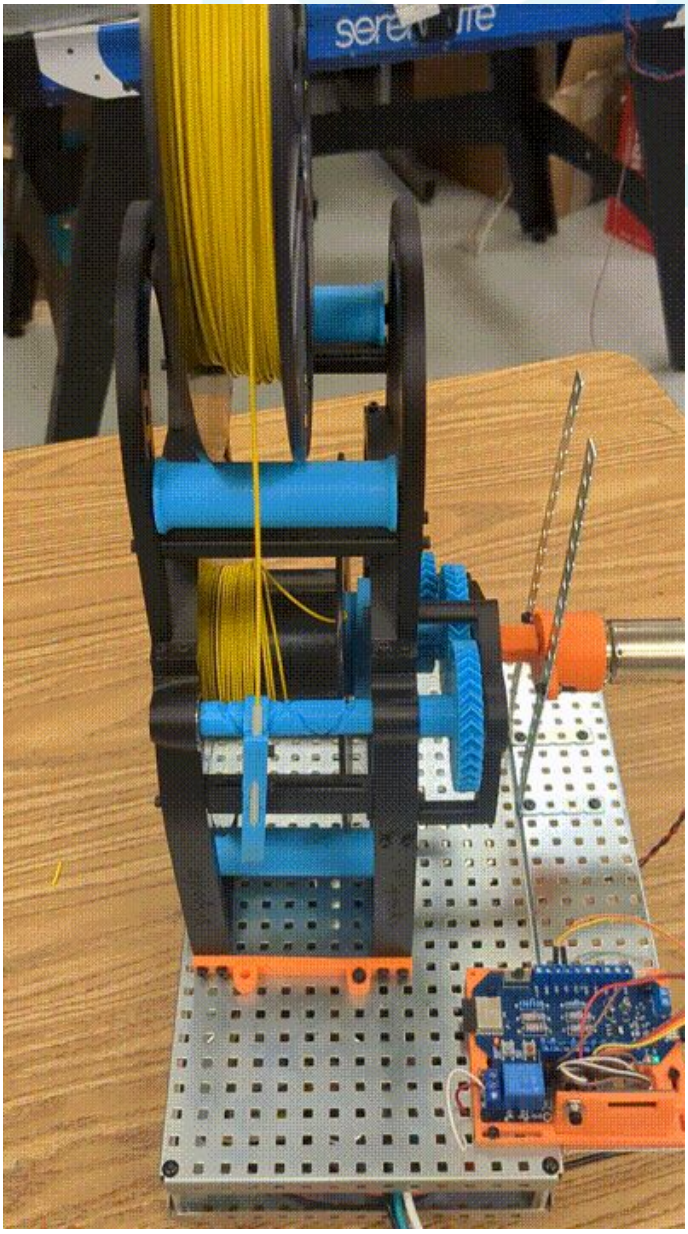


FINAL IMAGES

Photos of the Final Prototype

The prototype FRS achieved all design criteria, being easy to use with the push of a button, faster than manually cranking the spooler, 2m 30s to transfer plastic rather than 7m 45s, and works with 80% of the previously unusable spools.

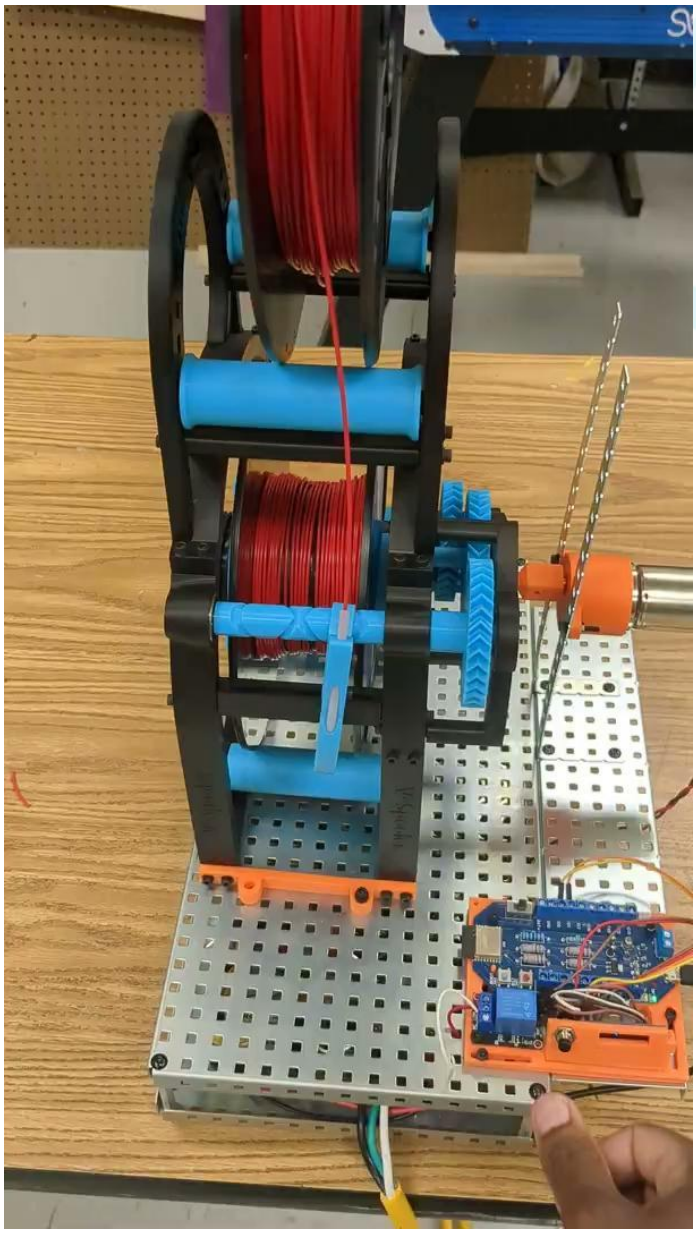




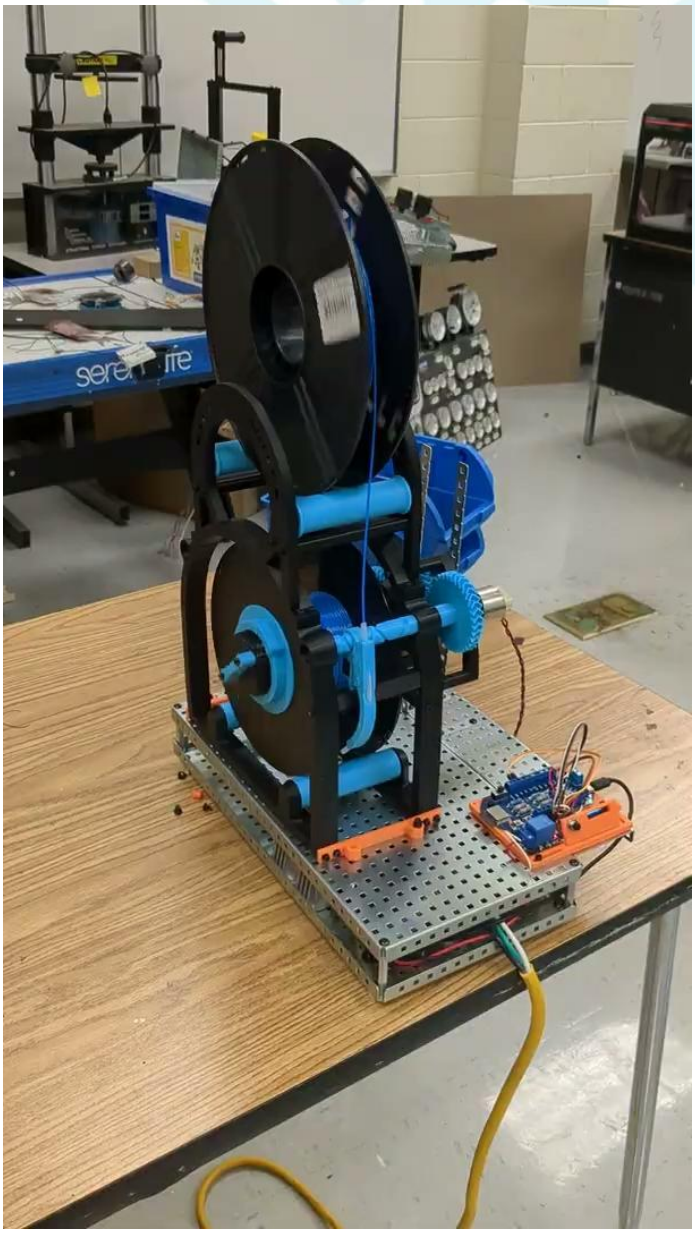
The FRS has an automatic E-Stop that activates every 60 seconds to prevent a user from leaving the system unattended.

FINAL VIDEOS

Videos of the Final Prototype



^Video^



^Video^

EVALUATE SOLUTION

EVIDENCE THAT PROJECT CRITERIA WERE MEET

At Hopewell high school, many of the 3D printers only support a limited number of plastic filament spools, limiting material and color options for students. The engineering class needed a way to reuse old, supported filament spools and transfer the new filament to the supported spool. The F.R.S solves this issue with flying colors, by first being incredibly easy to use and set up by a student who has no experience with the system. Furthermore, the Instruction manual further simplifies the process, and the code can be modified by any students who have worked with the widely popular Arduino IDE programming language (Based in C++). The F.R.S is faster than manually transferring a spool, where manually spooling 1kg would take around 7m 45s, the F.R.S only takes around 2m 30s to transfer the plastic. Also, the transferring process is almost completely hands free, and compatible with all sorts of spools (ranging from cardboard, spools with a too large outer diameter, and spools with too small of an internal diameter). Lastly, the F.R.S uses two 7.5" x 15" VEX base plates as its main metal structure, along with 1 5x25 VEX C-channel bracket to mount the DC motor assembly making this entire device have a relatively small footprint, and easy to carry and store in the Hopewell engineering laboratory.

REFLECTION AND RECOMMENDATIONS

If I could start this project over, I would further develop the coding portion of the F.R.S project, to not only give forward/reverse control for the FRS, but to also provide statistical data about its use, and to use programmable LED's to display the systems status in order to improve the user experience. Also, after the respooling process is completed, the plastic filament is exposed to a lot of moisture from the surrounding air degrading 3D print quality. Therefore I would find a way to dry and lubricate the filament while it's being transferred to better prevent moisture and printing issues.

I decided to do this project to learn more about Software, Mechanical, and Electrical engineering, and I have learned a lot more about programming in the Arduino IDE, programming user interfaces, and how to design bigger and more complex mechanical parts with Computer Aided Design. Furthermore, I now understand how to use a multitude of different electrical modules like relays, OLED screams, how to debounce buttons/inputs, and I have gained more skills in parametric modeling for mechanical devices, and mounting for electrical systems.

PRESENT SOLUTION

Video

^Video^