# NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

**FINAL PRESENTATION**
**The University of Akron**
**Dr. Scott Sawyer**
**April 16th, 2020**

# Presentation Overview

- Team Introduction
- Problem Statement & Objectives
- Summary of Midway Presentation
- Vehicle Construction
- Progress to Final Vehicle
- Lessons Learned & Conclusion

# The University of Akron Team

- 5th-Year Mechanical Engineers
- Advisor: Dr. Scott Sawyer
- Mentor: Brian Shields

Left to Right: Luke Featherston, Alex Colucy, Evan Blitz, David Kotovets, Jacob Steiner

# Problem Statement and Objectives

- Design a custom vehicle utilizing hydraulic components to compete in The Fluid Power Vehicle Challenge
  - Sprint Race: 500 feet time trial.
  - Efficiency Race: Travel maximum distance using pressurized accumulator from a stop.
  - Endurance Race: 1 mile time trial.

# Summary of Midway Presentation

- Design Objectives
- Vehicle Design

- Circuit Design
- Selection of Hardware

- Calculations and Results

# Design Objectives

1. Frame Selection
2. Minimize number of added components
3. Optimize design for future improvements
4. Design to the parameters of the competition

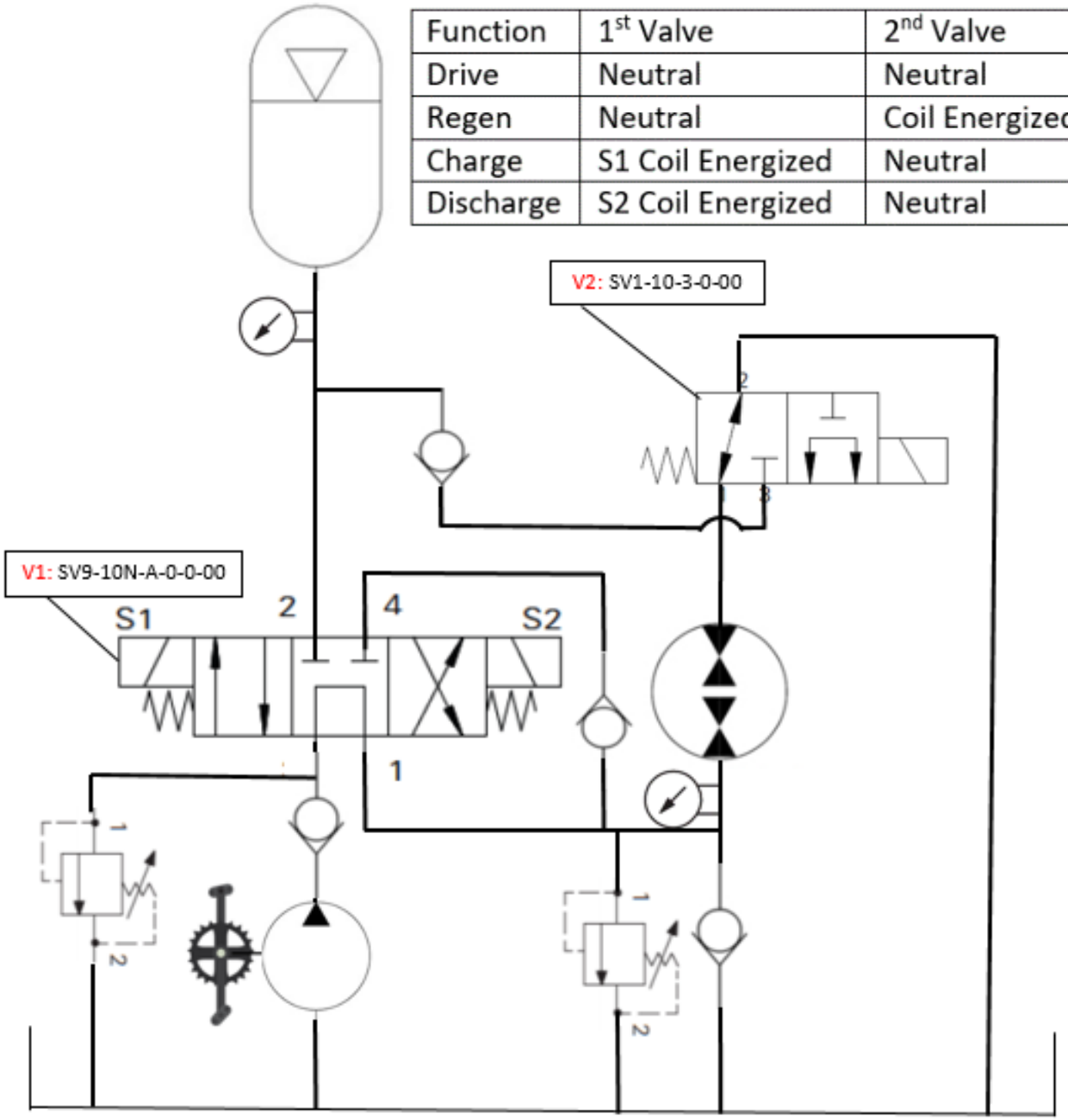
# Vehicle Design

Initial Bike Design → Final Bike Design

# Circuit Component List

- SV9-10N-A
  Solenoid Valve (4-way, 3-position)
- SV1-10-3
  Solenoid Valve (3-way, 2 position)
- RV1-10
  Pressure Relieving Valve
- CV3-8
  Check Valve
- F11-5 Parker Motor/Pump
- 1 Gal. Steelhead Accumulator

| Function | 1st Valve | 2nd Valve |
|---|---|---|
| Drive | Neutral | Neutral |
| Regen | Neutral | Coil Energized |
| Charge | S1 Coil Energized | Neutral |
| Discharge | S2 Coil Energized | Neutral |

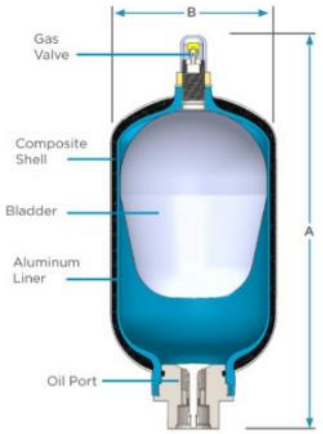


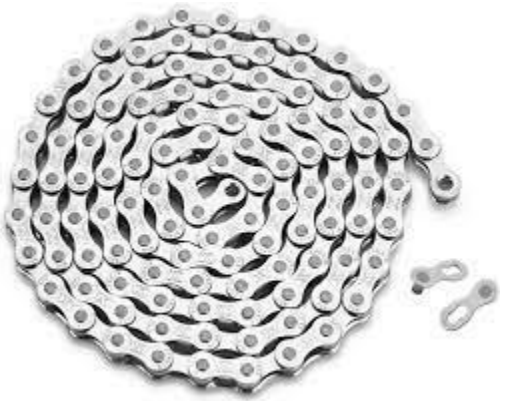

# Circuit Overview

# Hardware Selection

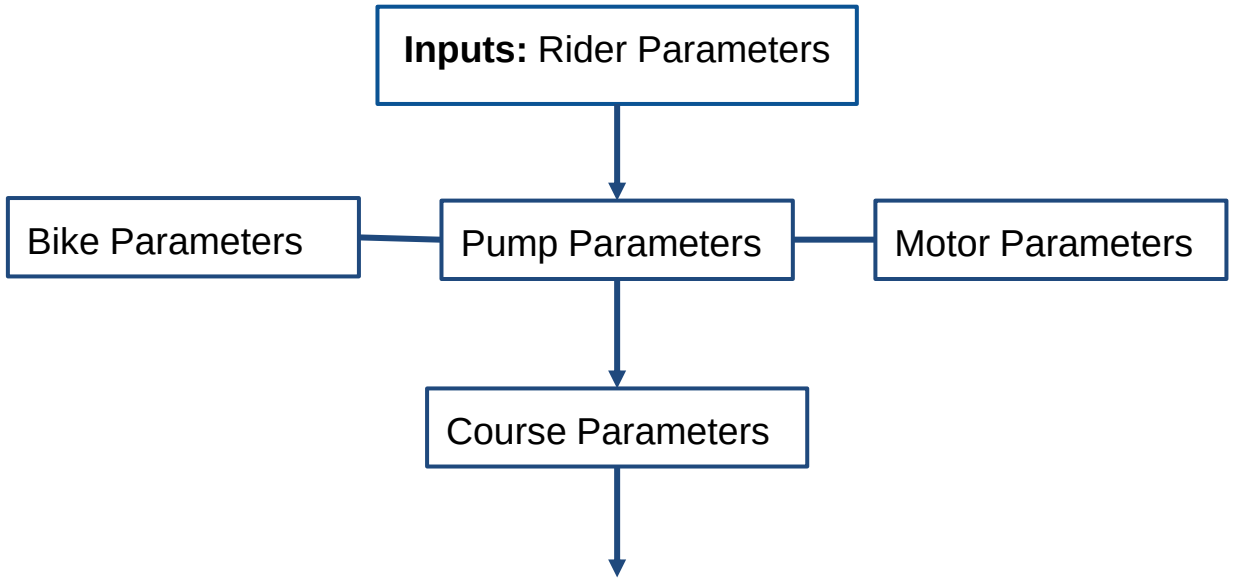
Planned Hardware:

- Driveline front sprocket (46 teeth)
- Single speed rear (16 teeth)
- Rim Brakes
- Standard Tires
- Chain Drive
- Steelhead Bladder Accumulator
- Parker F11-5 Motor / Pump
- eX705 HMI
- Hydac TTC-32 Controller
- 2 12V Batteries



# Calculations



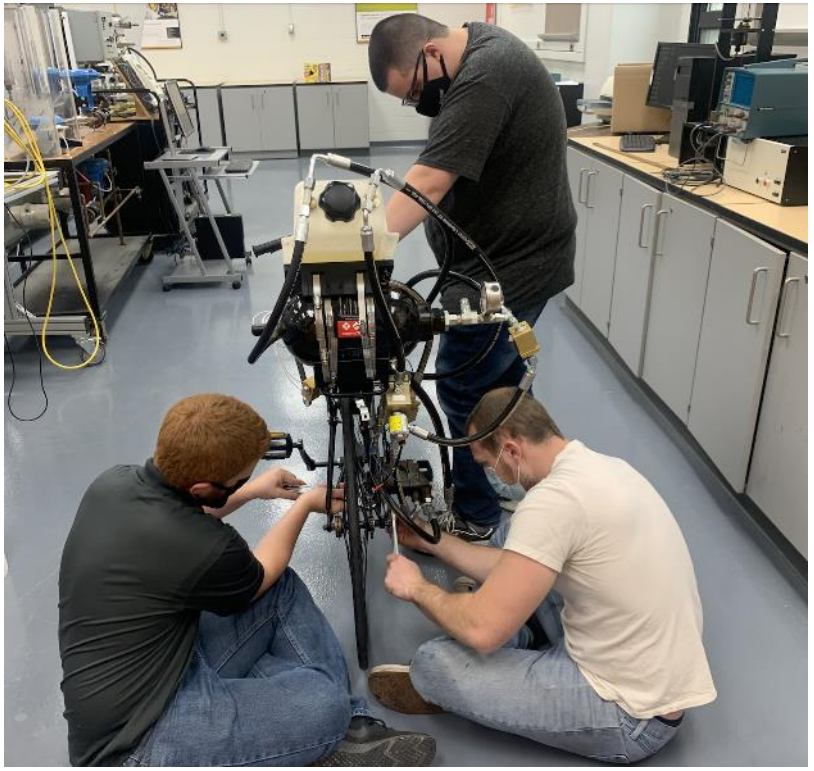

<u>Target Values Based off of Calculation Predictions:</u>

Endurance Challenge: 4 minutes and 50 seconds

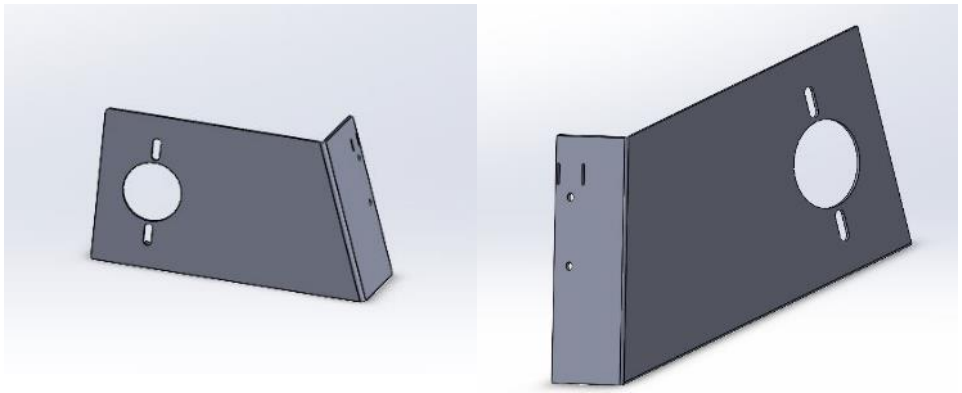
Sprint Challenge: 14.71 seconds

Efficiency Challenge: 31.63%

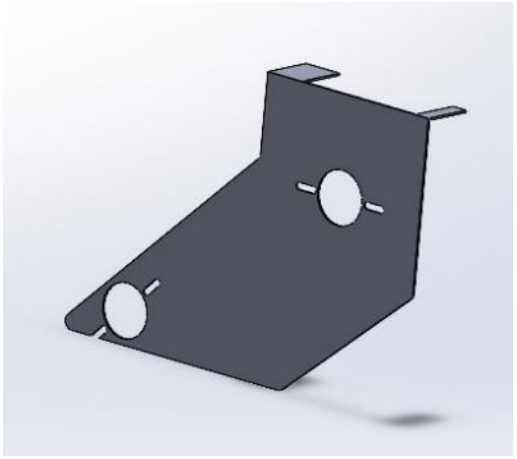
# Vehicle Construction

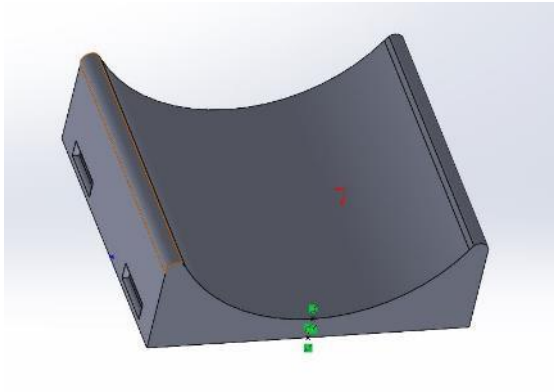
# Design Improvements



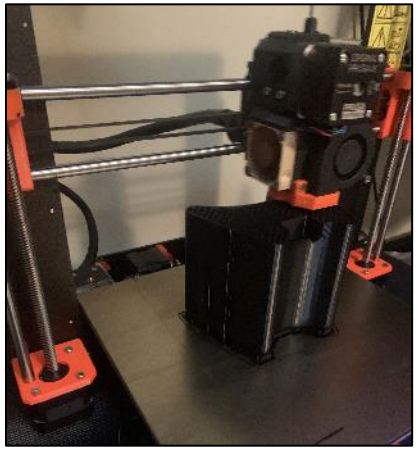
Initial Motor / Pump Mount Designs

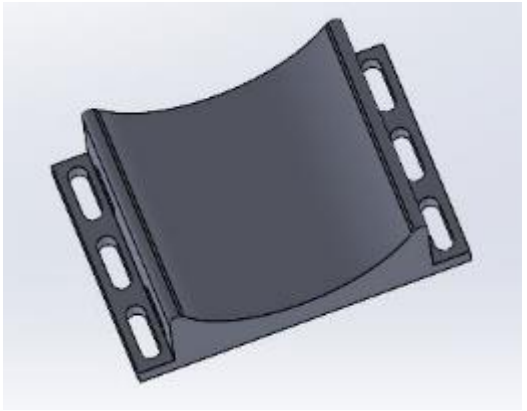


Final Mount Design



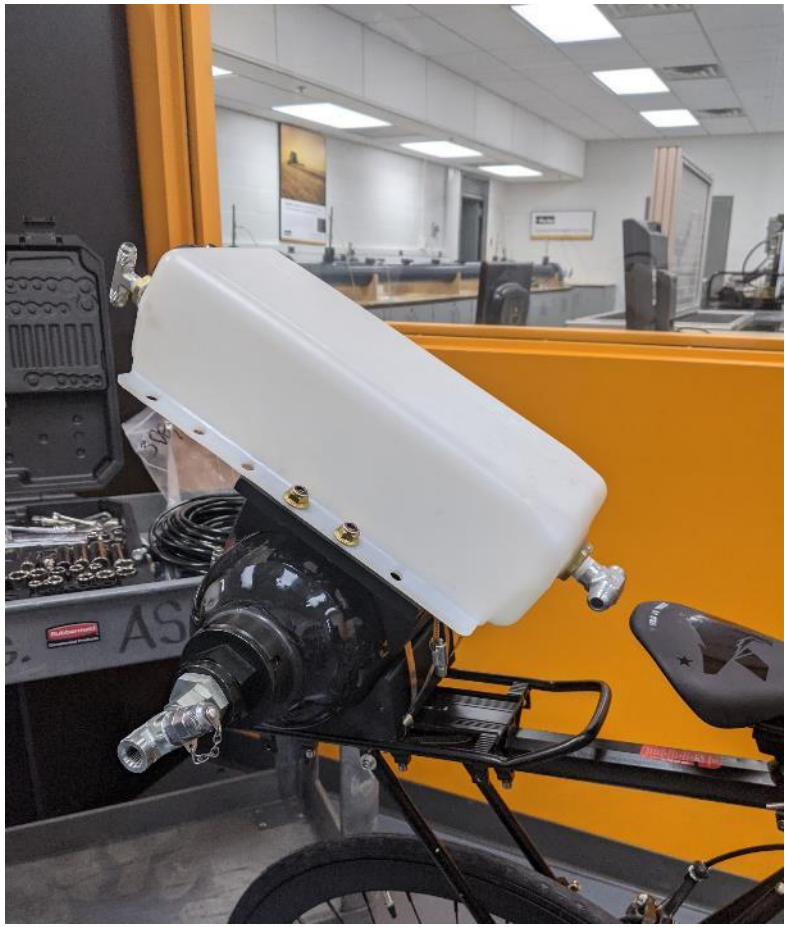
Accumulator Mount Design

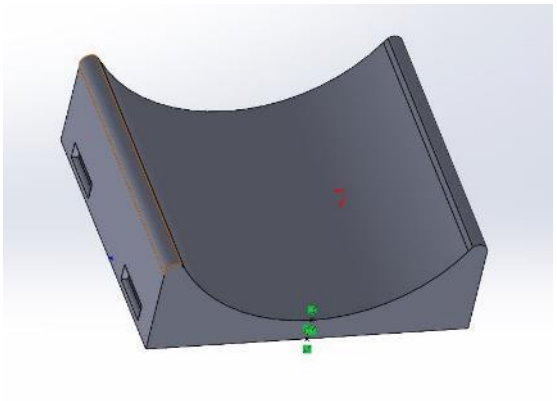


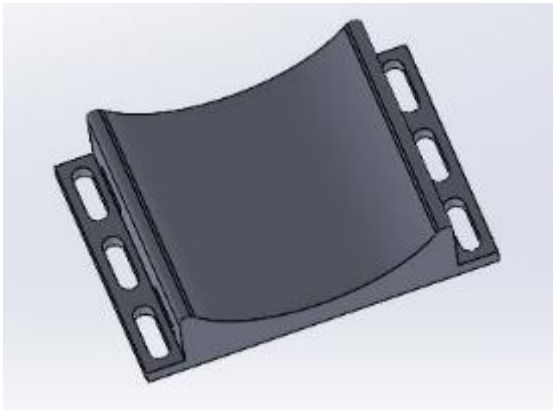


Reservoir Mount Design

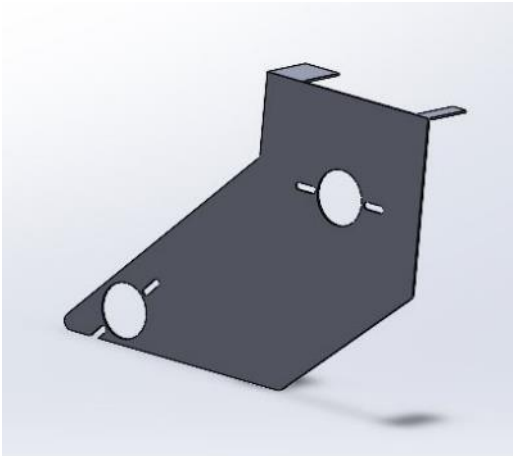
# Mounting Reservoir and Accumulator







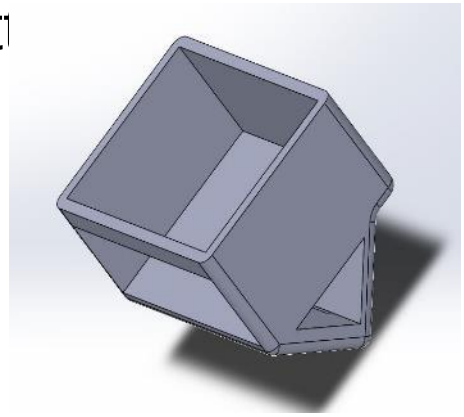
# Mounting The Pump and Motor



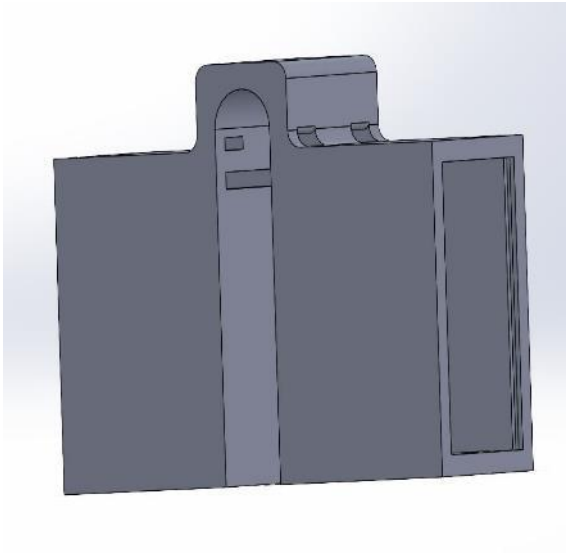
# Electronic Mounting

Mount for HMI

Bat



Mount for



# Programming

HMI: eXor 705

-Simplified Screen layout

-Button turns green when circuit is activated.

Controller: Hydac TTC-32

-modified program for our needs

# Pneumatic Brakes

**Design objective:** To create a system using compressed air to assist with slowing down of the hydraulic vehicle.

**Original Line® Air Cylinder**


**Non-Repairable Reservoir / 3D Printed Mount (Go Zips!)**

**Heavy Duty 2-Position 3-Way Normally Closed Switch**


**0 Series Regulator**

# How it works

By hooking up the air cylinder to a regular caliper brake, toggling of a 3-Way switch, and directing the flow of air to retract the piston rod; We were able to achieve a braking force applied to the tire rim.

# Progress towards Final Vehicle

# Valve Mounting & Hose Routing

-After pump & motor were mounted

-Hoses bought at our local Parker store


Before crimping/tightening

# Chain sizing

- Chains would keep popping off
  - Tried several different chain lengths
  - Needed a half-link
  - Adjusted mount for better alignment between sprockets

# Transfer of Programs/Wiring

- Issues encountered with logging in to the controller (baud rate mismatch)
- Wired up a temporary control circuit that had to be used for our final races

HMI Customization

Soldering

# Results

Efficiency: 12%

Distance Traveled: 1,312 ft.

Sprint Race: 41.3 seconds

Endurance: 7 minutes, 10 seconds

# Lessons Learned


- Fundamentals of hydraulics
- Iterative design process
- Working with a team virtually
- Time needed for testing
- Troubleshooting
- Elementary knowledge of electronics

# Conclusion

**Special Thanks to:**

- **NFPA**
- **Josh Scarbrough - IFP Rep**
- **Brian Shields- Team Mentor**
- **Dr. Scott Sawyer - Team Advisor**
- **Aaron Trexler - UA Engineering Technician**

# Thank You to Our Sponsors!

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