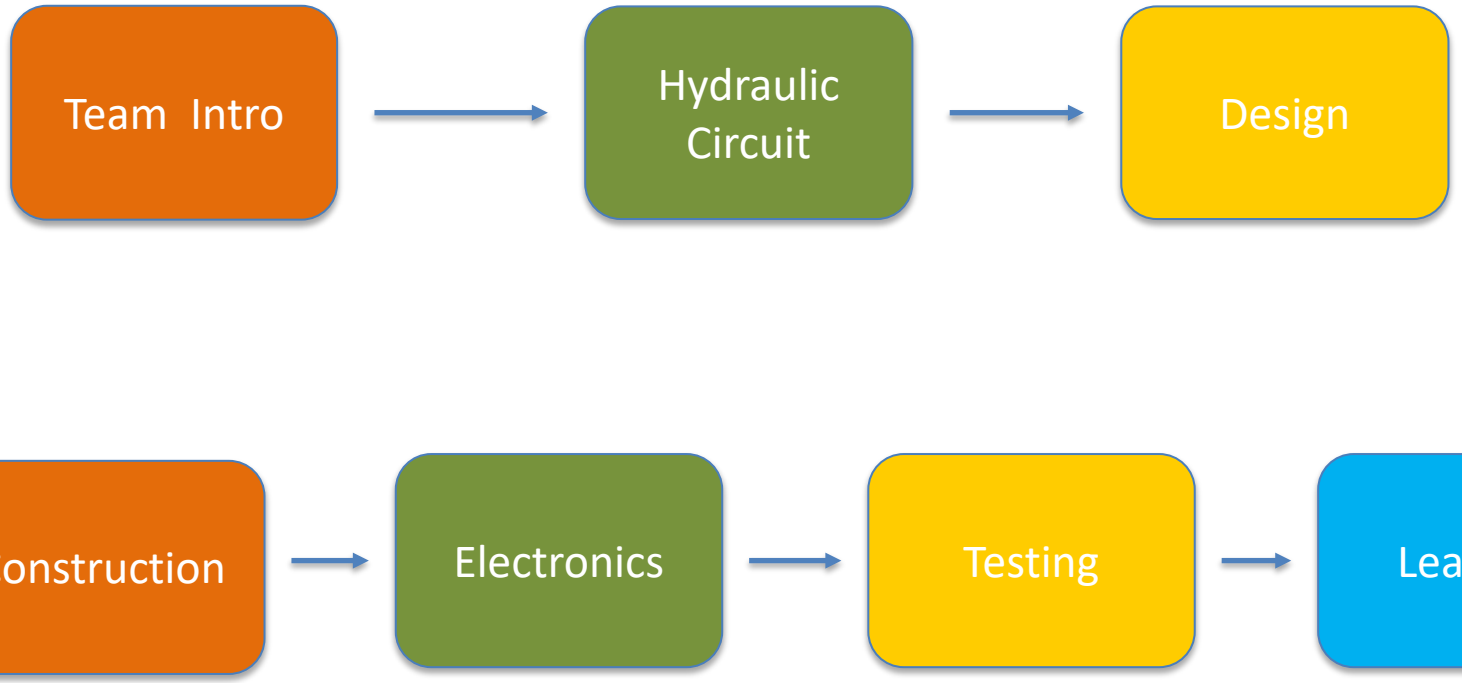
NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION
Minnesota State University
Mankato
5/2/2025

Department of Integrated Engineering
MINNESOTA STATE UNIVERSITY, MANKATO

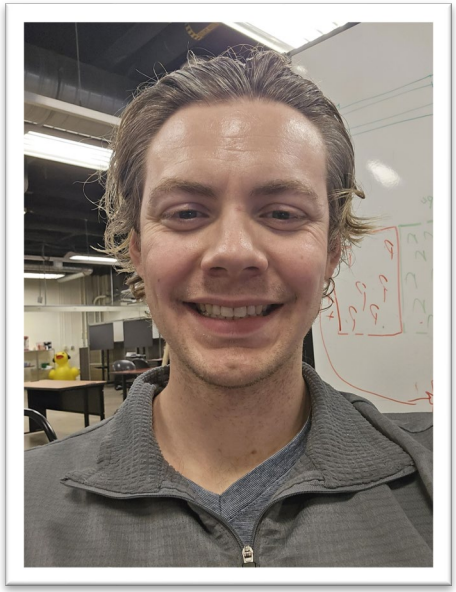
Outline


Team Intro
Hydraulic Circuit
Design
Construction
Electronics
Testing
Learning

Team Description

Sam Hansen
Lead Student
Engineer

Justin Beck
Student Engineer



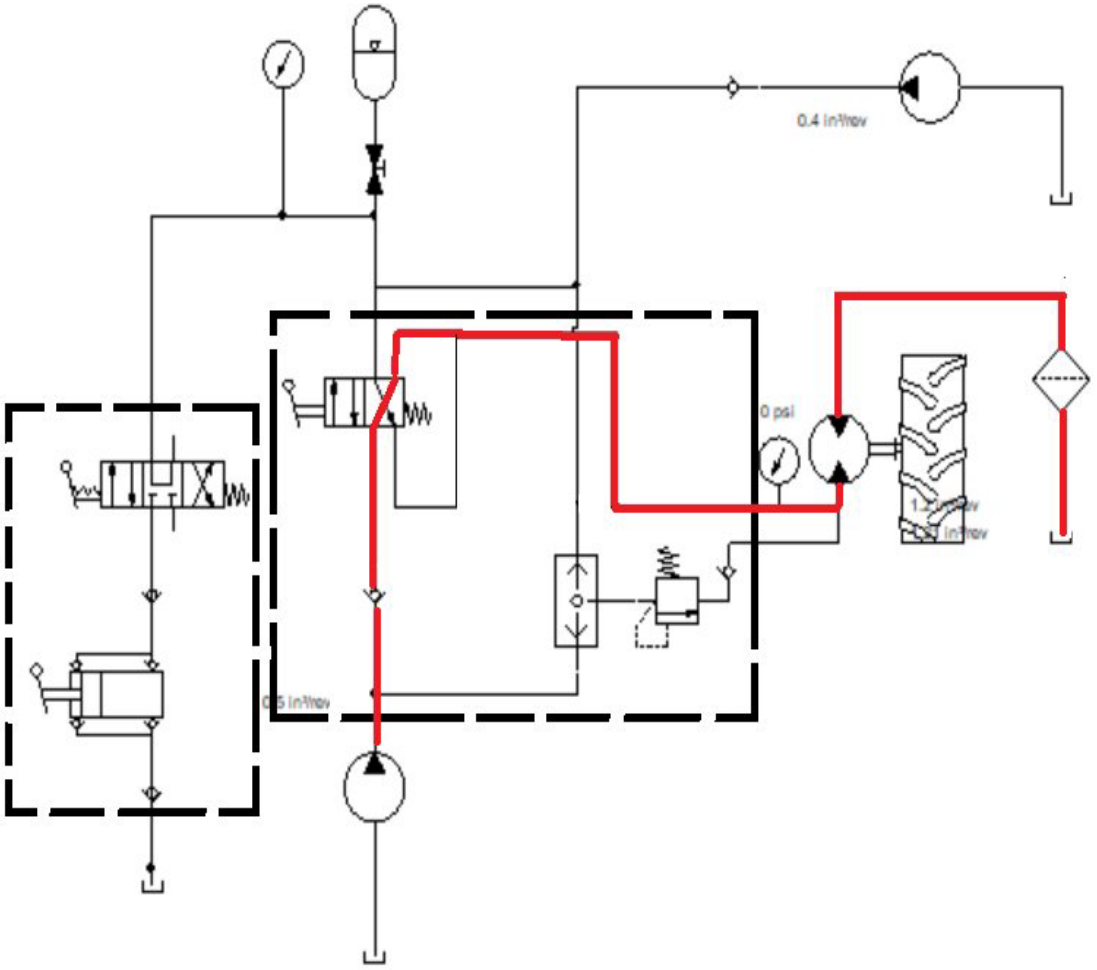
Abdi Hussein
Student Engineer

Project Goals

- Trike design was focused on the sprint race.
  - Reach 30 mph
  - Have a reasonable pedaling force
  - Improve upon coasting

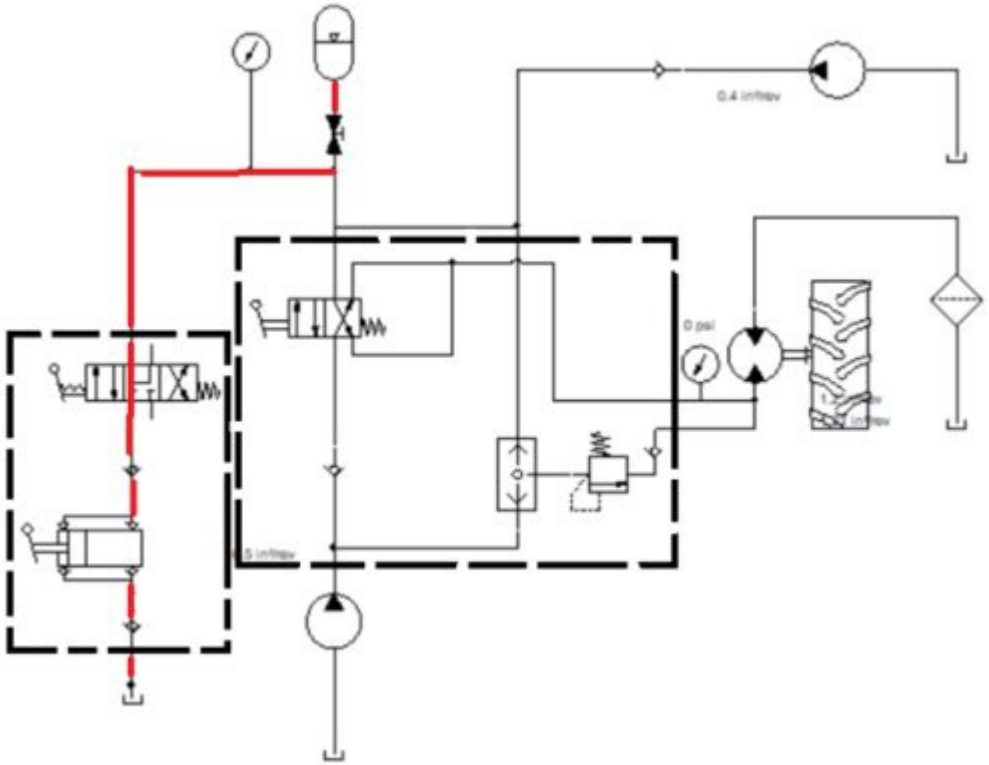
Hydraulic Circuit

Pedal Drive Path



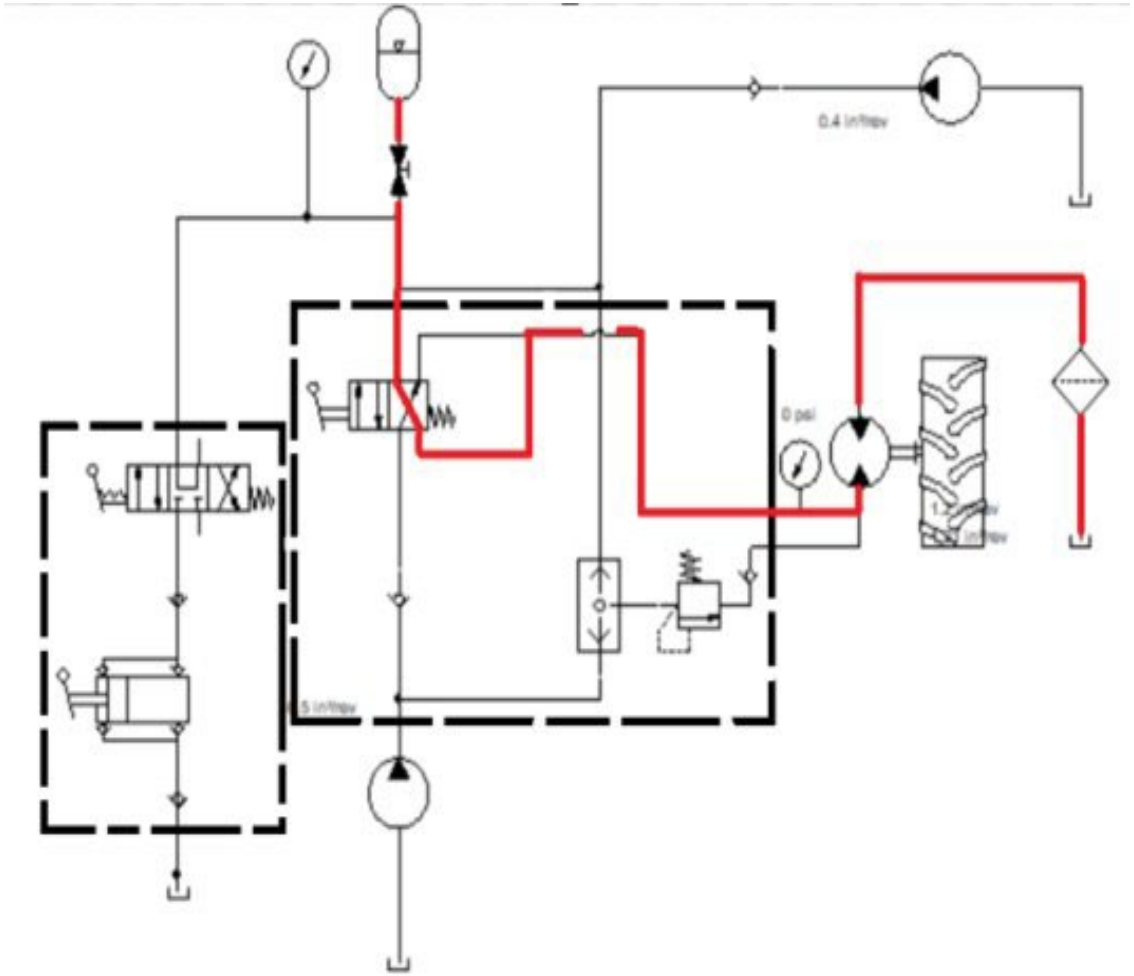
Hydraulic Circuit

Pre-charge Path



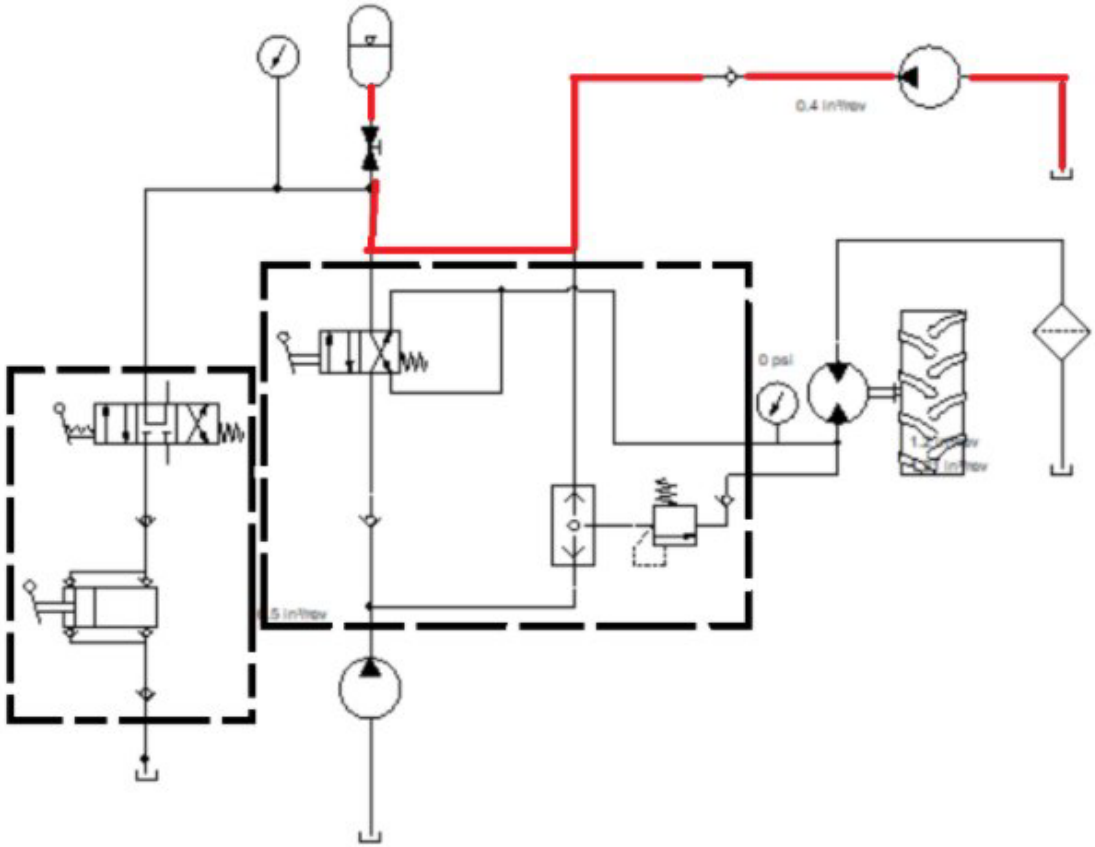
Hydraulic Circuit

Accumulator Powered Path

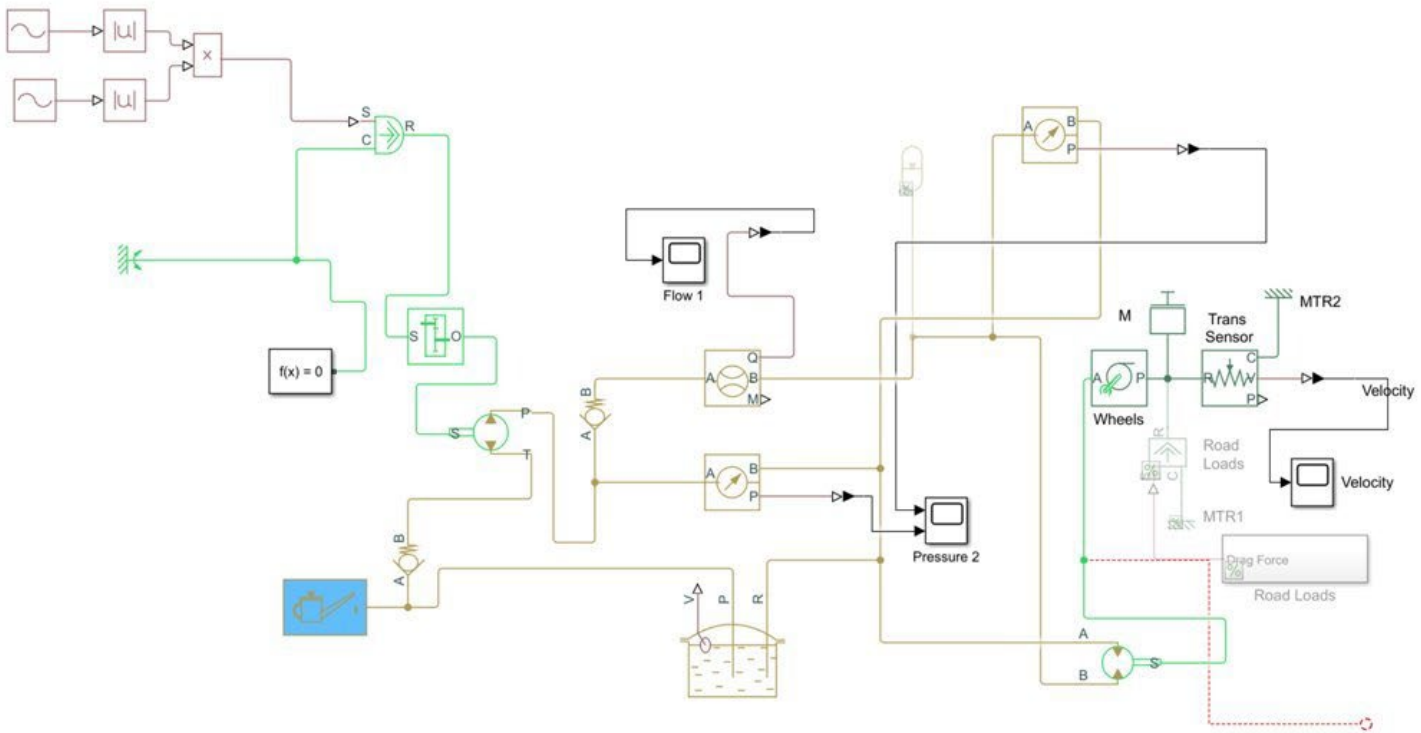


Hydraulic Circuit

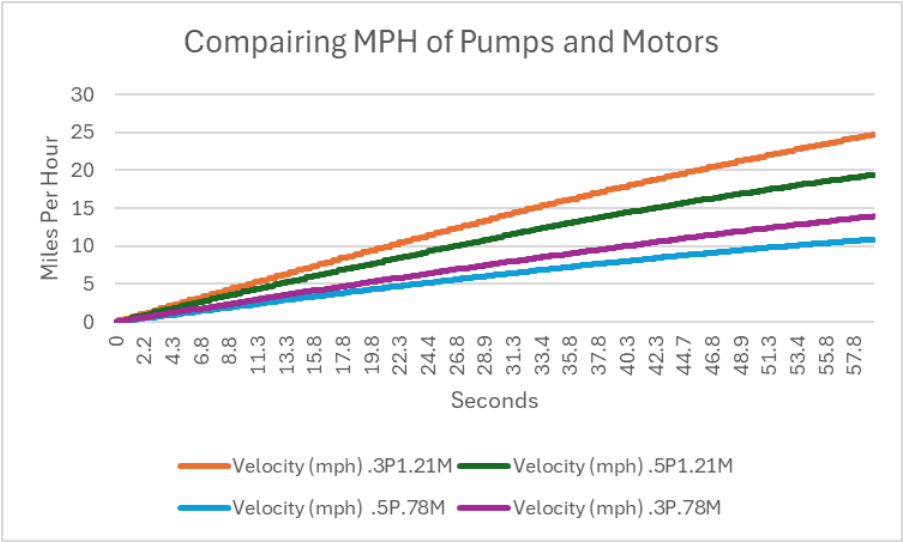
Regenerative Brake

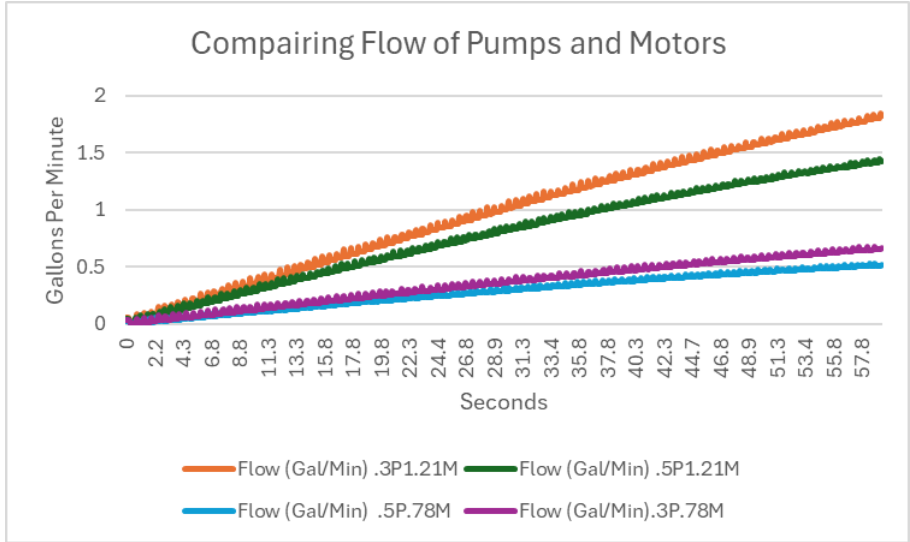


Simulation


f(x) = 0
Flow 1
Pressure 2
M
MTR2
Trans
Sensor
Velocity
Wheels
Road
Loads
Velocity
MTR1
Drag Force
Road Loads

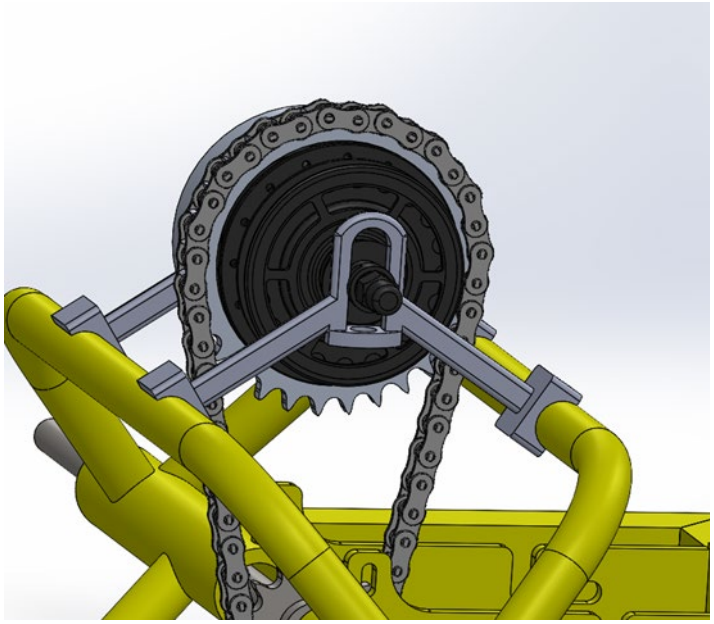
Simulation


Compairing MPH of Pumps and Motors
Miles Per Hour
30
25
20
15
10
5
0
0
2.2
4.3
6.8
8.8
11.3
13.3
15.8
17.8
19.8
22.3
24.4
26.8
28.9
31.3
33.4
35.8
37.8
40.3
42.3
44.7
46.8
48.9
51.3
53.4
55.8
57.8
Seconds
Velocity (mph) .3P1.21M
Velocity (mph) .5P1.21M
Velocity (mph) .5P.78M
Velocity (mph) .3P.78M

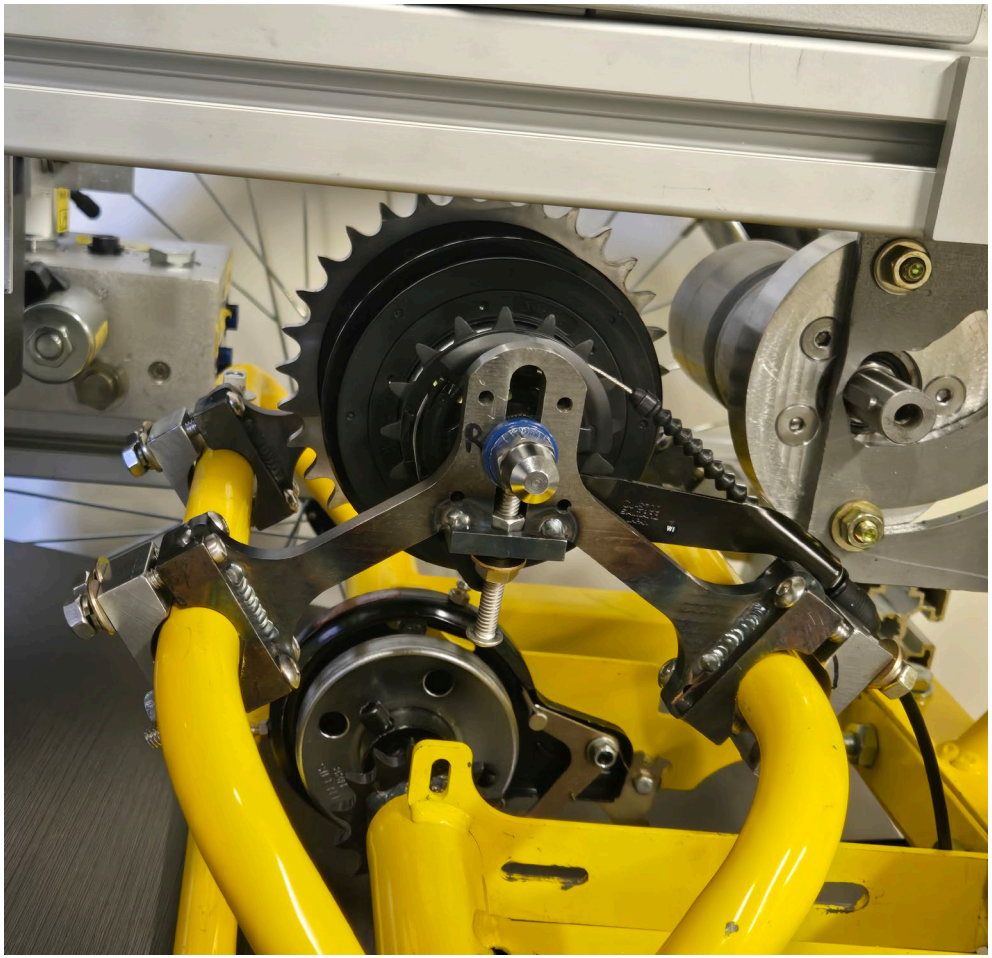

Compairing Flow of Pumps and Motors
Gallons Per Minute
2
1.5
1
0.5
0
0
2.2
4.3
6.8
8.8
11.3
13.3
15.8
17.8
19.8
22.3
24.4
26.8
28.9
31.3
33.4
35.8
37.8
40.3
42.3
44.7
46.8
48.9
51.3
53.4
55.8
57.8
Seconds
Flow (Gal/Min) .3P1.21M
Flow (Gal/Min) .5P1.21M
Flow (Gal/Min) .5P.78M
Flow (Gal/Min).3P.78M

Transmission

Design Changes

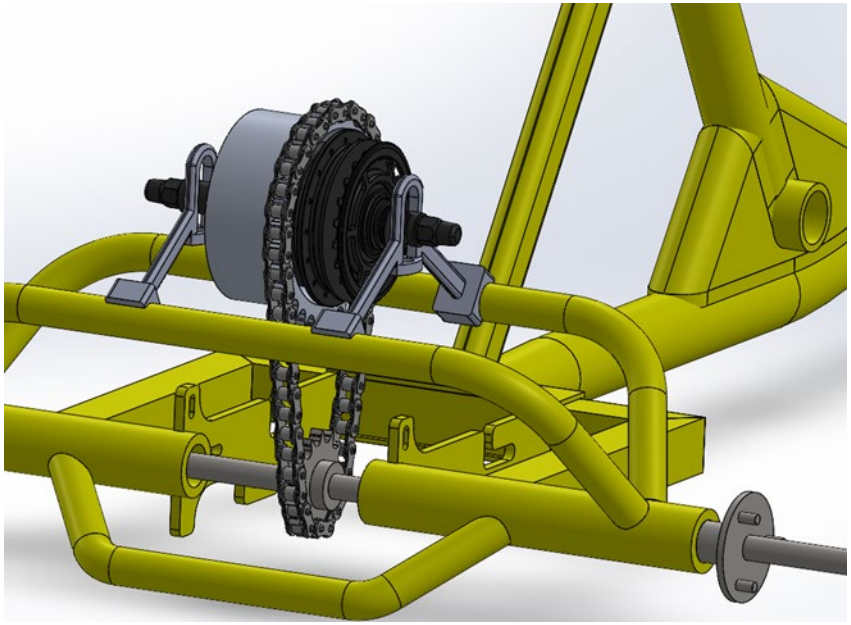


Brackets originally designed to be 3D printed using carbon fiber reinforced nylon

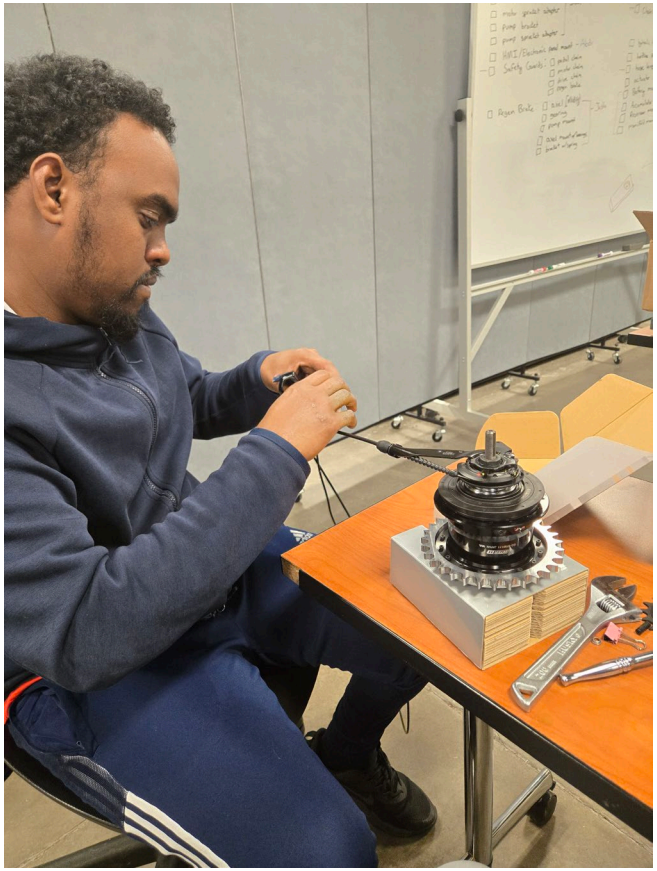


Transmission

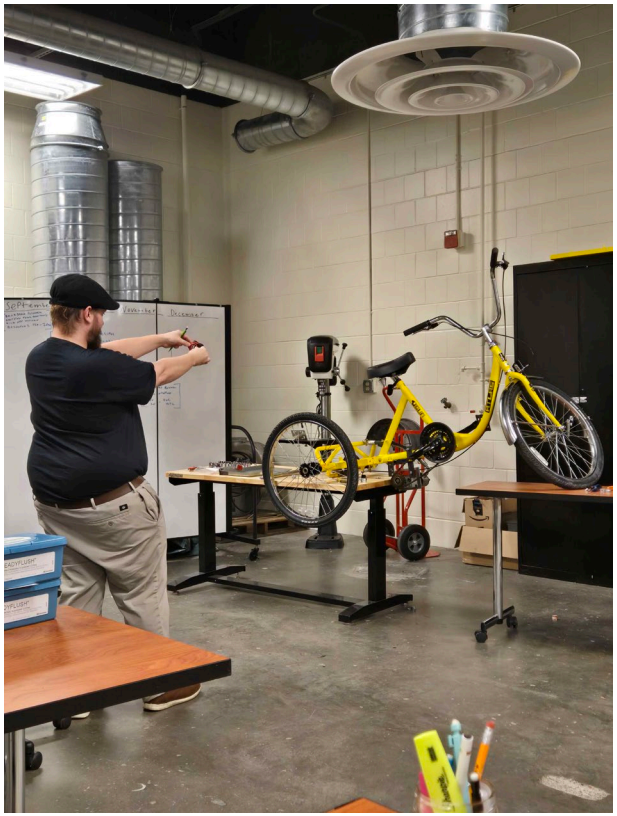
Design Changes



Vehicle Construction(Cont.)



Vehicle Construction(Cont.)



Vehicle Construction(Cont.)

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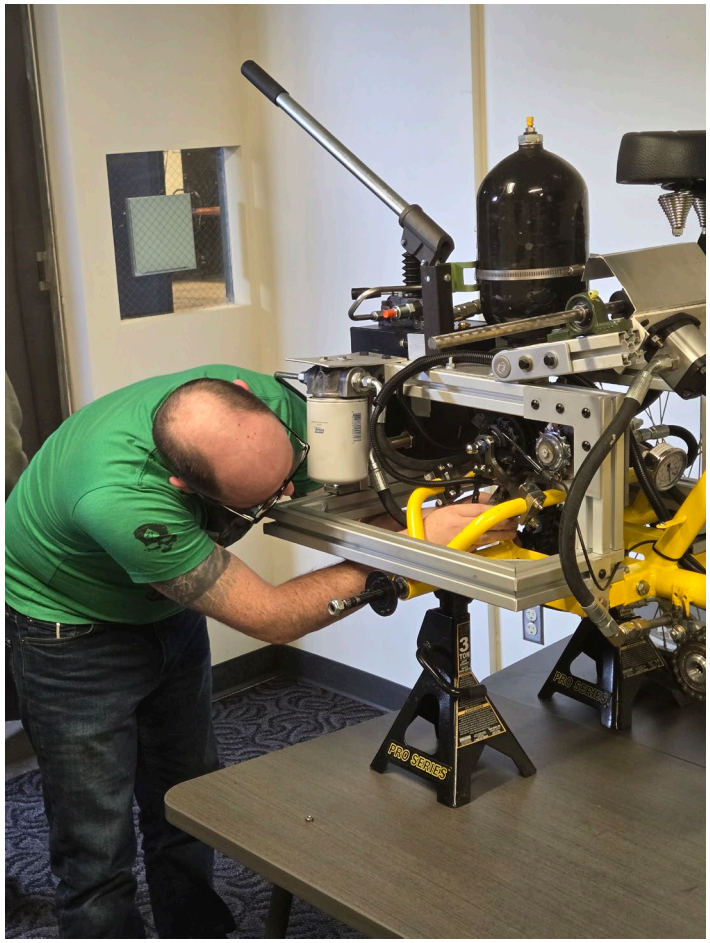
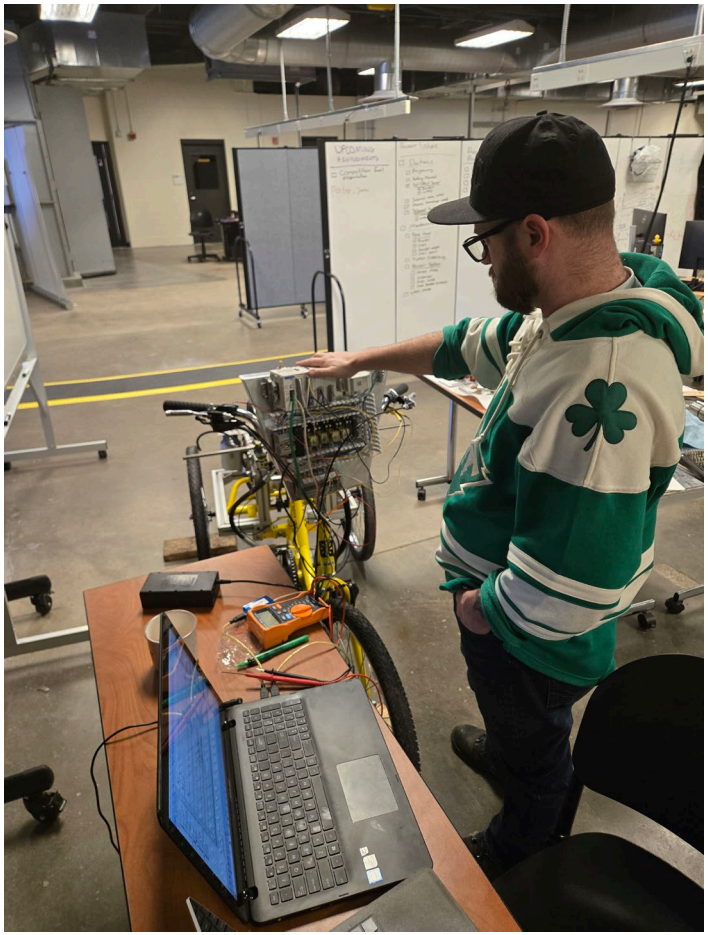
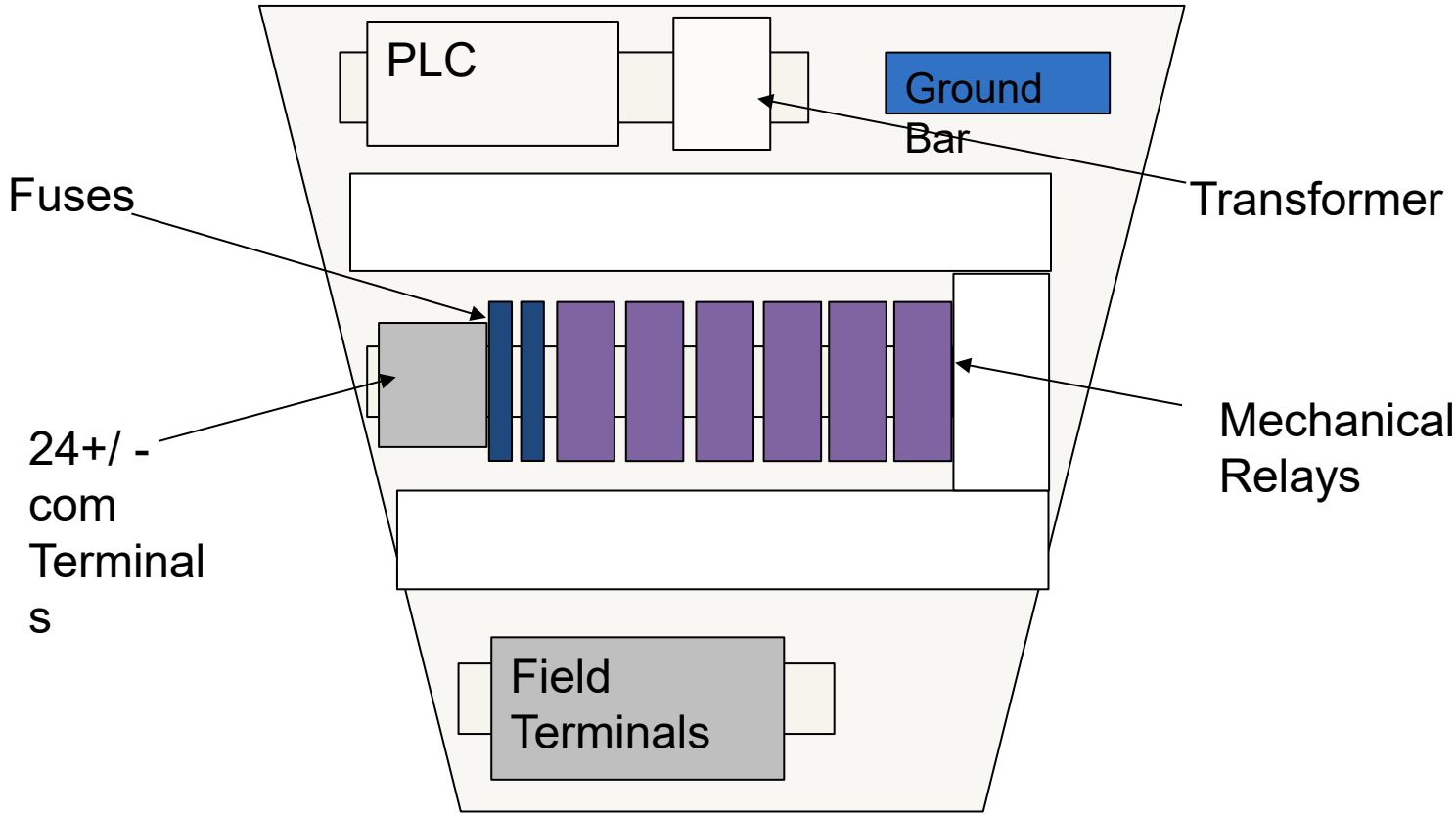


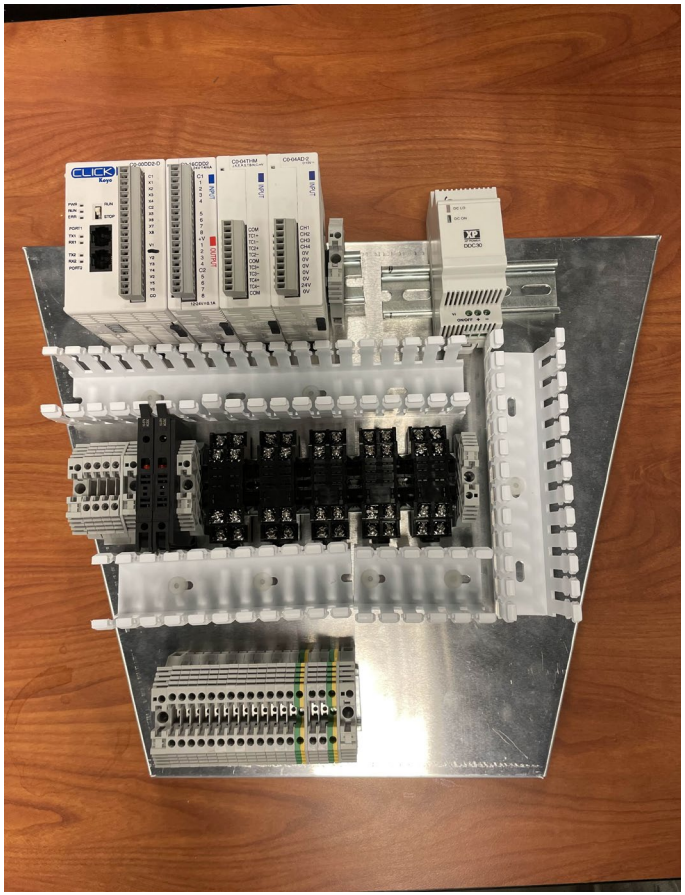


Final Product

Control Panel



Control Panel



Vehicle Testing

- Visual Inspection
  - Ensure proper clearance for components.
  - Tension chains.
  - Check sprocket alignment.
- Signal Testing
  - Ensure proper communication between electrical components and PLC.
- Bench Testing
  - Ensure no leaks.
  - Verify the direction of rotation on motor and pumps.
- Road Testing
  - Verify the safe operation of each mode.
  - Verify transmission shifts smoothly.

Lessons Learned

- Time management.
- Utilize system cognizant student engineers.
  - Properly define what their role.
- Check the output shaft configuration of pumps.
- Designs will change when assembling.
- Order multiples of parts when possible.

Acknowledgements

- Special thanks to... Nathan Albright, John Neu and the St. Paul College Machinist Program

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Questions?

Twin Cities Engineering

Minnesota State University Mankato