

**10 YEARS**

N F P A

**Fluid Power**  
= **VEHICLE**  
**Challenge**



NFPA  
Education and  
Technology  
Foundation

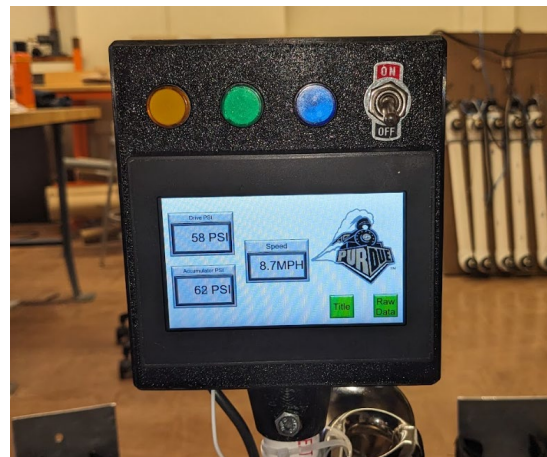
**FINAL PRESENTATION & DESIGN REVIEW**  
**PURDUE UNIVERSITY**  
**WEST LAFAYETTE**  
**DR. JOSE GARCIA-BRAVO**  
**APRIL 22<sup>nd</sup> -24<sup>th</sup>**



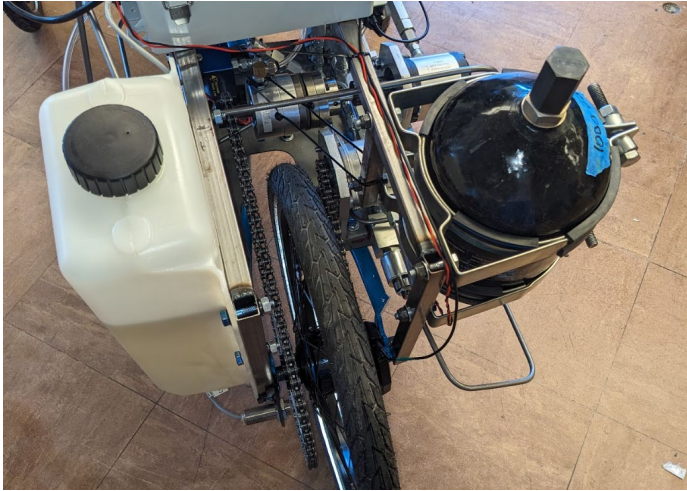
# Front Vehicle Design



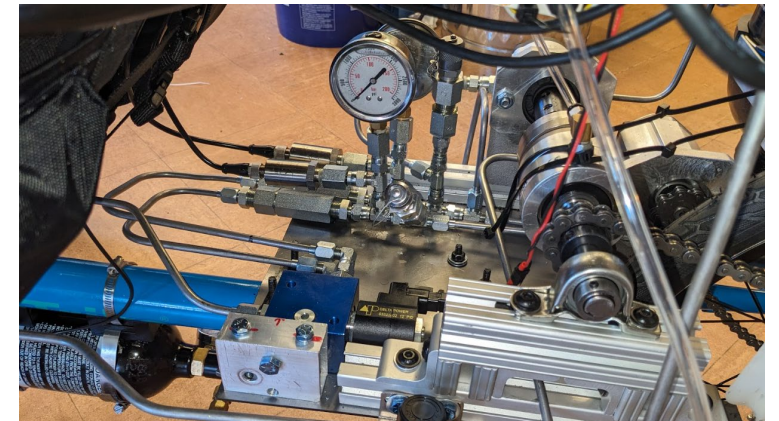
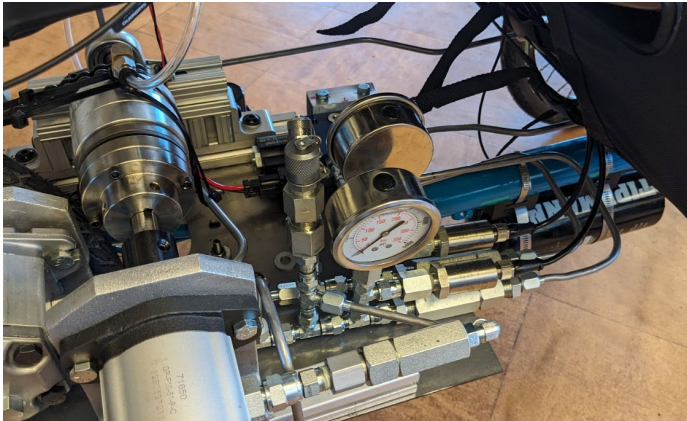
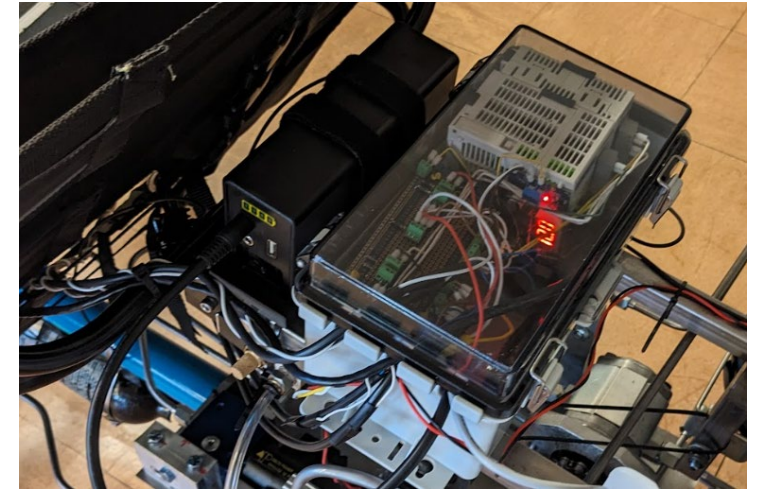
- Trike frame
- Double acting piston pumps
- Seesaw pedal design
- 4 check valves
- HMI control panel
- Tactile switches



# Rear Vehicle Design



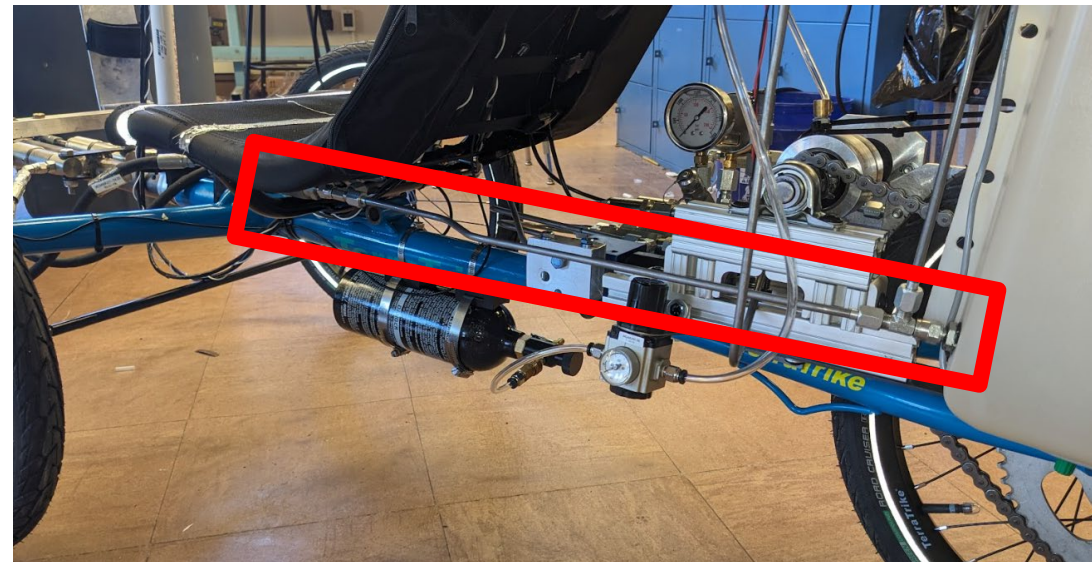
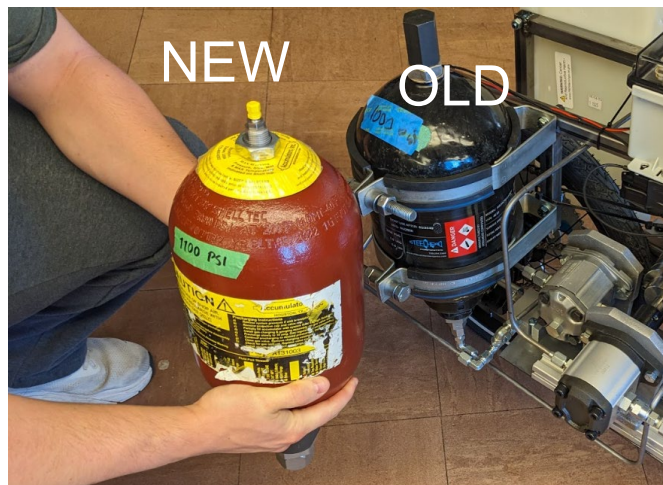
- Pneumatic Clutch
- Air Tank
- 3 on/off flow solenoids
- Regen Pump
- Drive motor
- Bladder Accumulator
- Test points and gauges
- Pressure and rpm sensors
- 3 check valves
- HDPE Reservoir



# Vehicle Testing



- Verified all systems functional
- Revealed leak in original accumulator
- Revealed supply line aeration



# Final Vehicle



Disc Brakes

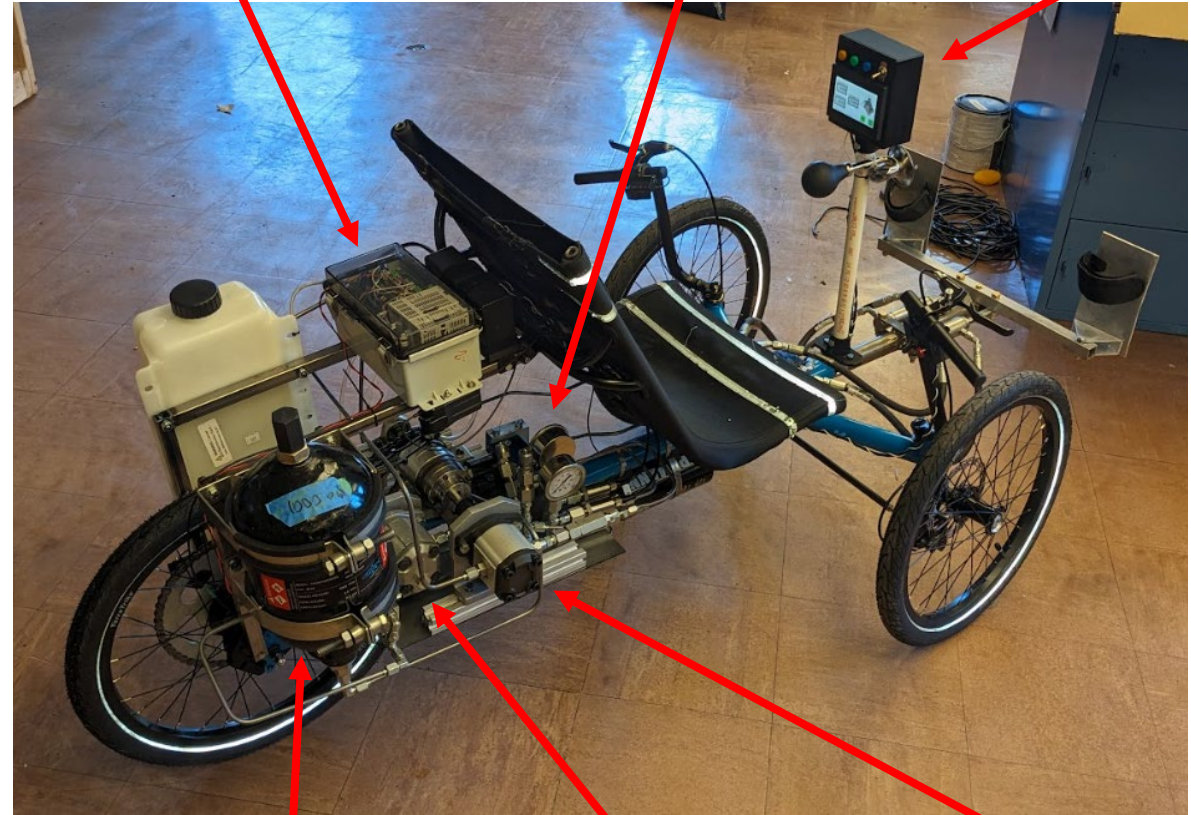
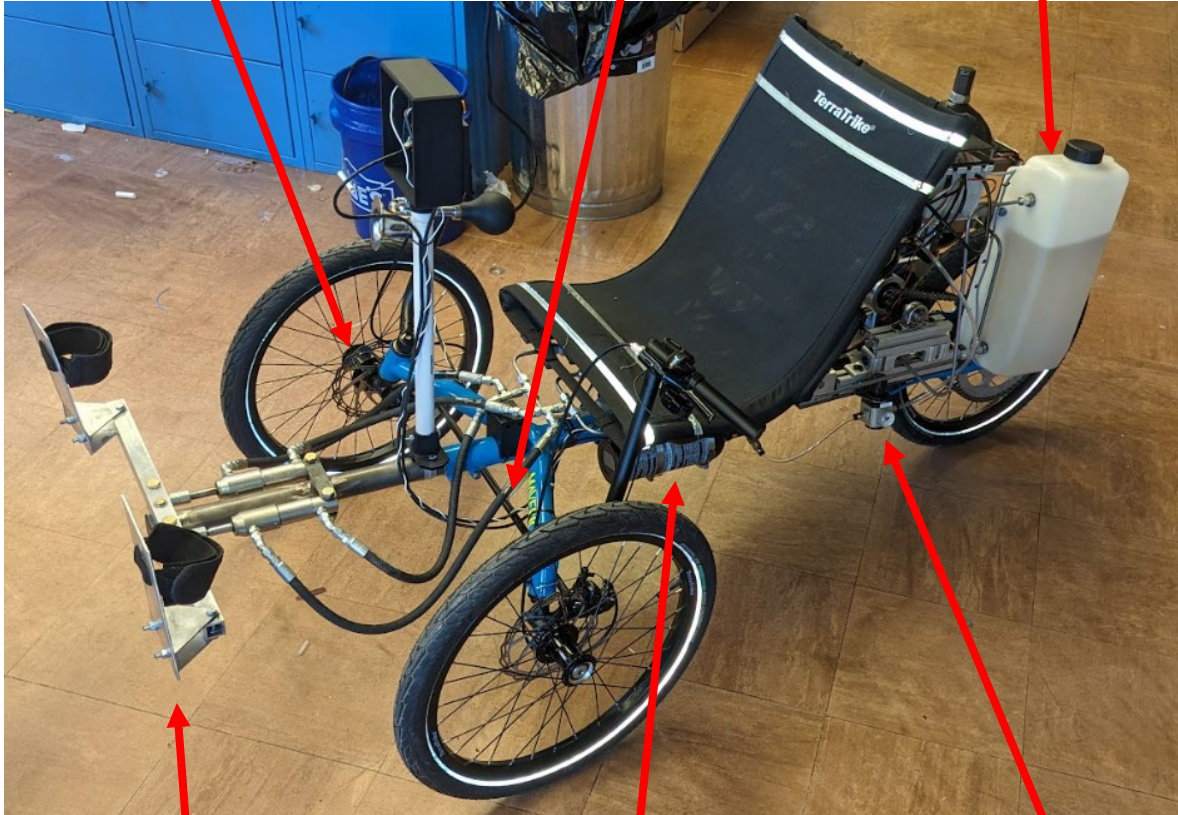
Steering

Reservoir

Electronics

Test Points

HMI



Piston Pedals

Air Tank

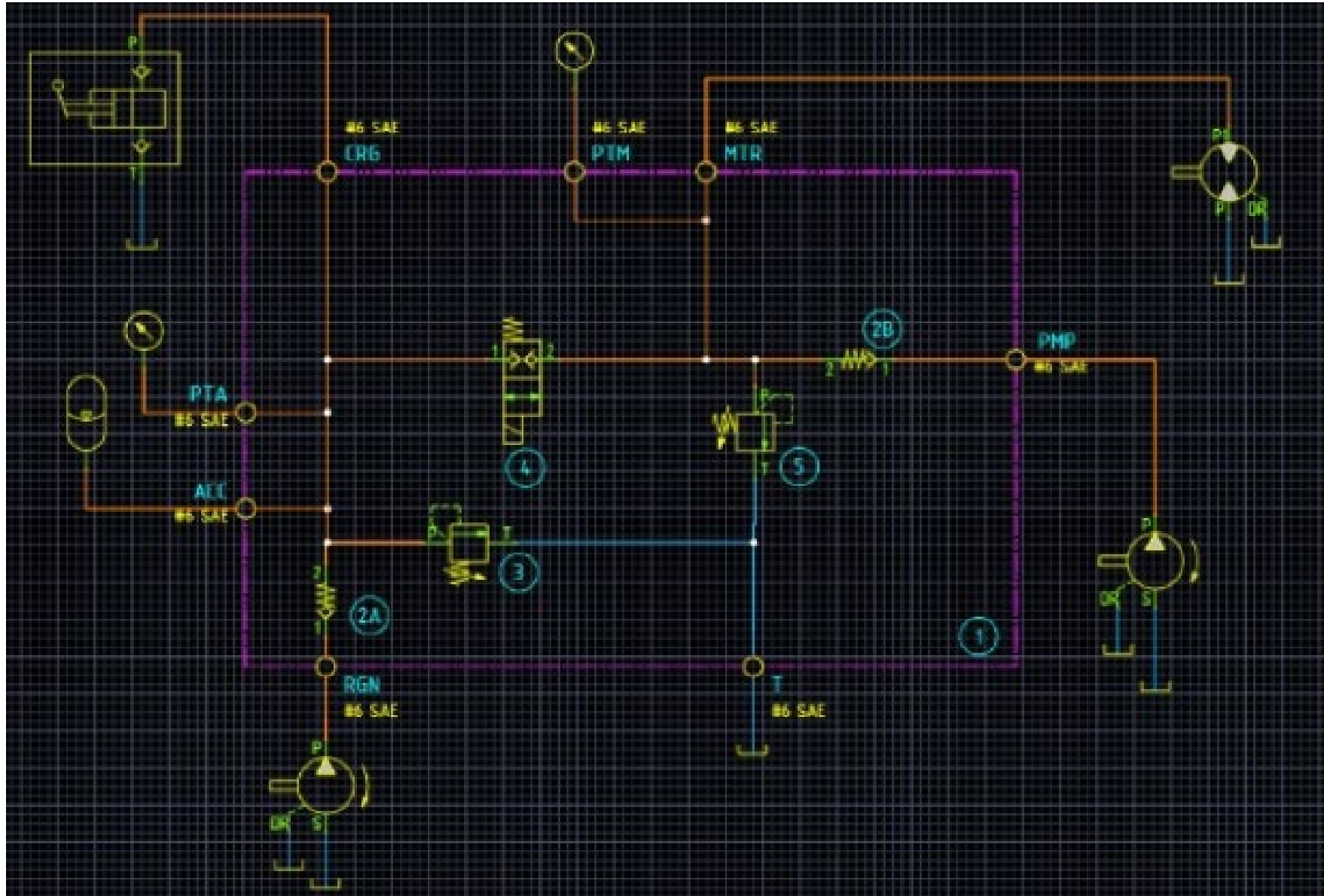
Air Regulator

Accumulator

Motor

Regen Pump

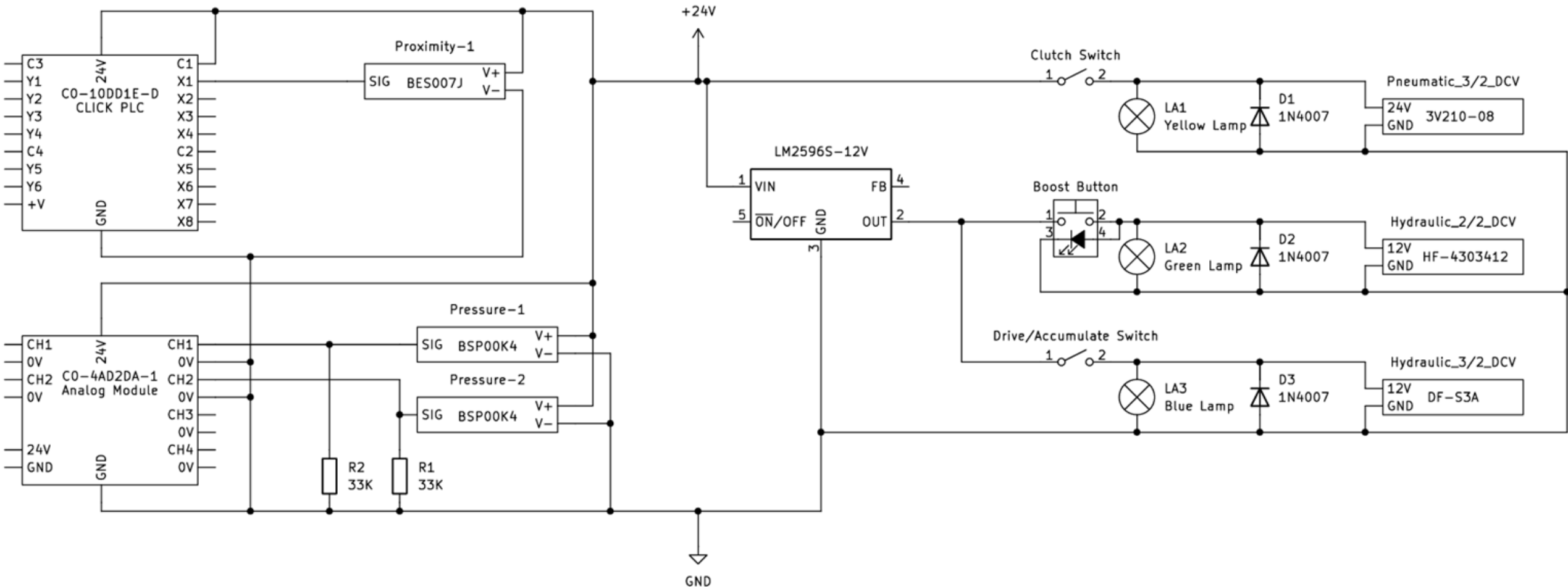
# 2025 Hydraulic Circuit



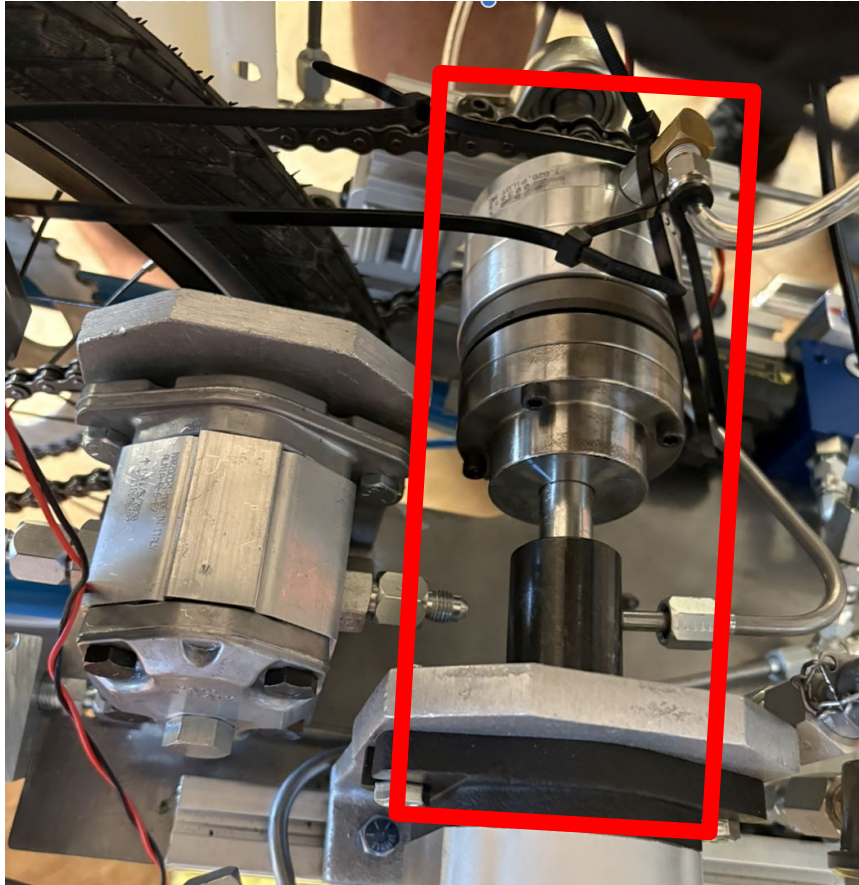




# 2026 Electrical Circuit

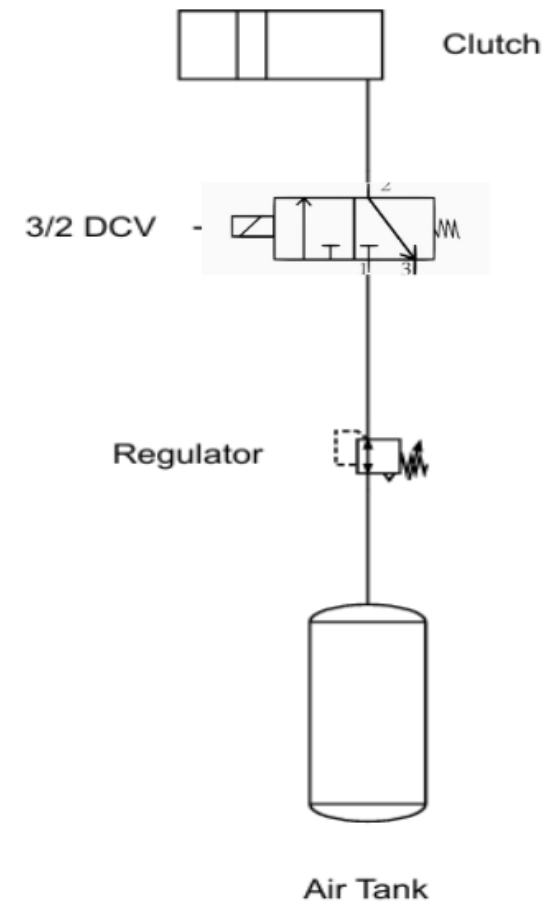


# Regenerative Braking System



- Pneumatic Friction Clutch (For engaging the hydraulic regen pump)
- Pump size 5.1cc Displacement
- Chain ratio: 5:1
- Operating Pressure : 80 psi
- 3/2 Solenoid DCV

Pneumatic Clutch Circuit :



# Key Differences

- More reliable
  - Functional brakes
  - Tight steering
  - Simplified controls
- More efficient
  - Hardlines
  - Less chain
- Less weight (**-90 lbs.**)
- Smaller packaging



2025



2026



# Lessons Learned

- Design and order manifolds far ahead of schedule.
  - Too late to order manifolds
  - Hydraulic redesign
- Expect manufacturing/shipping delays.
  - Shipping delays caused by unexpected world events
  - Declining parts availability
- CAD every single component as accurately as possible.
  - Chain alignment issues
  - Added parts/weight not in expected in BOM



**Thank you**

**Q&A**