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Virtual Design Review 5
Team 505

Danfoss Stepper Motor Lifecycle Fixture

02/18/2025

Team Introductions

Bradford Andrews
Mechatronics Engineer

Albert Auer
Mechanical Design Engineer

Presenter

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Manufacturing and Test Engineer

Joseph Garvie
Systems Engineer

Presenter

Mason Herbet
CAD Designer

Presenter

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Sponsor and Advisors

Sponsor
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Senior Mechanical Design Engineer

Academic Advisor
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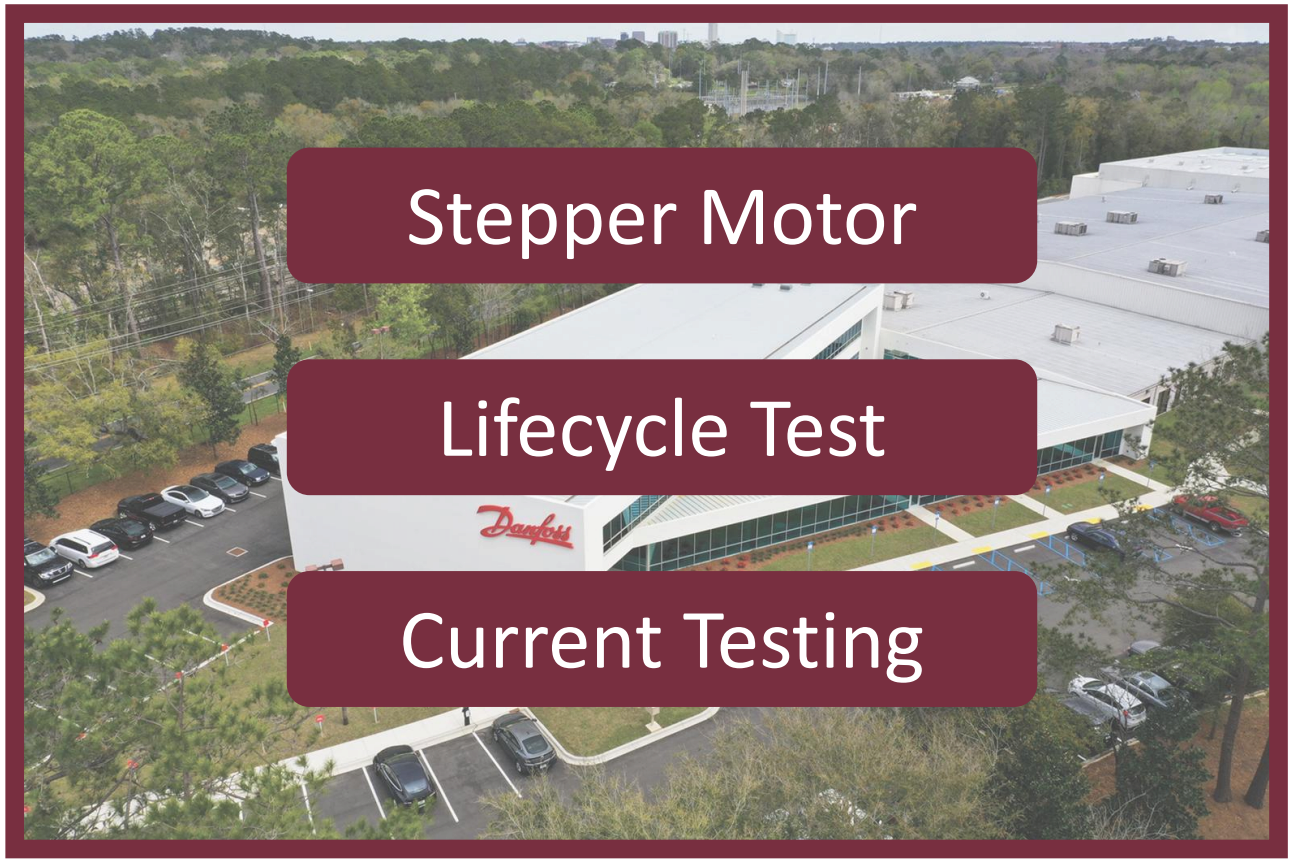
Associate Professor & Undergraduate Coordinator

Academic Advisor
Shayne McConomy, Ph.D.
Senior Design Professor

Project Description

The objective of this project is to design and produce a stepper motor lifecycle test fixture for Danfoss Turbocor to improve user-friendliness and reliability over their current testing procedure.



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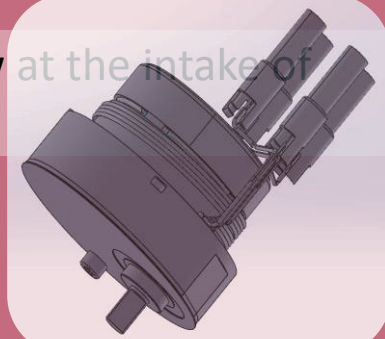
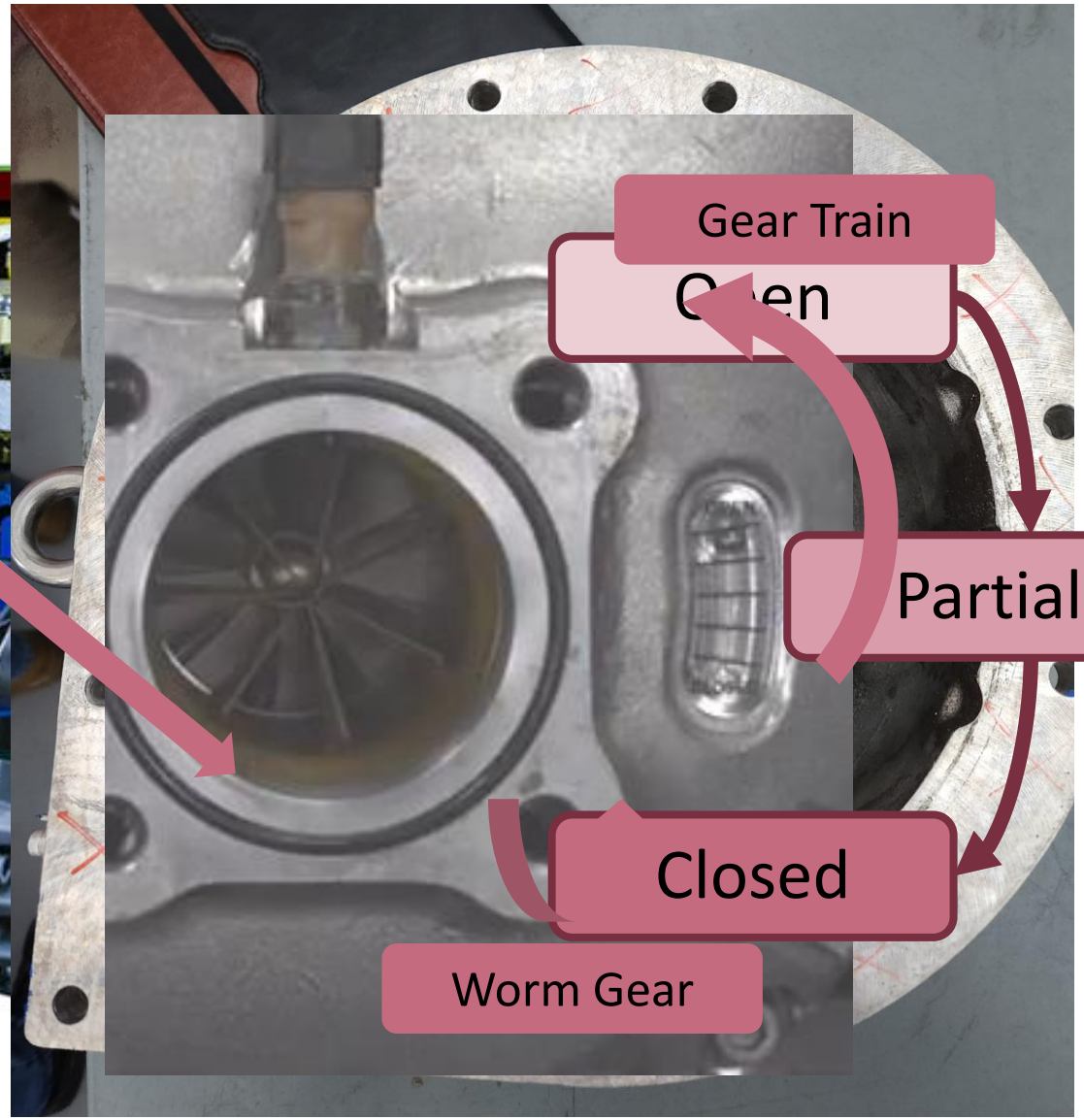
IGV Assembly

910098 Stepper Motor

Controls the fluid flow at the intake of the compressor



Danfoss Turbocor TG Series



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What is it?

- A stepper motor lifecycle test aims to evaluate the expected lifespan and reliability of the motor under typical operating conditions.

Why does Danfoss use it?

- Quality control
- Customer Confidence
- Varied Motor Manufacturers

Proposed Lifecycle = Actual Lifecycle

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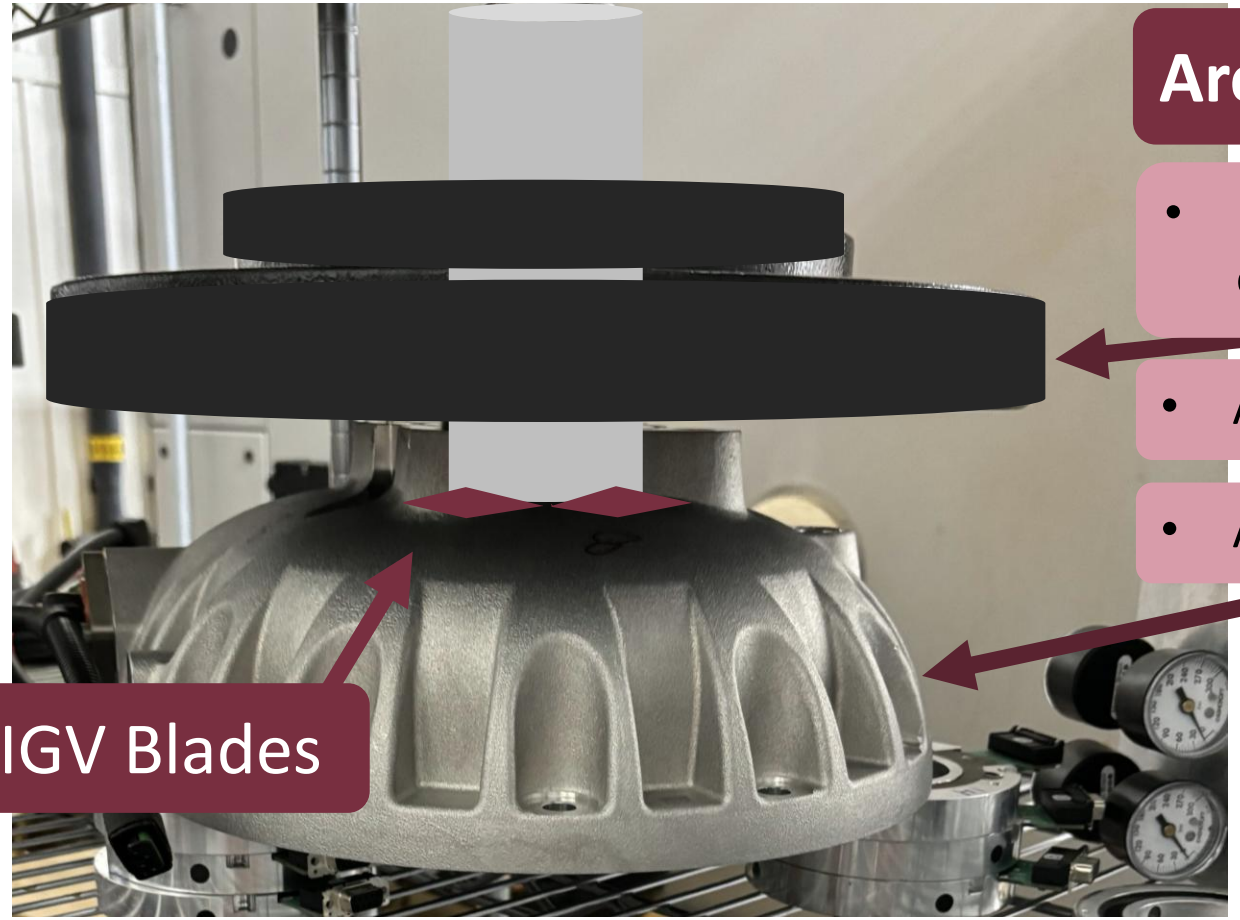


Areas of Improvement:

- Better representation of typical operating conditions
- Add Human-Machine Interface (HMI)
- Automate Rotation Counting

Starting Point

Perma-Tork

Uses permanent magnets to apply a constant torsional load to the central shaft

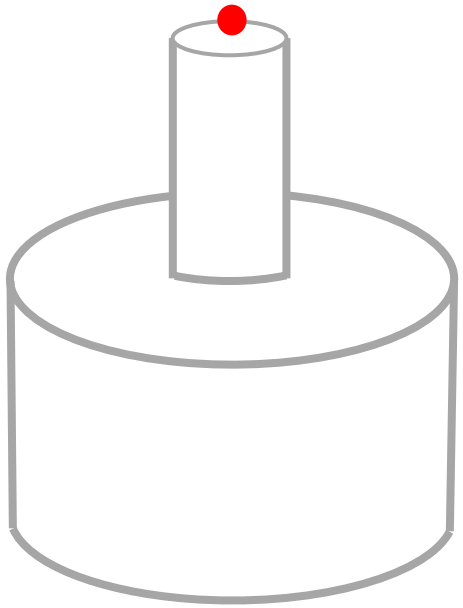
Reasons to Use:

- Eliminates unnecessary friction
- Requires no power supply
- Allows manual torque adjustment

Customer Needs

Albert Auer

One Direction Test

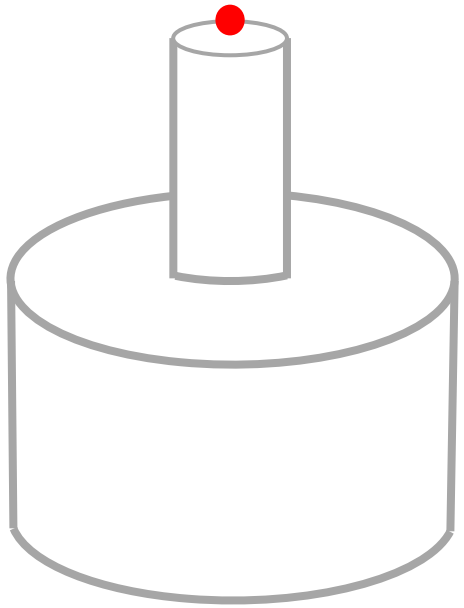


Runs continuously in one direction (CW CCW)

Similarities

- Constant speed (pulses per second)
- Constant resistance torque (N-m)
- Run until failure (motor cannot rotate)
- Track total runtime and total rotations

Alternating Test



Switches direction after a designated period of time (cycle time)

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Concept Selection

Customer Needs

Motor is oriented downwards

Assumptions

Standard 120V Outlet

Fixture housed on 16in wire shelf

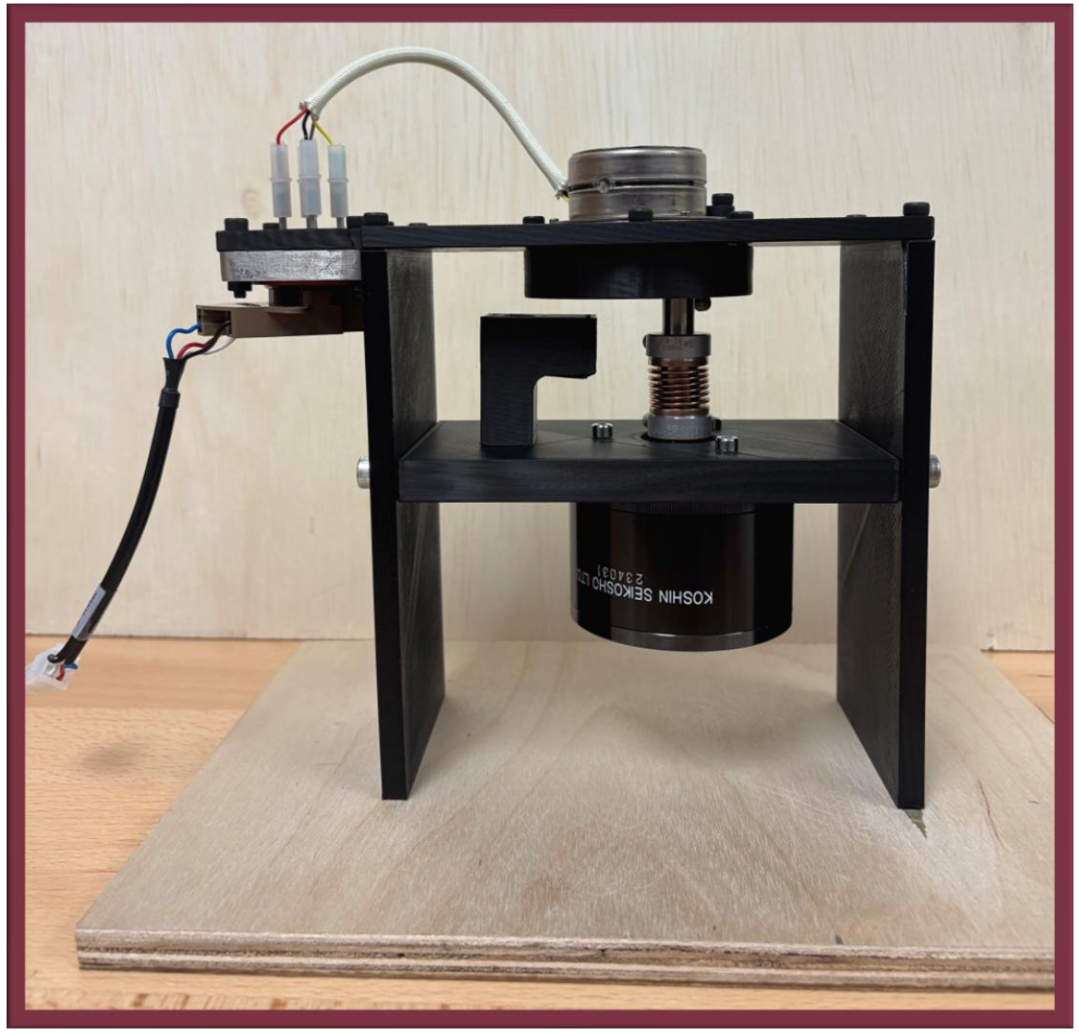
Targets/Metrics

Adjust Cycle Time (0-300sec)

Adjust Speed (0-250pps)

Track Rotations (>98% Acc)

H-Frame Prototype



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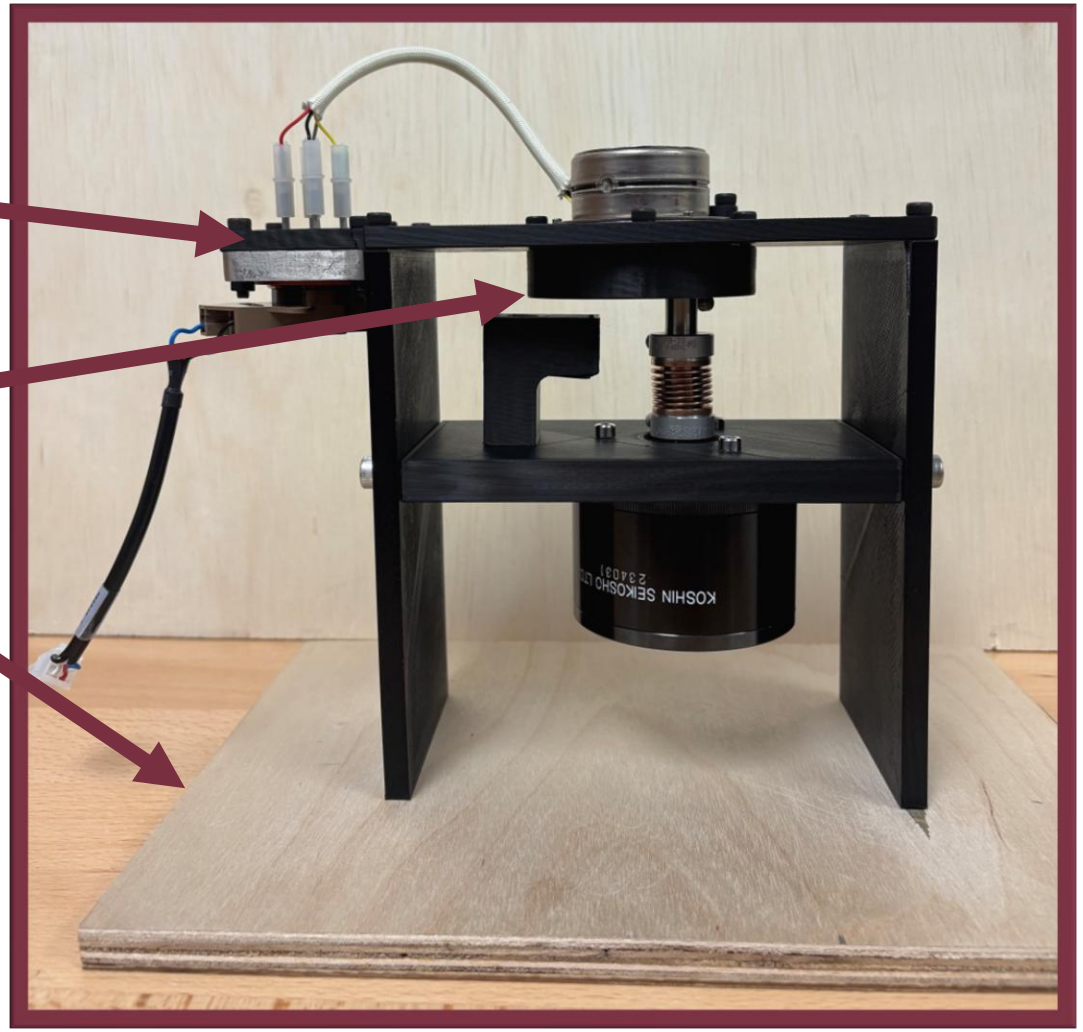
Concept Selection

Prototype Improvements

- Consolidation of stepper motor wiring to top plate
- Design choices for easy CNC machining
- Addition of baseplate to accommodate HMI

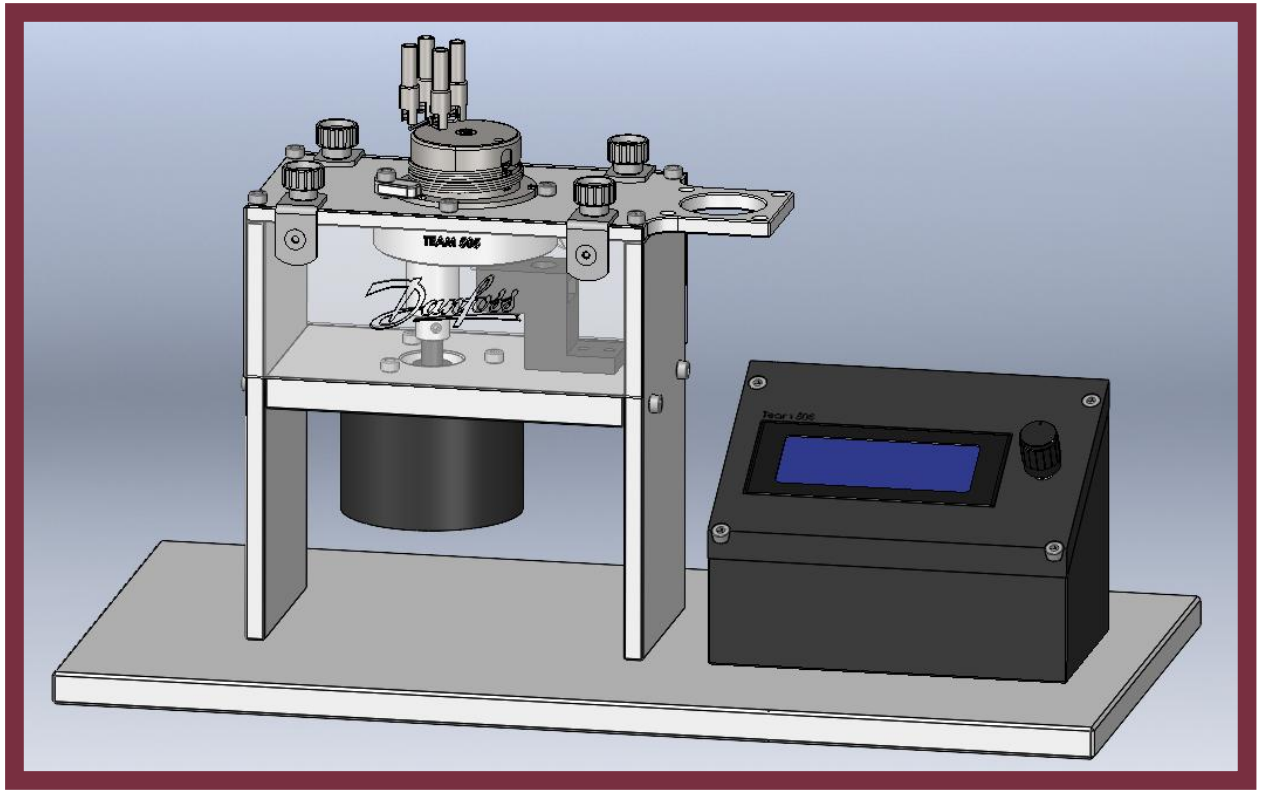
H-Frame Prototype



Structure Design Changes

Improvements

- Plexiglass paneling
- Aluminum Structure
- Standardization of fasteners



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HMI Integration

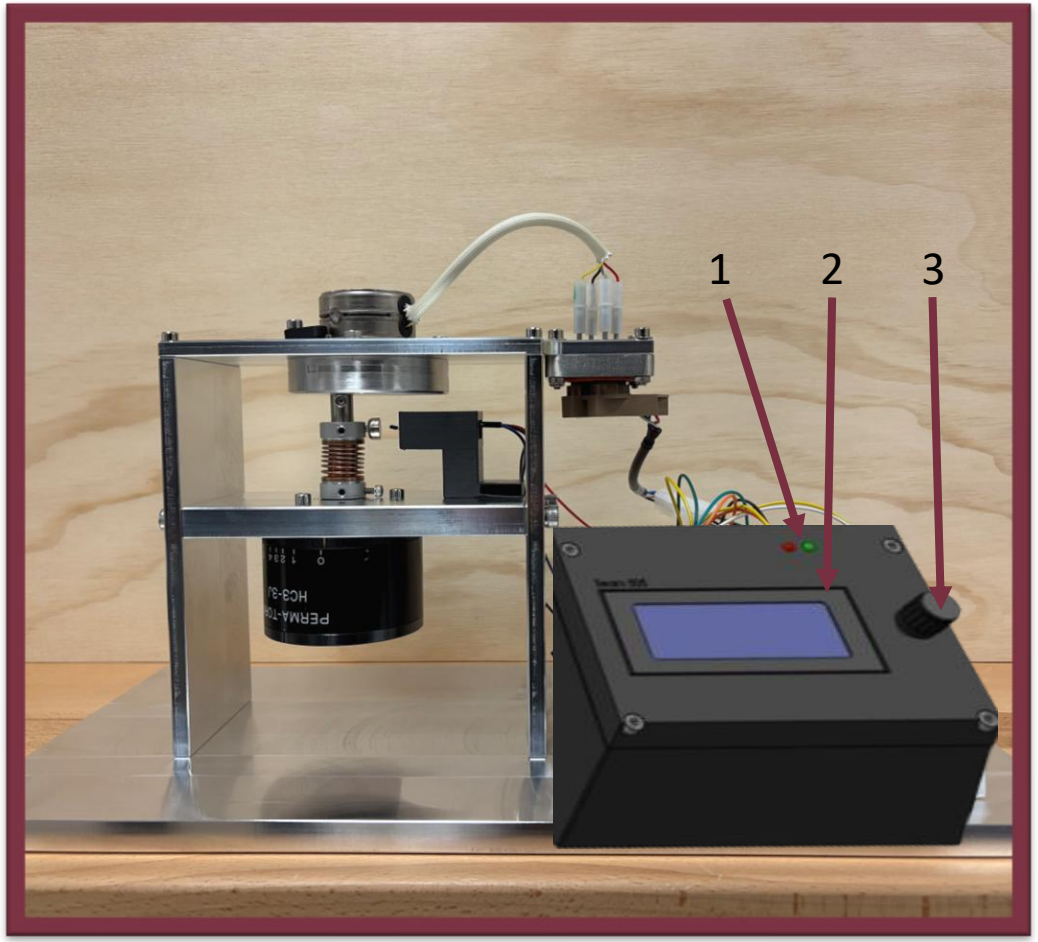
Hardware Integration

1) Status LEDs
2) LCD Screen
3) Rotary Encoder

Safety and compliance

8-pin Molex Connector

Custom PCB



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Coupler with Fastened Magnet

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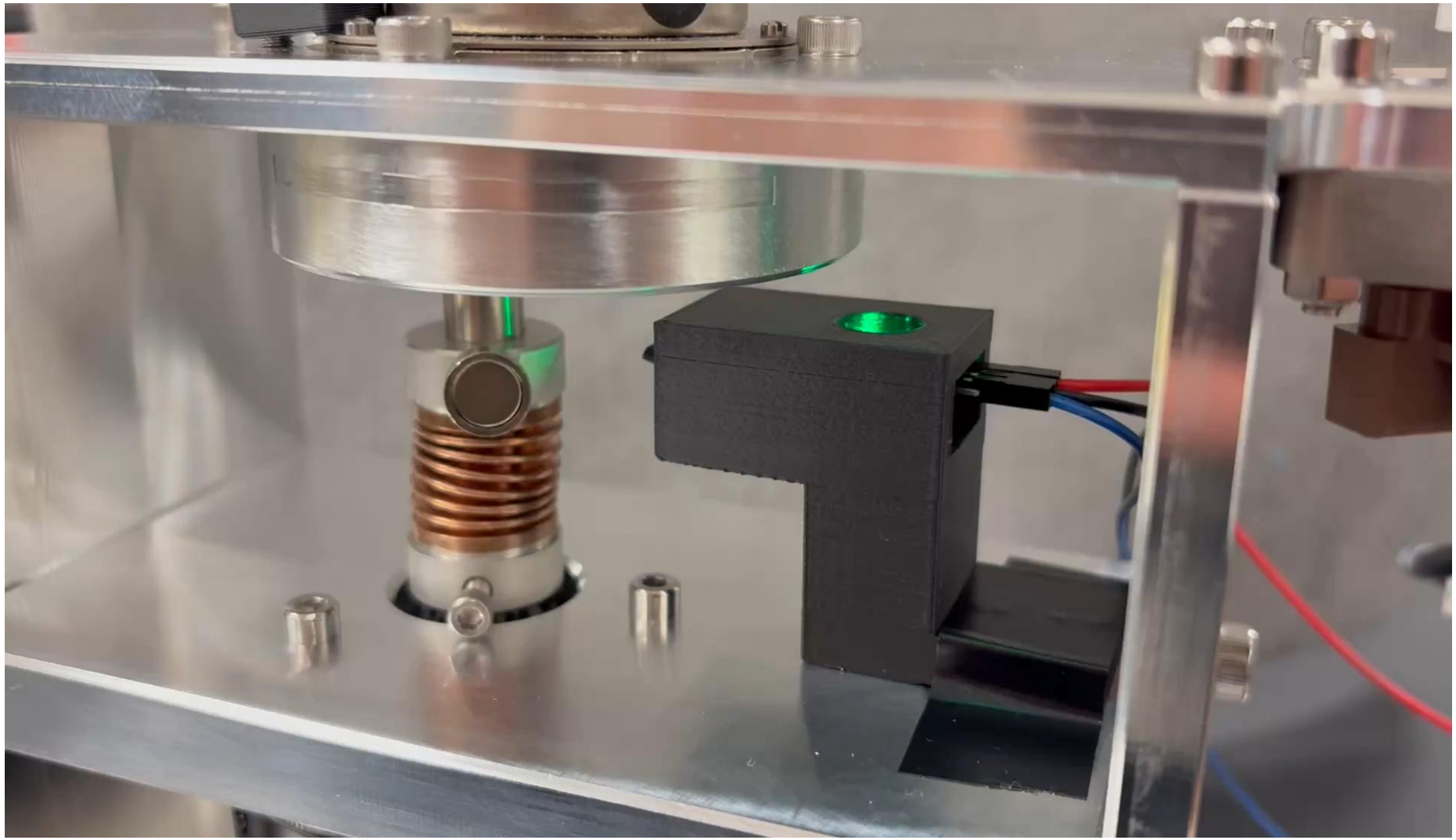

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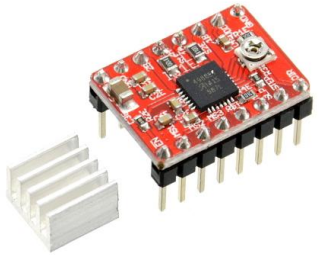
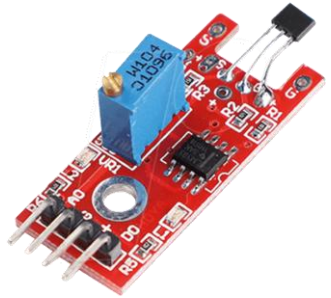
Main Electronics

Arduino Uno



Stepper Motor Driver



Magnetic Sensor

4x20 LCD

Rotary Encoder

HMI

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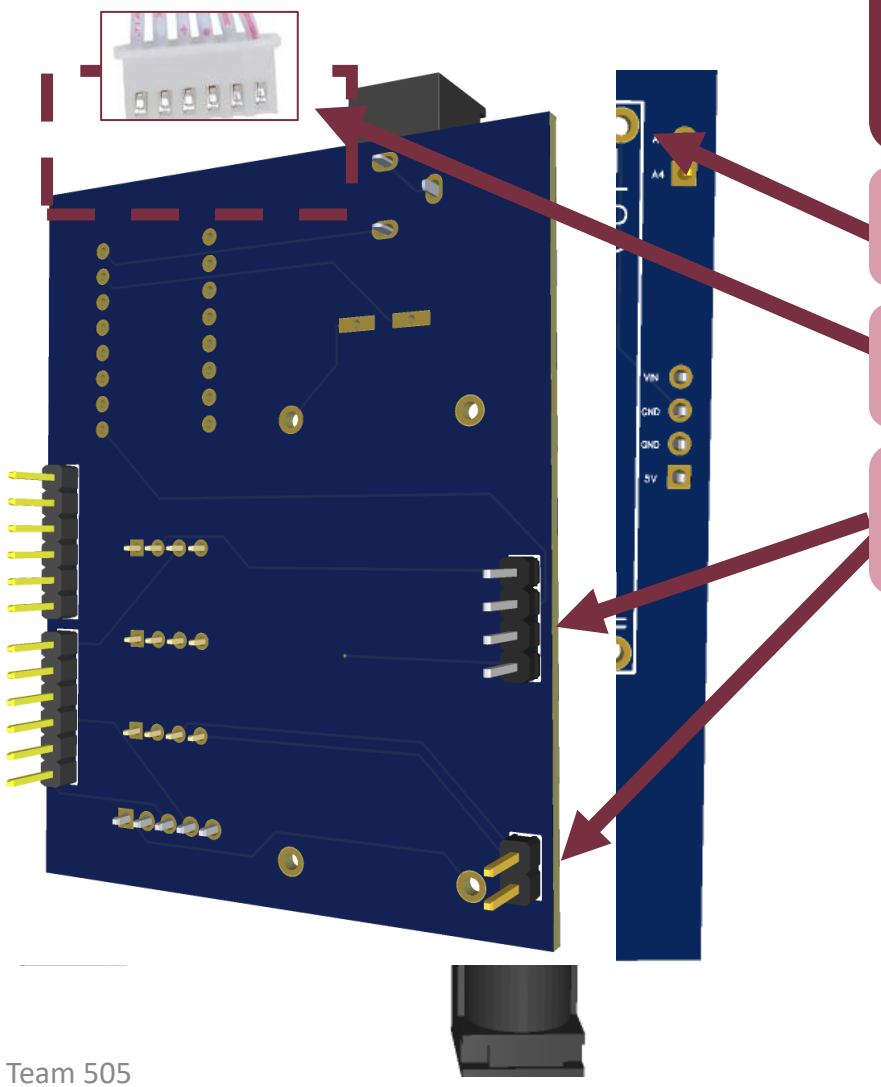
Hardware



Custom Printed Circuit Board (PCB)

- Two-Layer with mounting holes for each component
- Plug-in connectors for sensor and motor wiring
- Pins on PCB match corresponding pins on Arduino board

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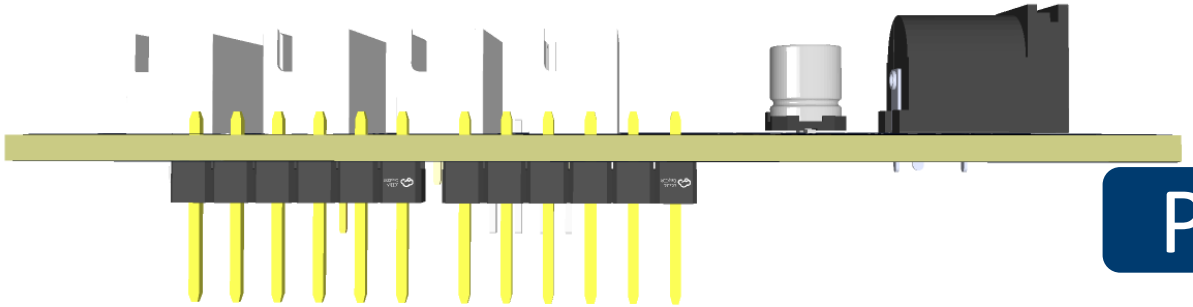
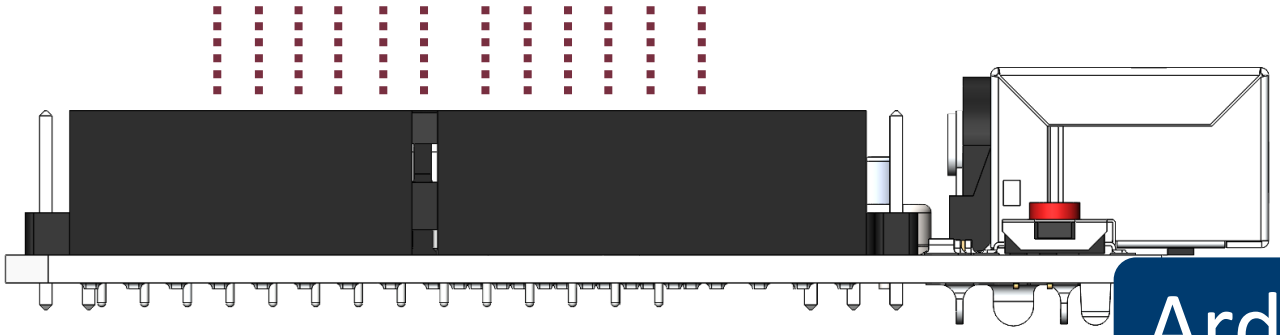
Hardware



PCB

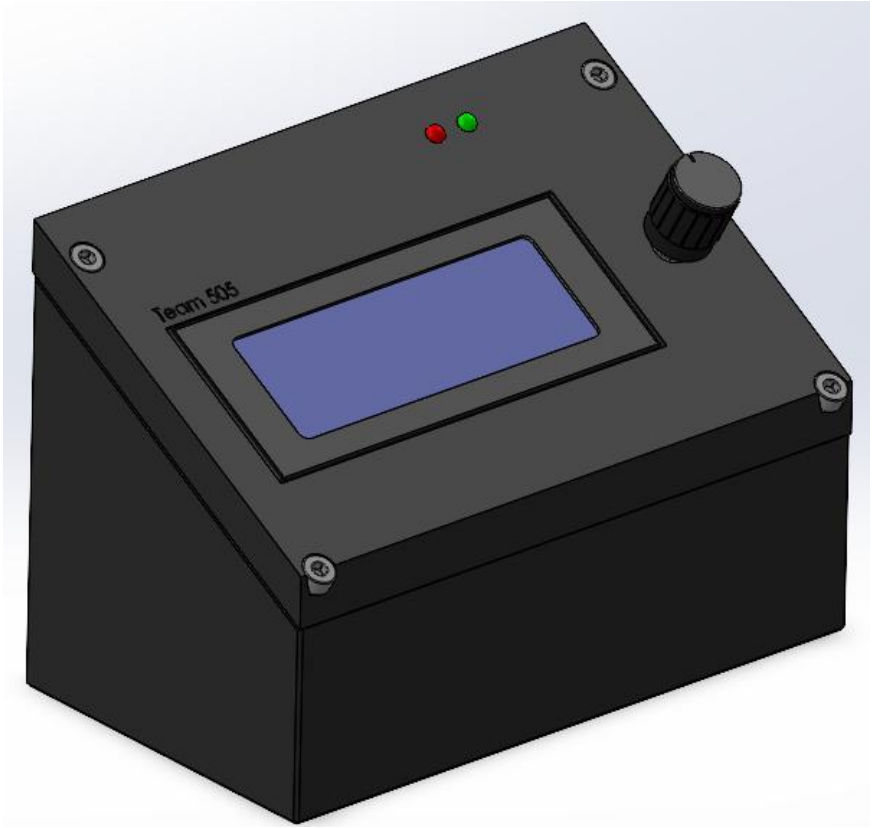
Printed Circuit Board stacks above Arduino

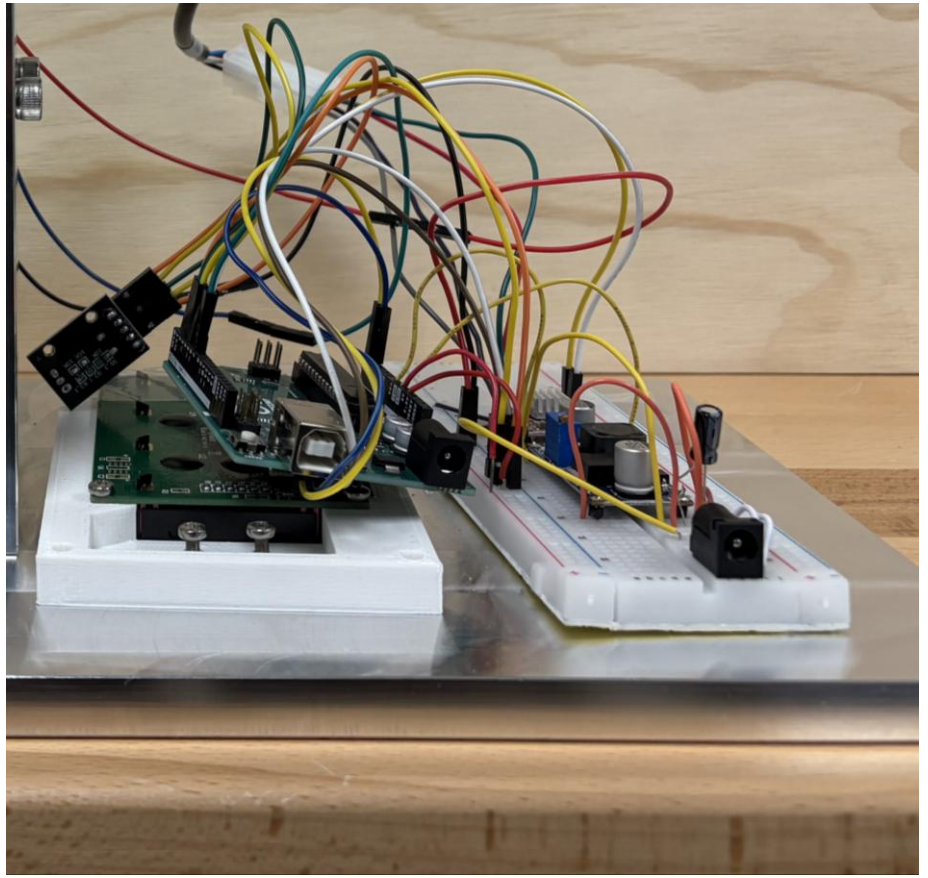
- Significantly improves wire management
- Allows for electronics to be stored in tighter spaces
- Easy for Danfoss to reproduce and assemble



Arduino

HMI User Interaction





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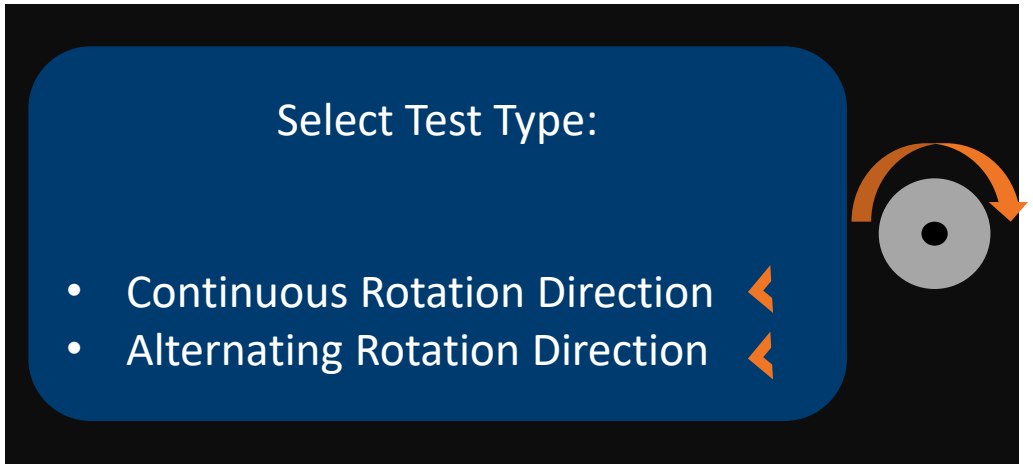
HMI User Interaction



Screen Adjustment Knob

- Rotate to scroll through test parameters
- Push to confirm selection

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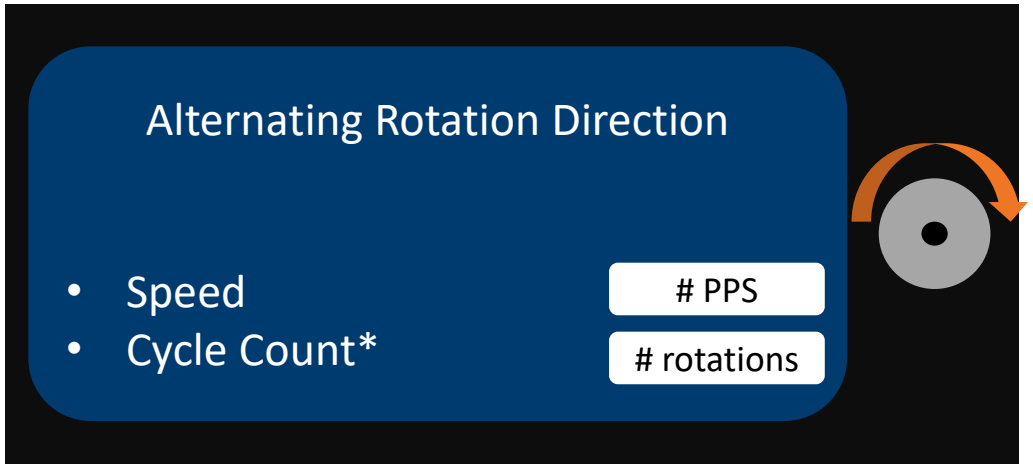
HMI User Interaction



*Represents the number of shaft rotations in one direction before switching to the opposite direction and repeating

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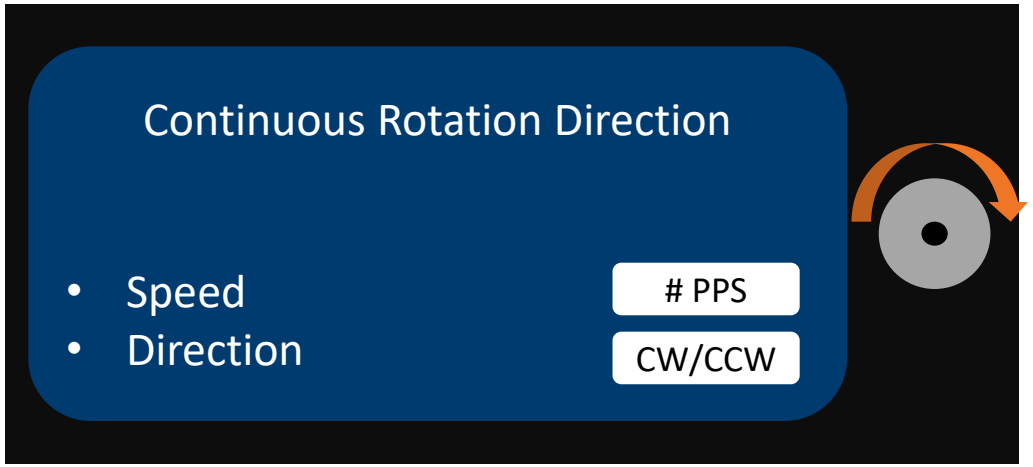
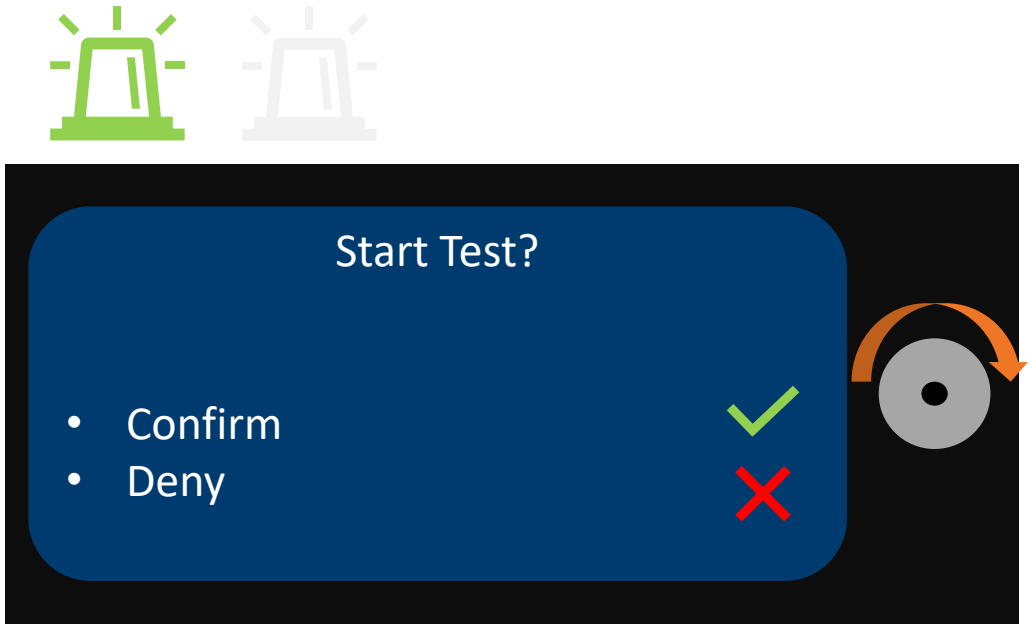
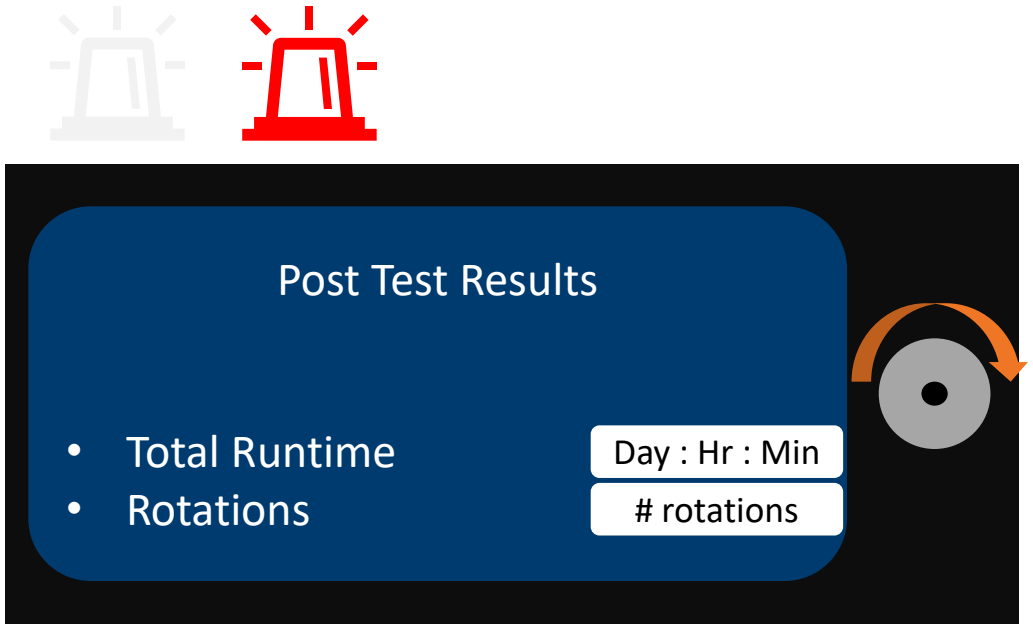
HMI User Interaction



HMI User Interaction



HMI User Interaction



HMI Display & Test Status

- Display test results on LCD screen
- Red/green LEDs indicate test completion status (motor failure)

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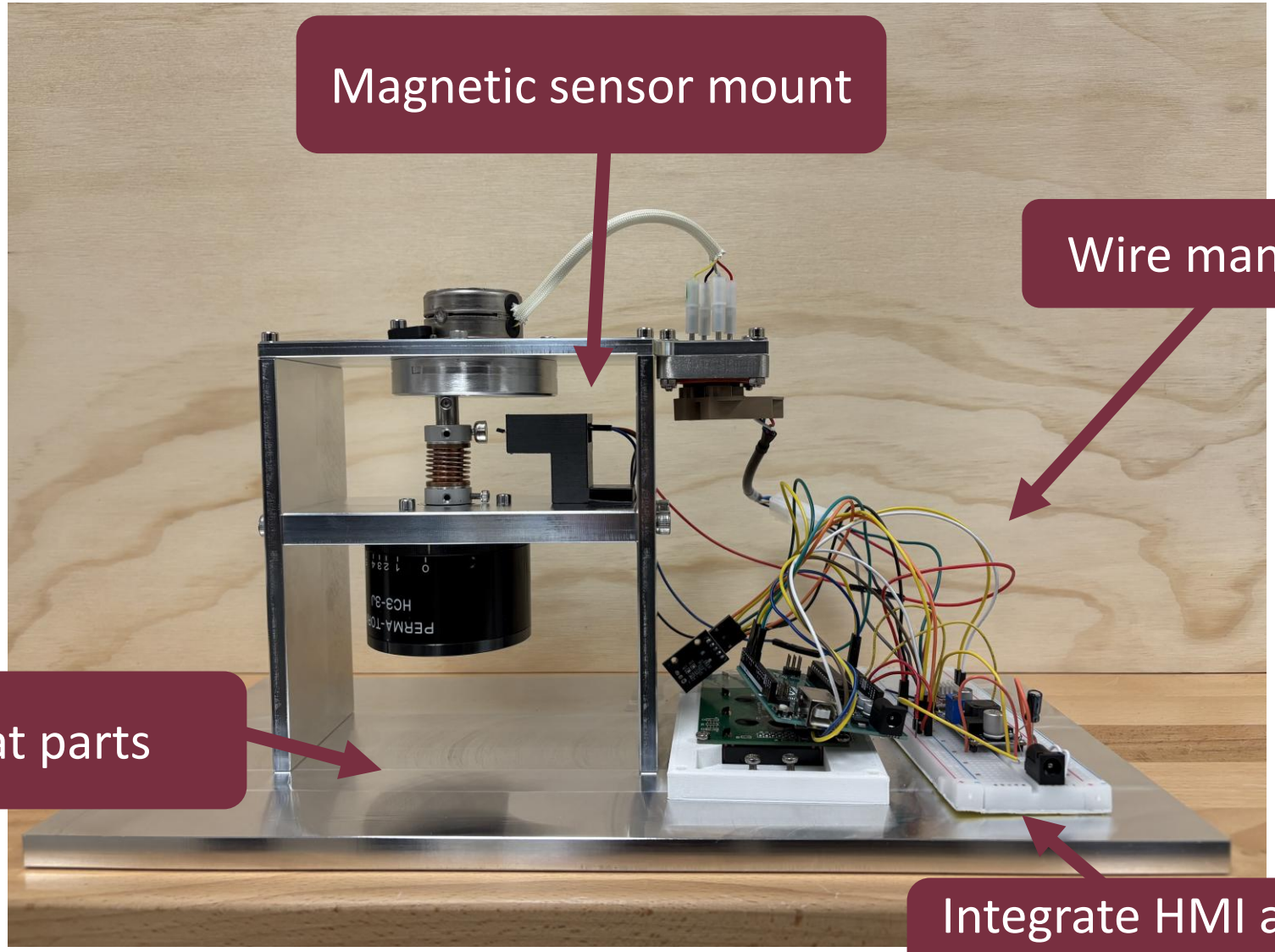
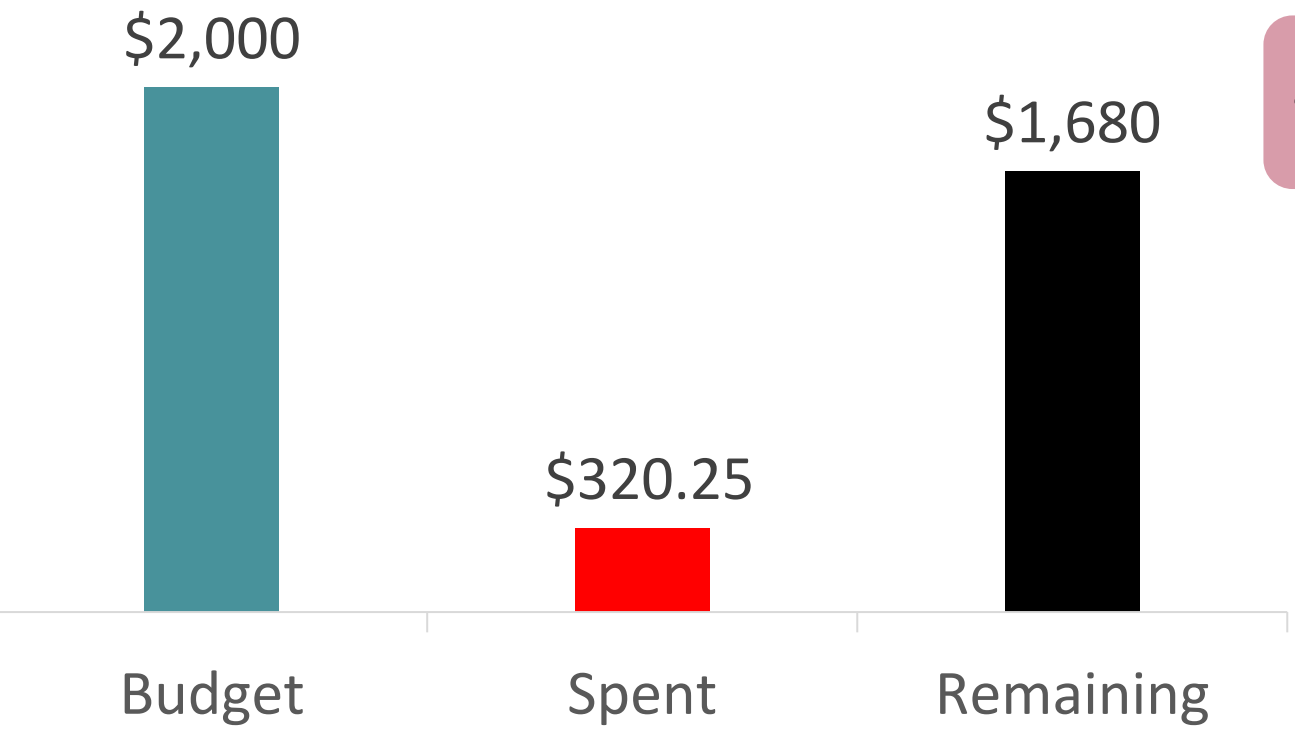
Future Improvements



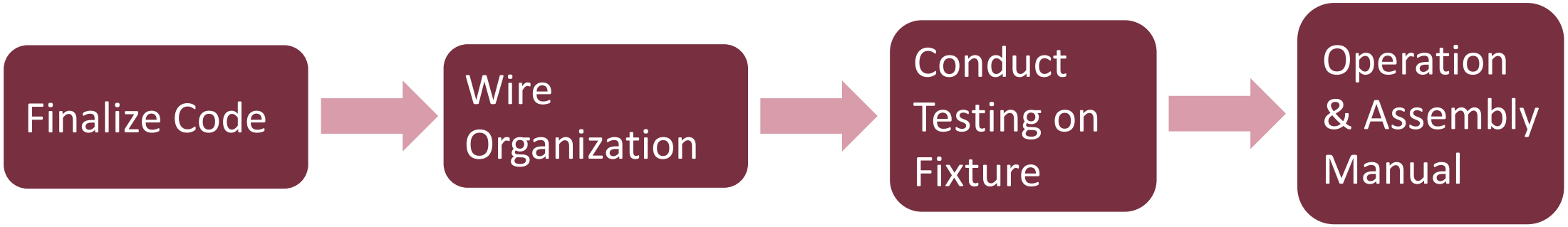
Updated Budget



Expected Future Costs

- Printed Circuit Board
- Powder coat machined parts

Future Work



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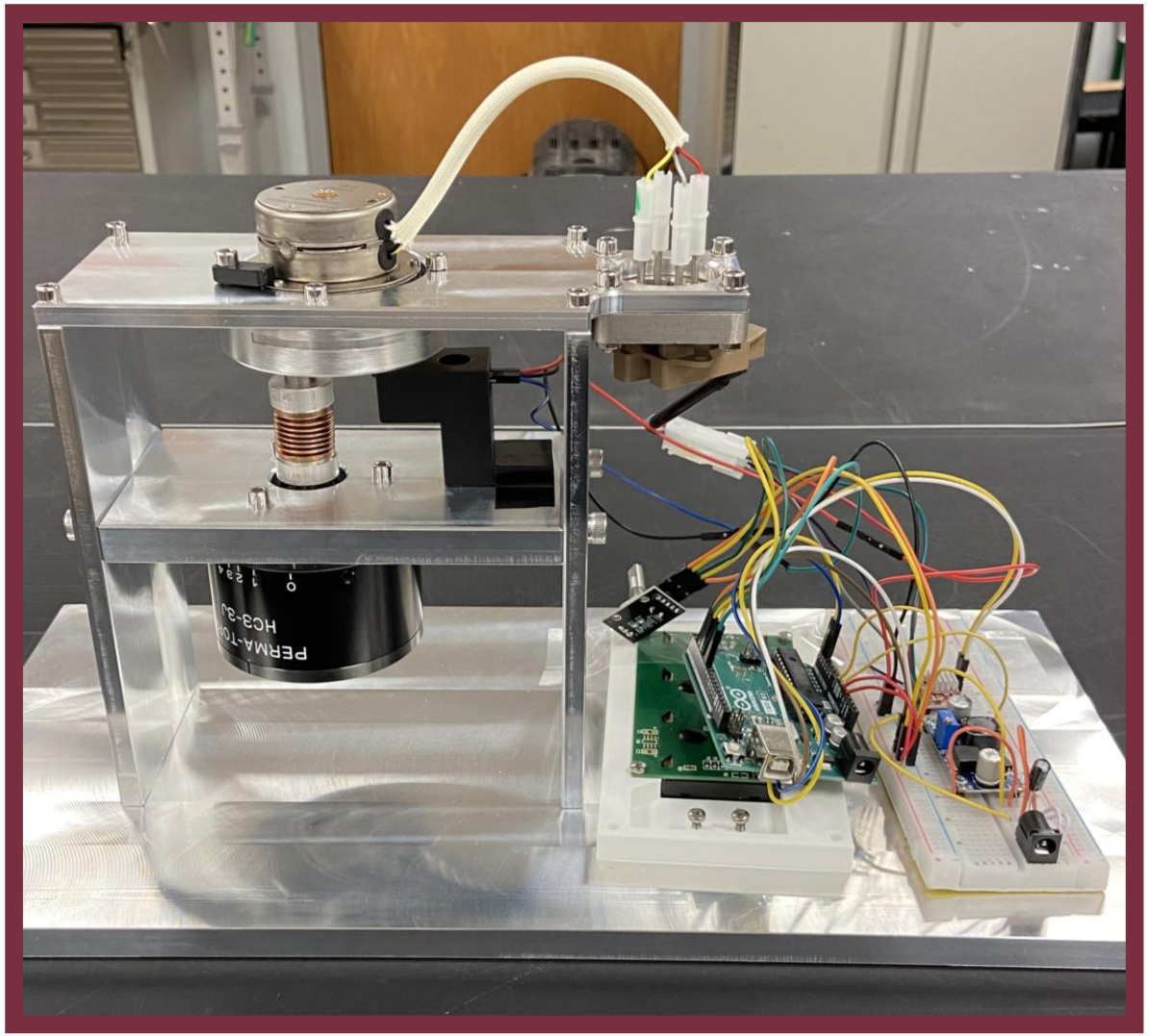
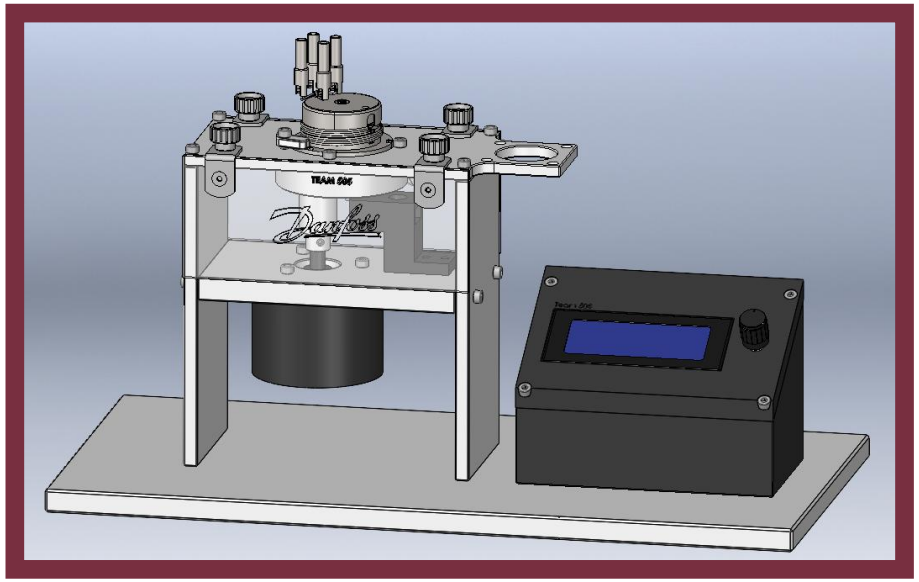
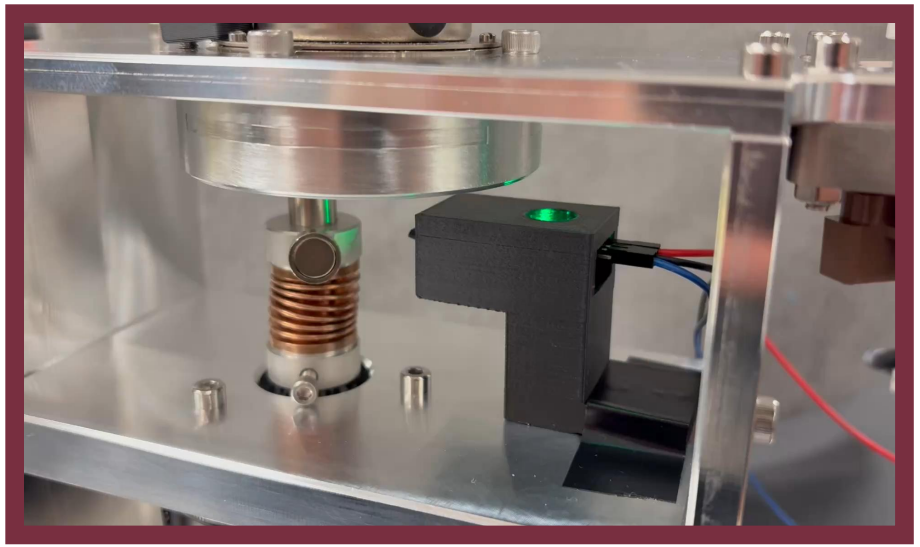
Questions?







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