10 YEARS

NFPA

# Fluid Power Vehicle Challenge

NFPA
Education and
Technology
Foundation

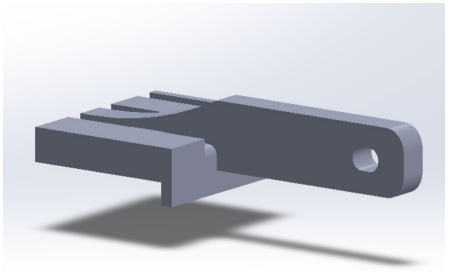
**Final Presentation & Design Review**
**Oakland University**
**Advisor: Dr. Yongsoon Yoon**
**4/16/2026**

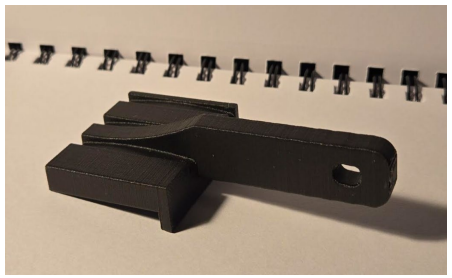
# Vehicle Construction

- Aluminum brackets for motor and pump mounting.
- Customized electronic boxes and display housing.
- Ergonomic switches for drive mode selection.

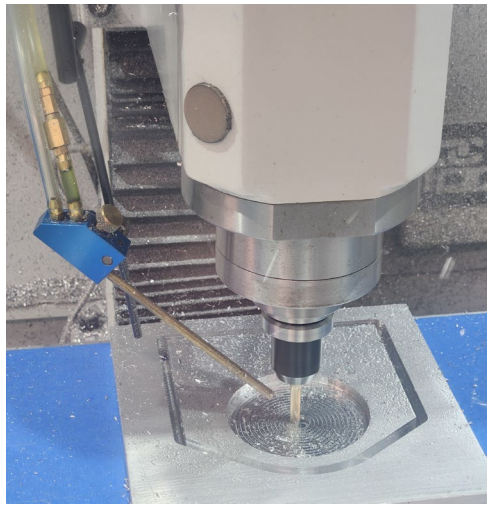
# Team Craftmanship

## Chain Tensioner (CF-PETG)

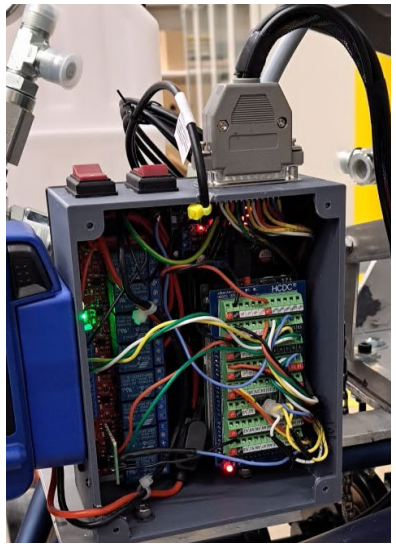




## Mounting Brackets (CNC Machines)



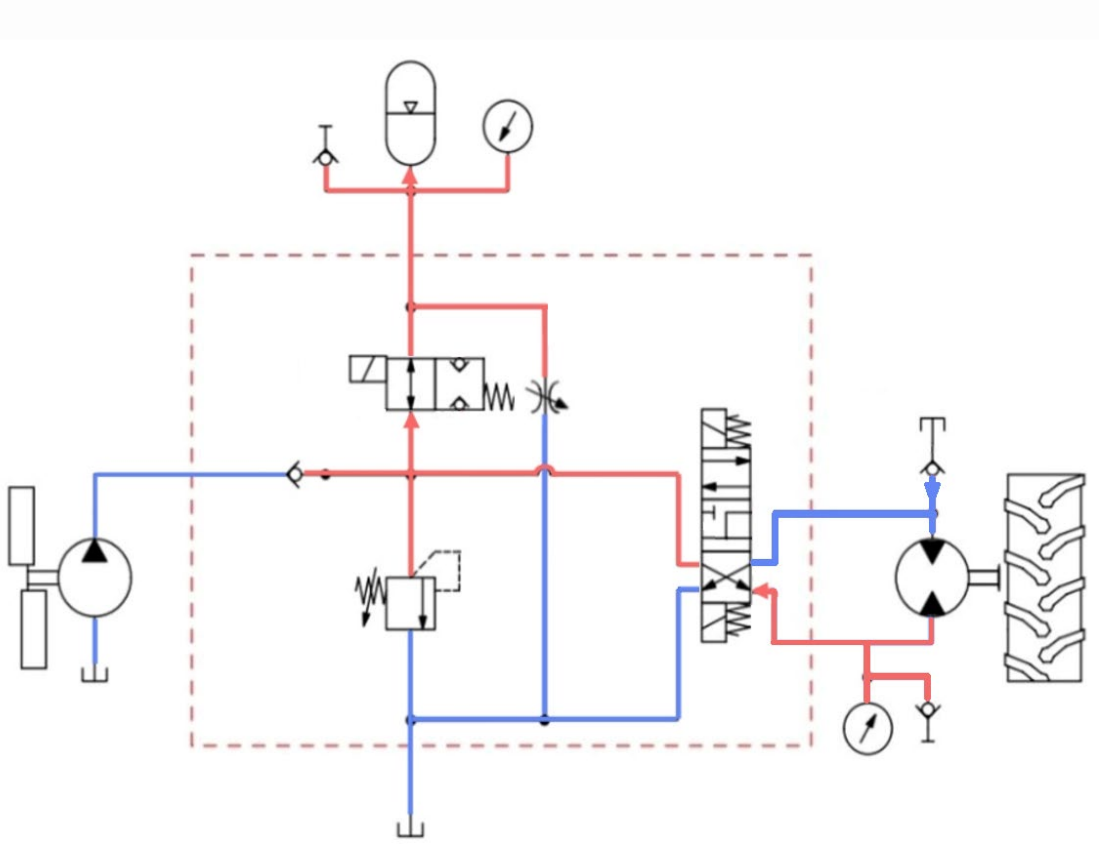
## PLC Panel (PLA)



## Tricycle

## Shipment Crate

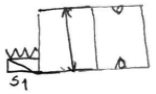
# Regenerative Braking Control



| | Action | 2/2 DCV | 4/3 DCV | Solenoid 1 | Solenoid 2 | Solenoid 3 |
|---|---|---|---|---|---|---|
| (A) Direct Reading | Pedal + Pump | Closed | Motor ↑↓ Reservoir | 0 | 1 | 0 |
| (B) Regenerative Braking (Vehicle in motion) | Braking | Open | ⤫ | 1 | 0 | 1 |
| (C) Charging | Pedal + Pump | Open | ⊣⊢ | 1 | 0 | 0 |
| (D) Discharging | Discharge | Open | ↑↓ | 1 | 1 | 0 |
| (E) Neutral | Moving Vehicles | Closed | ⊣⊢ | 0 | 0 | 0 |


4/3 DCV
let $S_2$ = solenoid 2
$S_3$ = solenoid 3

2/2 DCV
let $S_1$ = solenoid 1




$(S_1, S_2, S_3)$

Sprint: (C) → (D) → (A) (optional)

Efficiency: (C) → (D)

Endurance: (A) → (B) (optional for charging) → (D)

Regen Demo: (Before start line) (A) → (B) → (start line) → (D)

Sprint
(C): (1,0,0)
↓
(D): (1,1,0)
↓ (optional)
(A): (0,1,0)

Efficiency
(C): (1,0,0)
↓
(D): (1,1,0)

Endurance
(A): (0,1,0)
↓ (optional)
(B): (1,0,1)
↓
(D): (1,1,0)

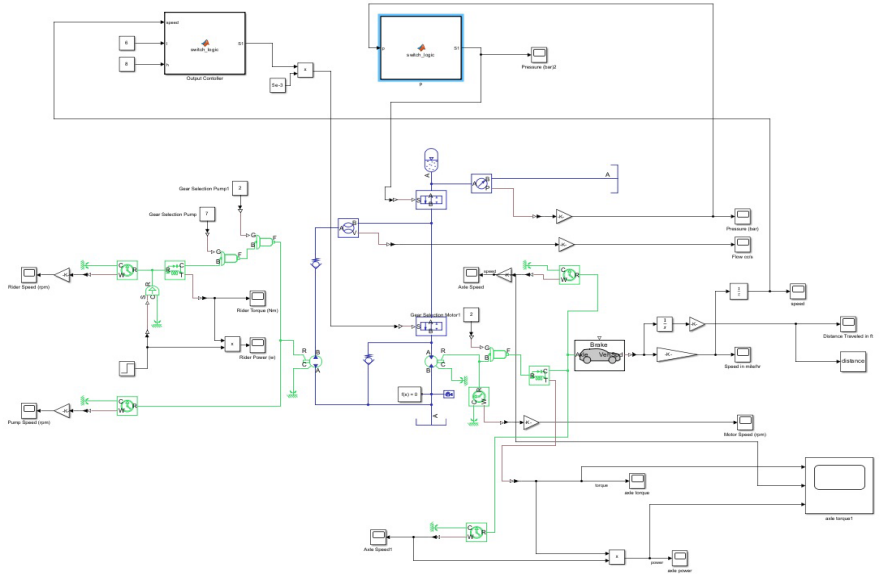
Brake Regen - Demo
(A): (0,1,0)
↓
(B): (1,0,1)
start - line
↓
(D): (1,1,0)

# Design Choices

- **Trike**
  - ✓ A trike was selected for better stability and higher load capacity compared to a bicycle.
- **Piston Pump & Motor**
  - ✓ High efficiency (~90-95%), including reverse operation.
  - ✓ High max speed (~8000 RPM) compared to alternative motors.
- **Accumulator**
  - ✓ A 1-gallon accumulator was selected based on energy density considerations.
  - ✓ Hydac accumulator is > 2lbs  than competition.
- **Gearing**
  - ✓ The optimal gear ratio was determined through IGH simulation.
  - ✓ The drivetrain was reconfigured with 10 & 14T gears for the pump and motor.


# Vehicle Testing

- **Efficiency Testing**
  - ✓ Multiple bang-bang control configurations were evaluated through simulation and experiments.
  - ✓ Testing showed performance approximately ⅓ below expectations.
  - ✓ However, travel distance improved from ~700ft to ~1200ft.
- **Sprint Testing**
  - ✓ A 300 feet sprint test was conducted under various pre-charge pressures.
  - ✓ An optimal value of 115 bar was identified.
  - ✓ Pedaling assistance greatly improved acceleration and reduced sprint time from 22s to 18s.



# Lessons Learned

- **Piston Pump & Motor**
  - ✓ Slow pressure build-up, limited rider input torque, and the absence of torque multiplication led to delayed acceleration during sprint testing, requiring significant rider effort.
- **Viribus VB1 Trike**
  - ✓ Frame interference and fabrication constraints limited components placement.
  - ✓ Restricted brake and drivetrain integration due to the non-removable rear axle.
- **Electrical Circuit**
  - ✓ Learning challenges with CODESYS and parts delays necessitated a transition to an Arduino Due-based control system in MATLAB/Simulink.
- **Teamwork**
  - ✓ Improvements are needed in time management, adaptability and practical engineering skills like CAD modeling, fabrication, and programming.