NFPA Fluid Power Vehicle Challenge

Final Design Review

Featherweight Cycles - 2022

Introductions

As a team of five mechanical engineering students at Cal Poly San Luis Obispo, we have all been very excited to partake in the Fluid Power Vehicle Challenge!

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Main Design Objectives

Vehicle Frame	Hydraulics	Pneumatics	Mechatronics
• Decrease Frame Weight compared to last year's design • Improve Sprint Performance	• Improve Efficiency • Fix direct drive mode • Implement Hydraulic Hardlines	• Implement a position controlled pneumatic seat • Test and Iterate	• Optimize Current Charge Platform • Implement Seat Position Control Model

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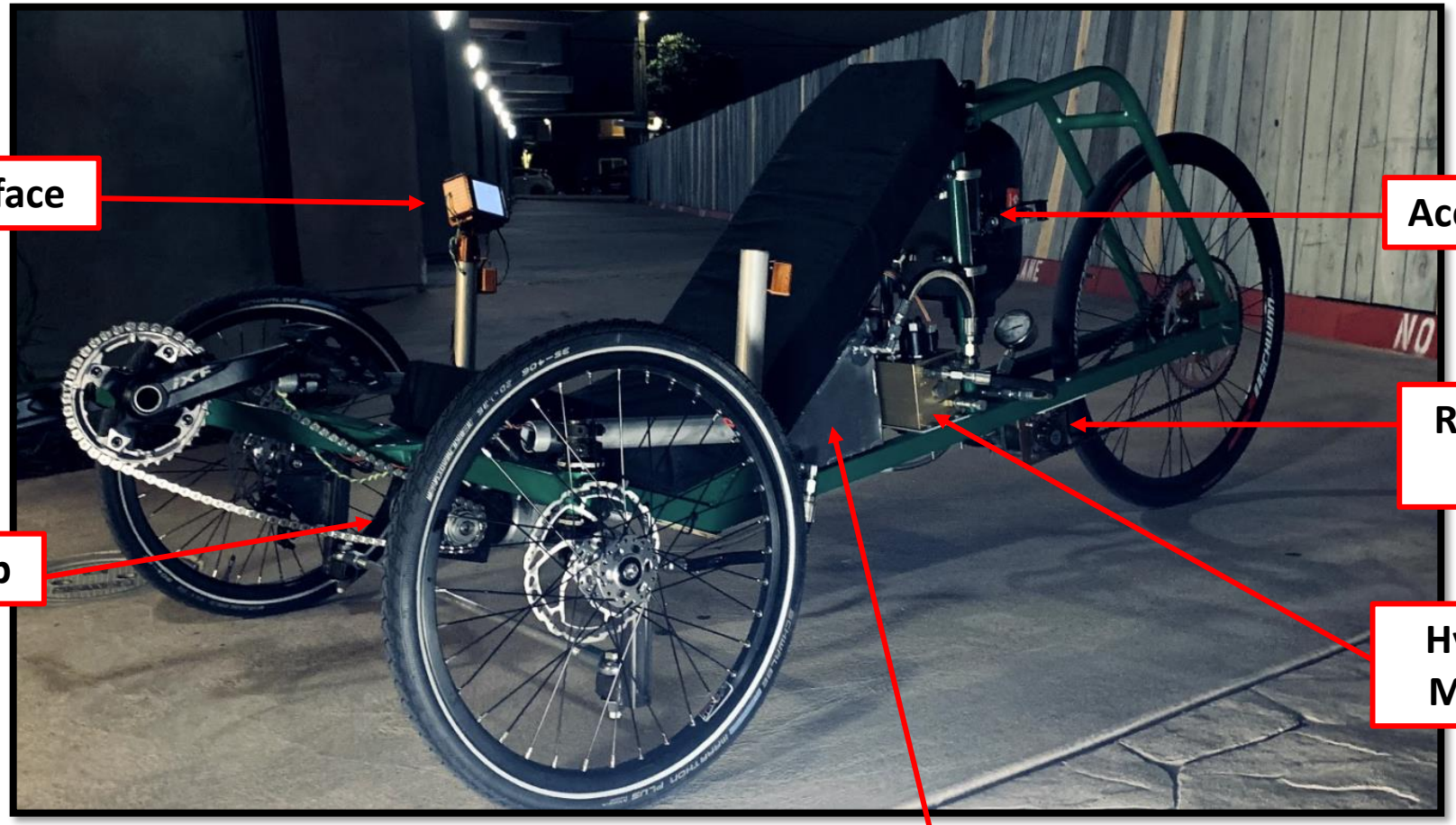
Summary of Midway Presentation

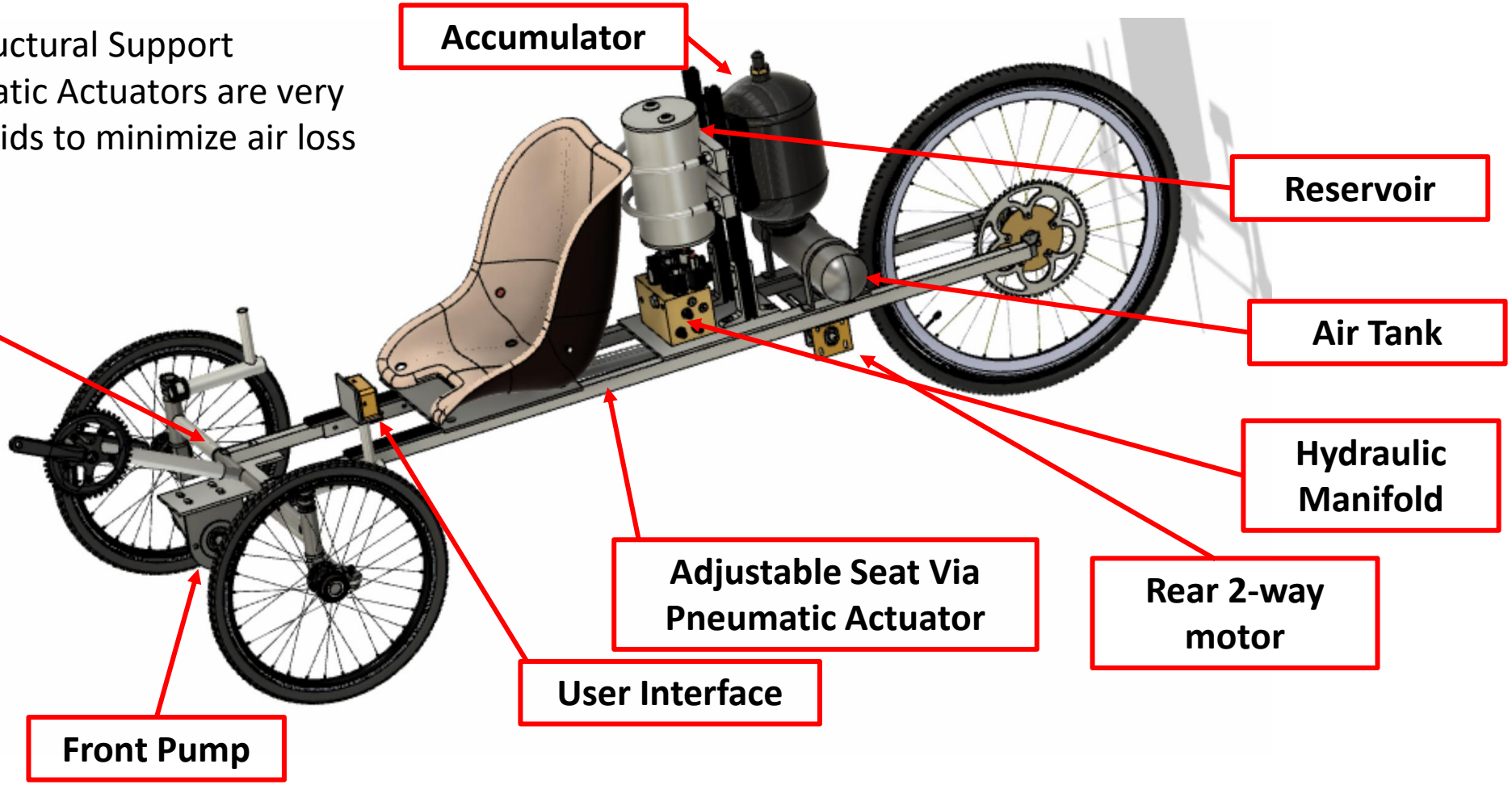
Previous Vehicle (Cal Poly 2021)



Midway Review Summary

Judge Feedback:

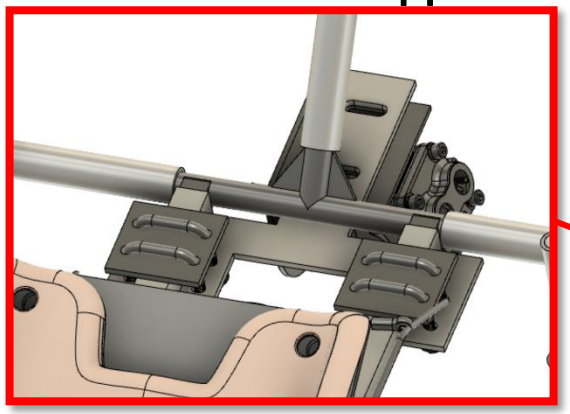
- Add Frame Structural Support
- Ensure Pneumatic Actuators are very close to solenoids to minimize air loss

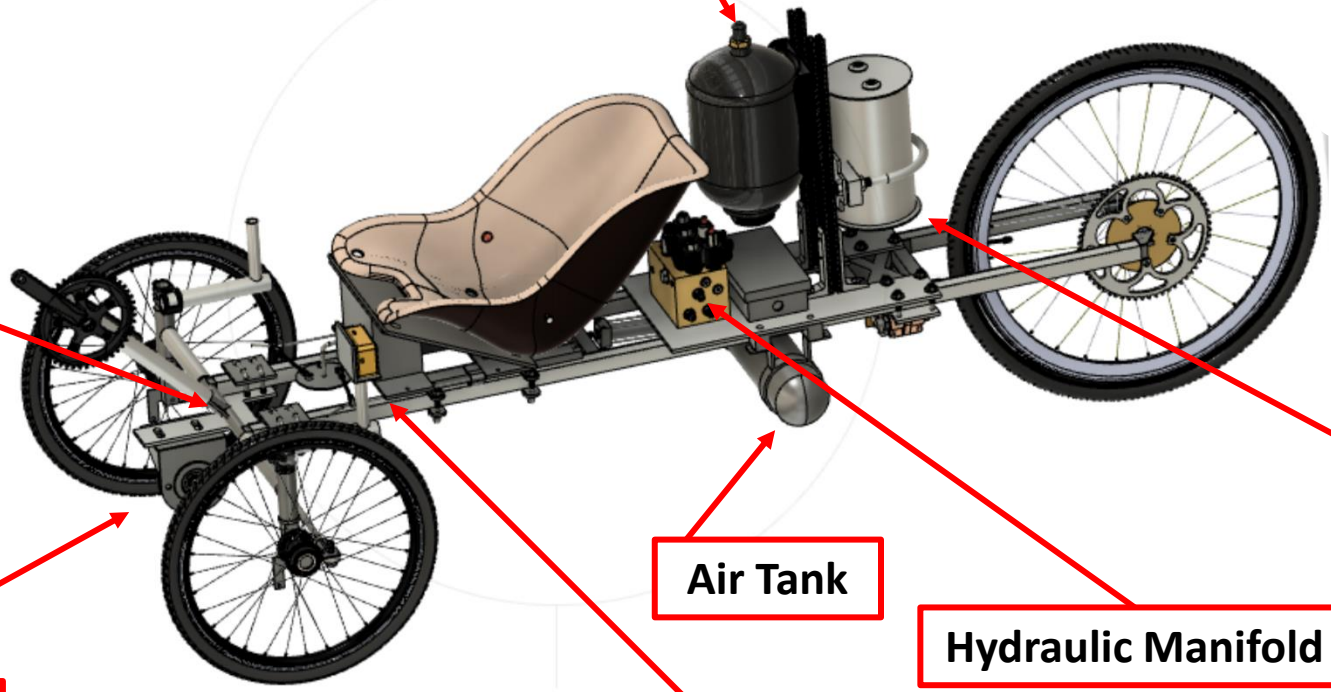


Final Design

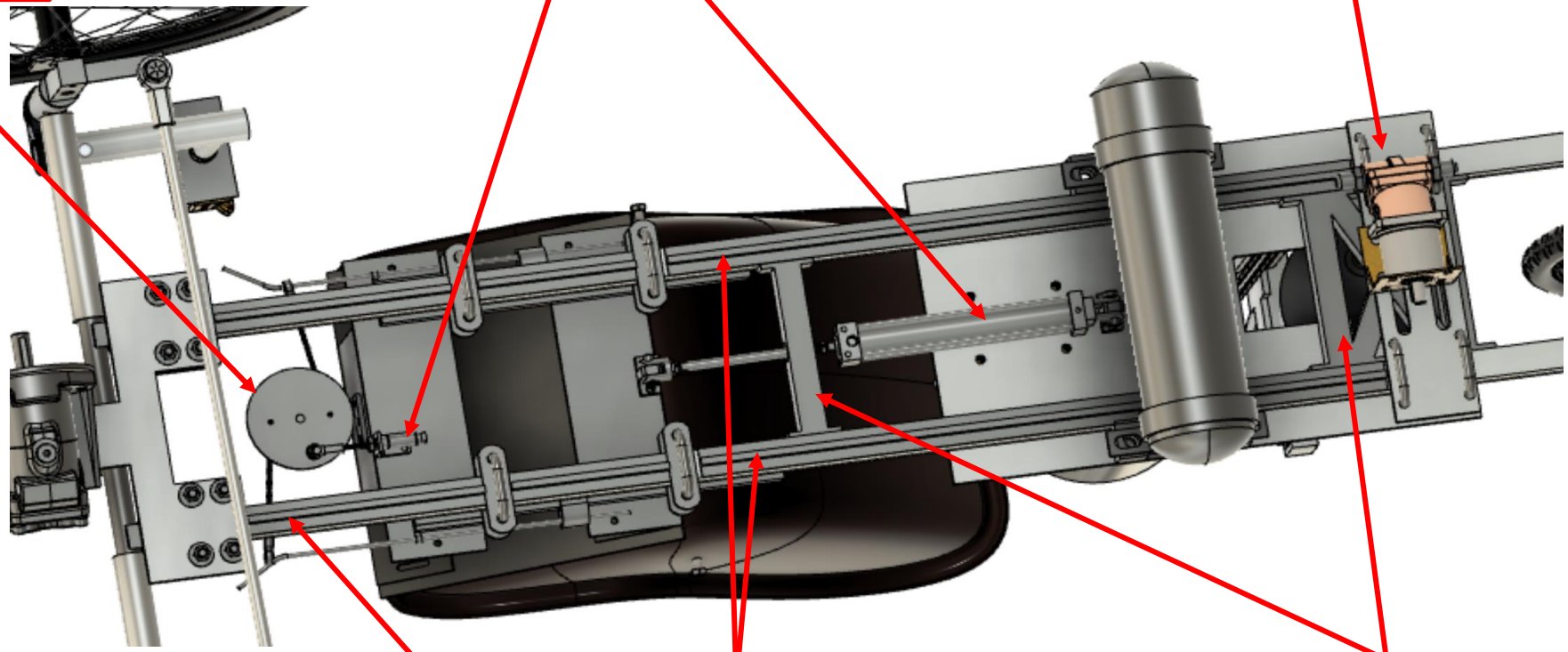
Final Design

Added Frame Support



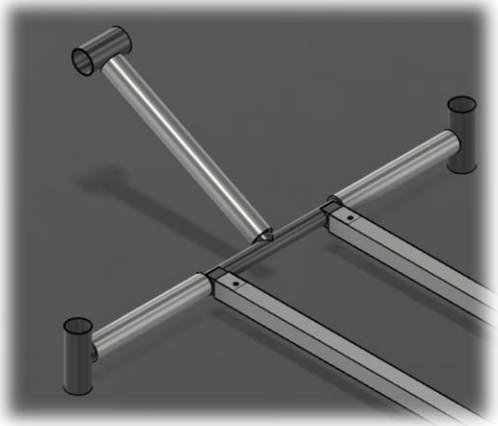


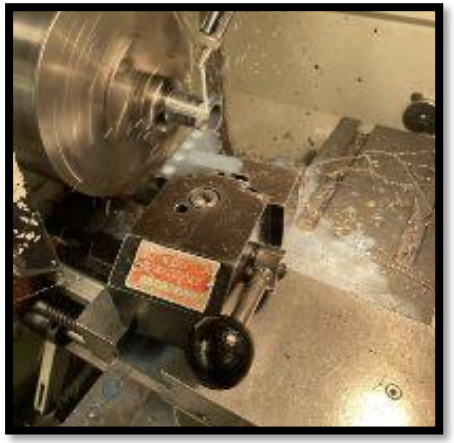
Final Design (Bottom View)

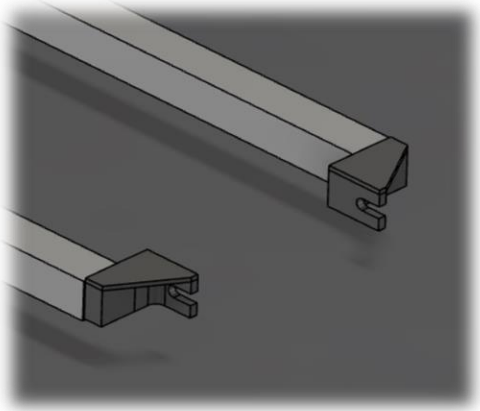


Frame Sub-Assembly

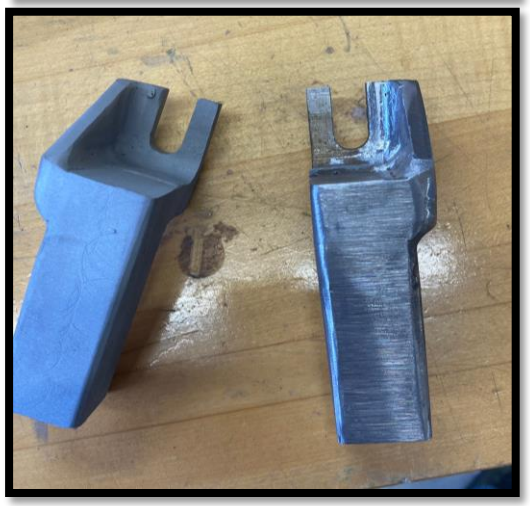
Manufacturing Frame Steel Inserts





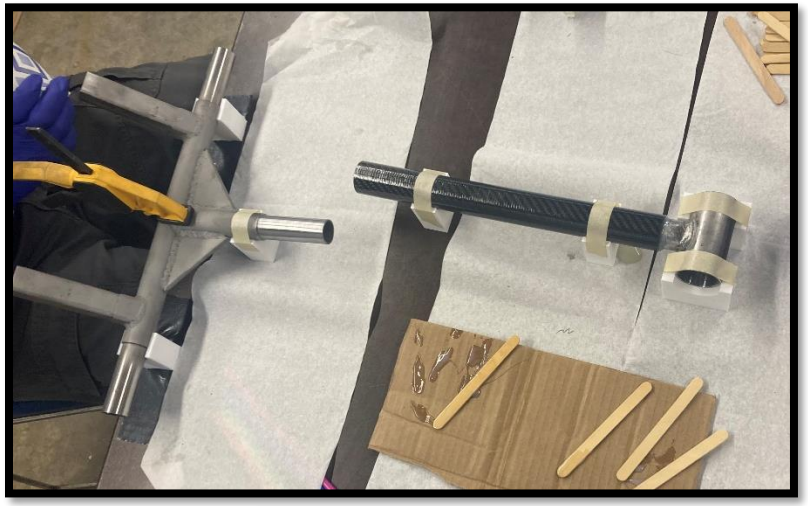


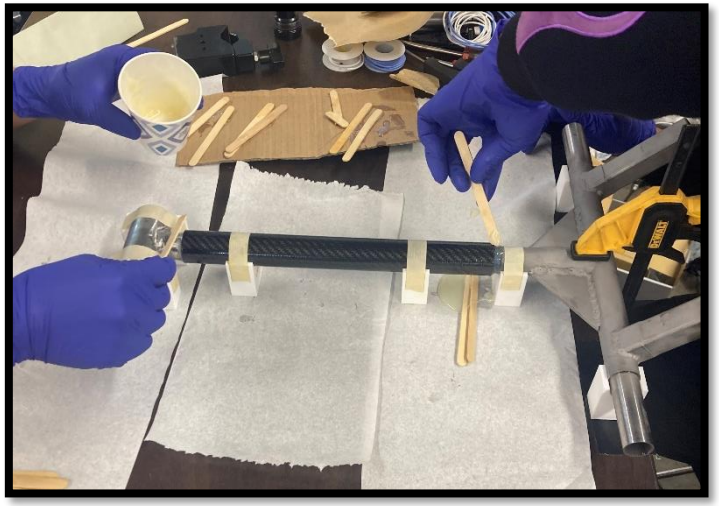
Final Products:



Frame Bonding

Front:



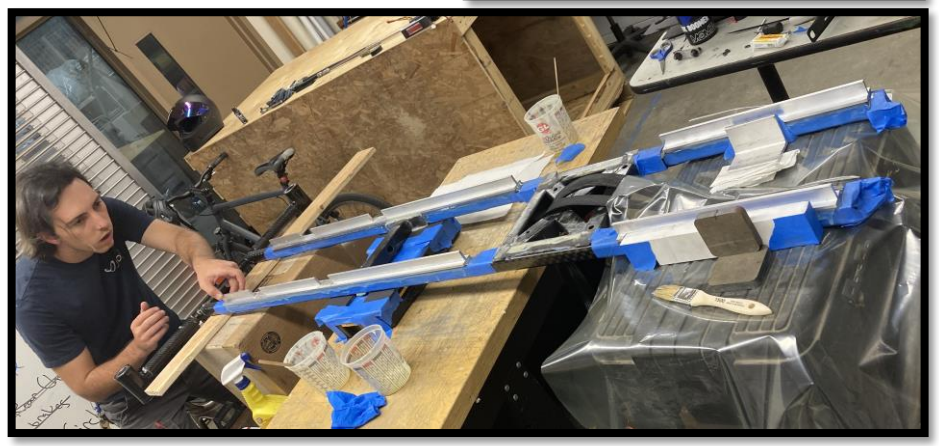


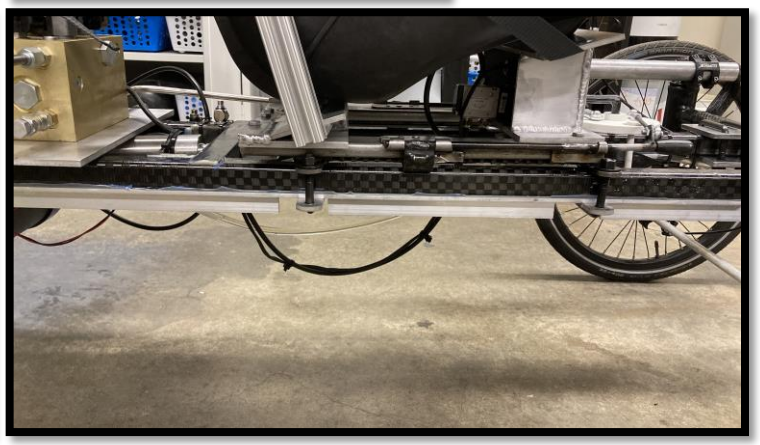
Middle & Rear:

Frame Stiffness Problem/Solution

Problem:

Solutions:





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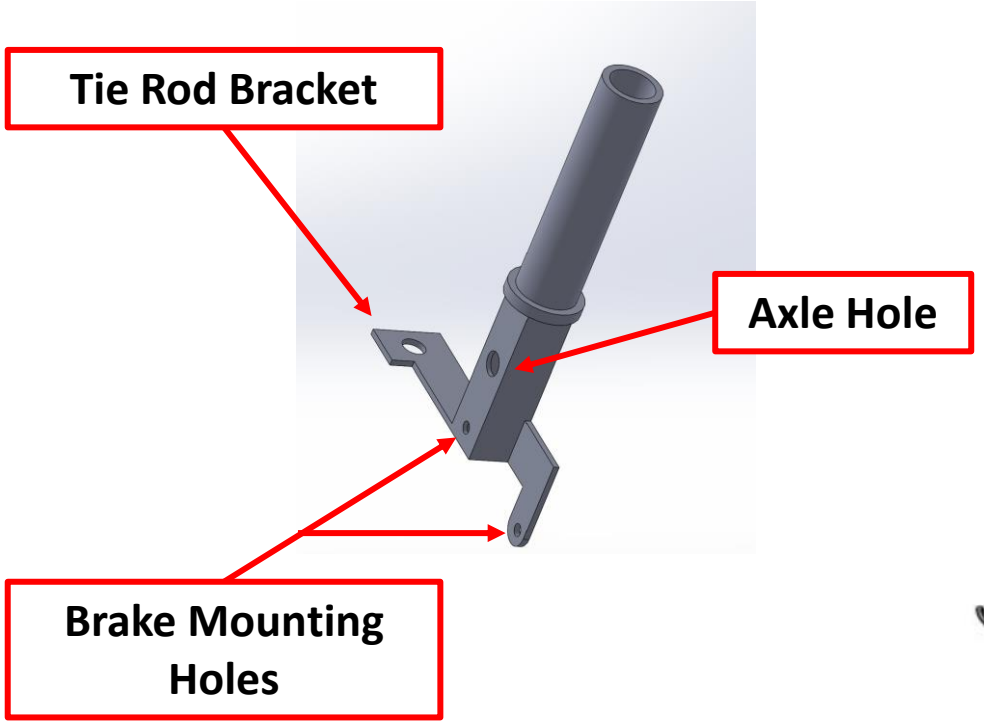
Steering Sub-Assembly

Manufacturing Headtube Assembly

Design:



Headtube Assembly:

Brake Assembly:

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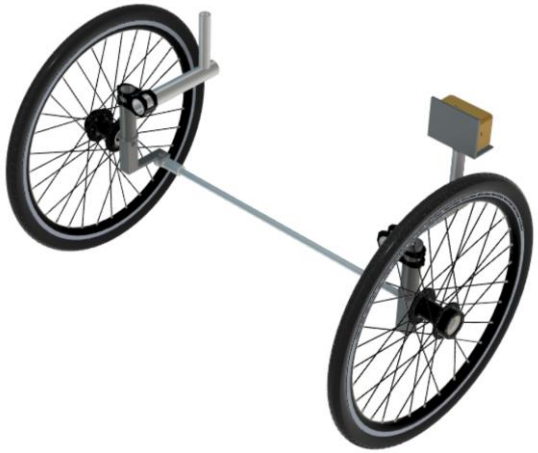
Full Steering Assembly

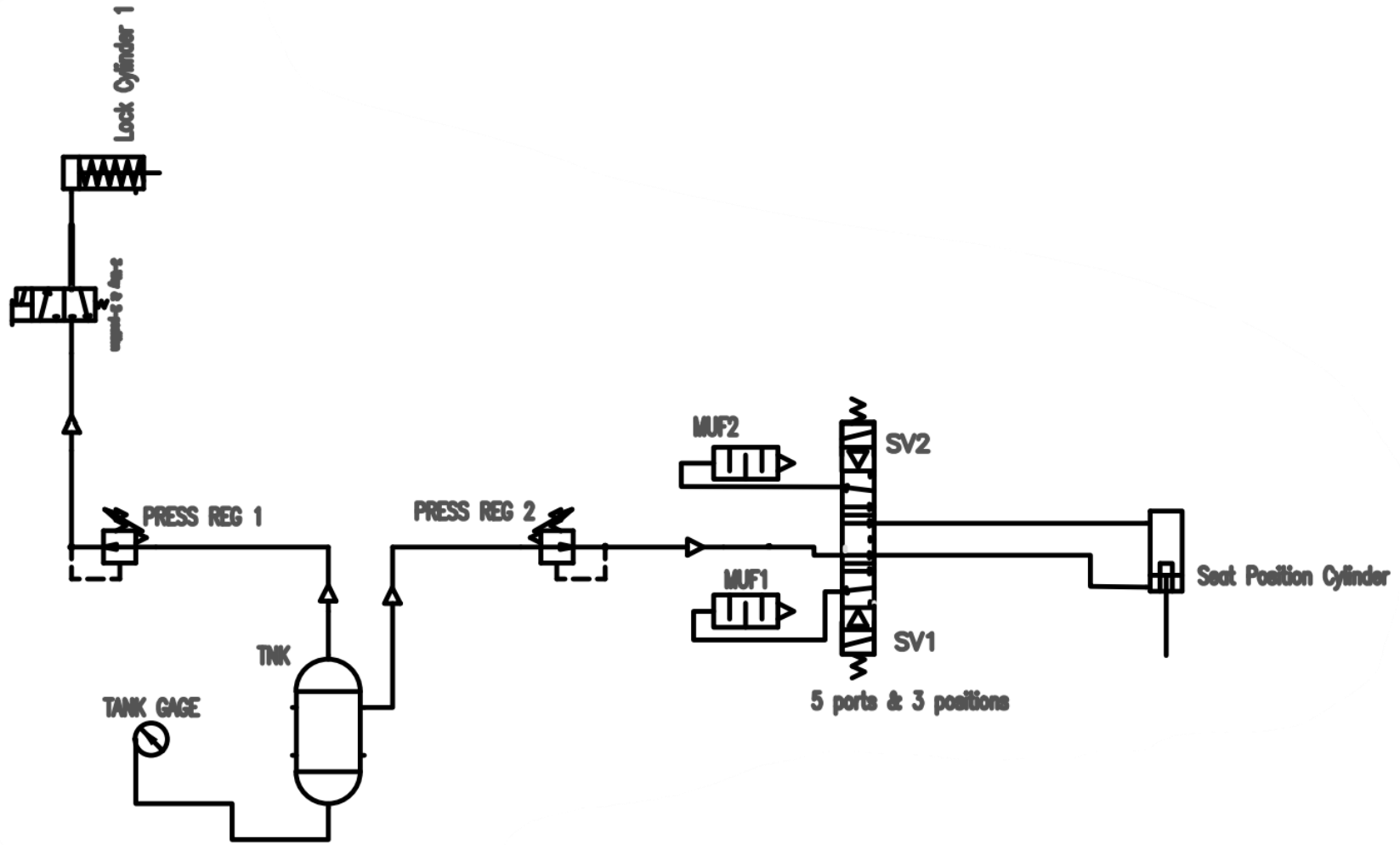
Components:



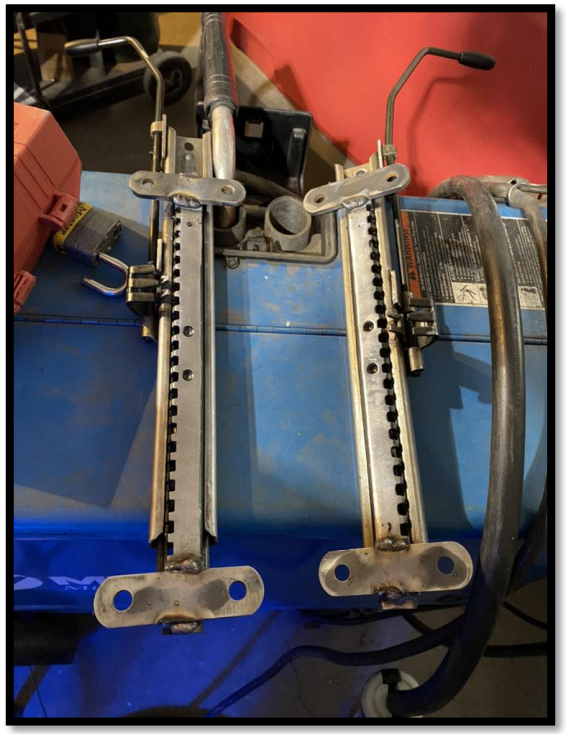
Full Assembly:

Pneumatic Sub-Assembly

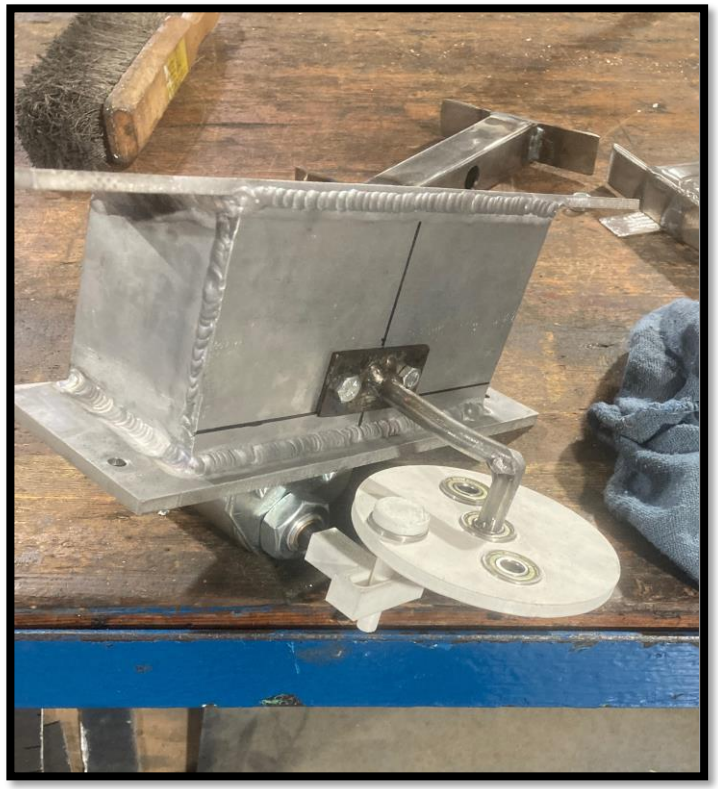
Pneumatic Circuit Diagram



Seat Rail Assembly



Locking Mechanism Assembly



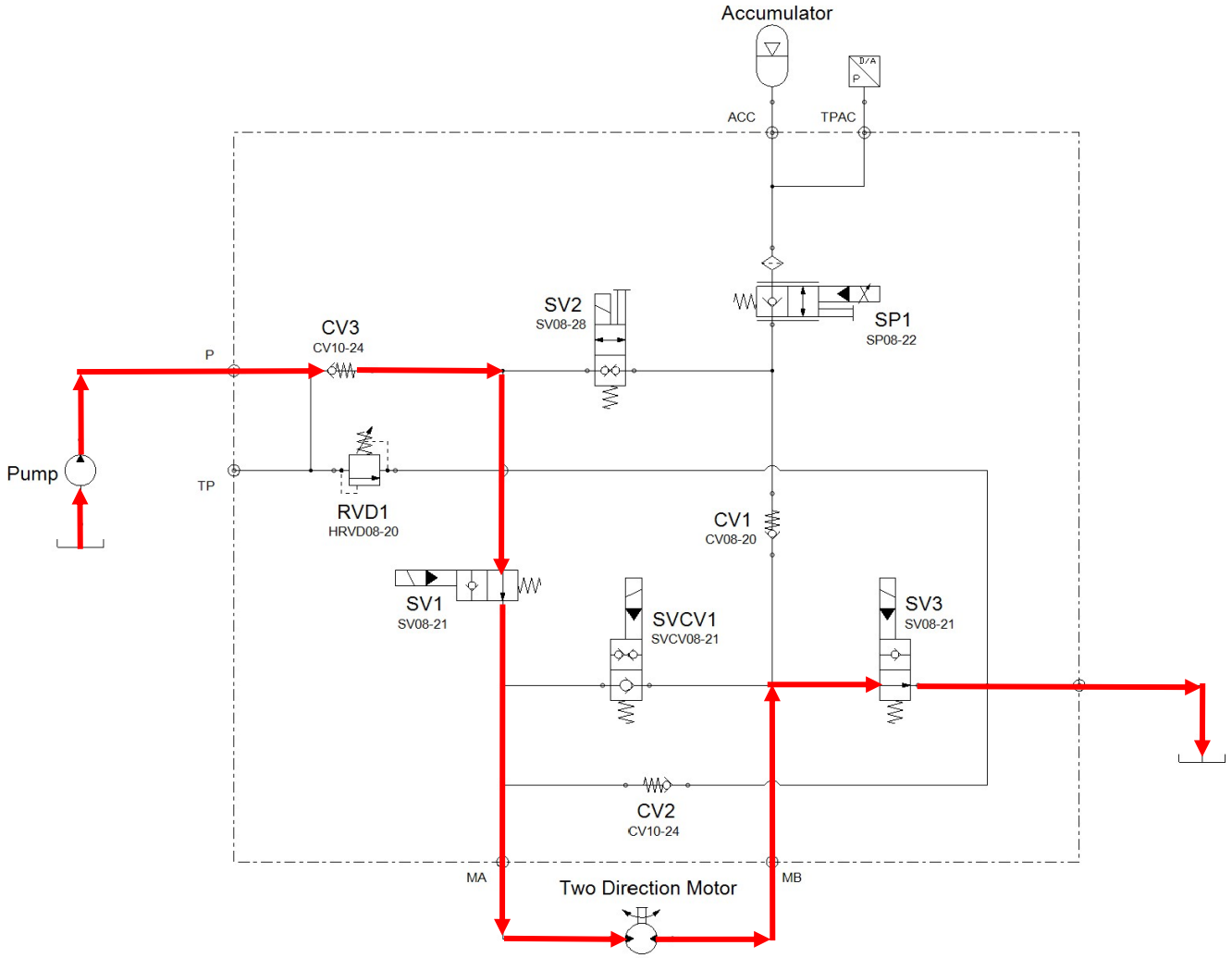
Testing Actuation

Forward/Backward Seat Position

Lock/Unlock Mechanism

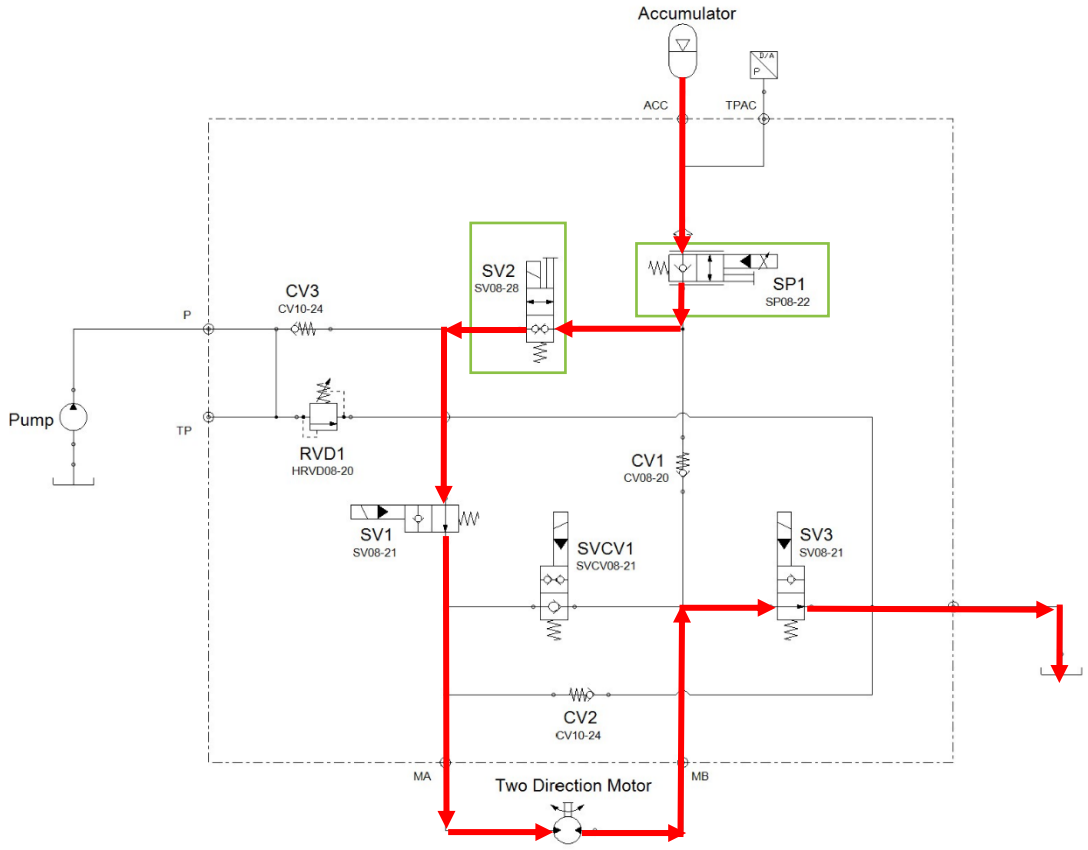
Hydraulic Sub-assembly

Direct Drive Mode

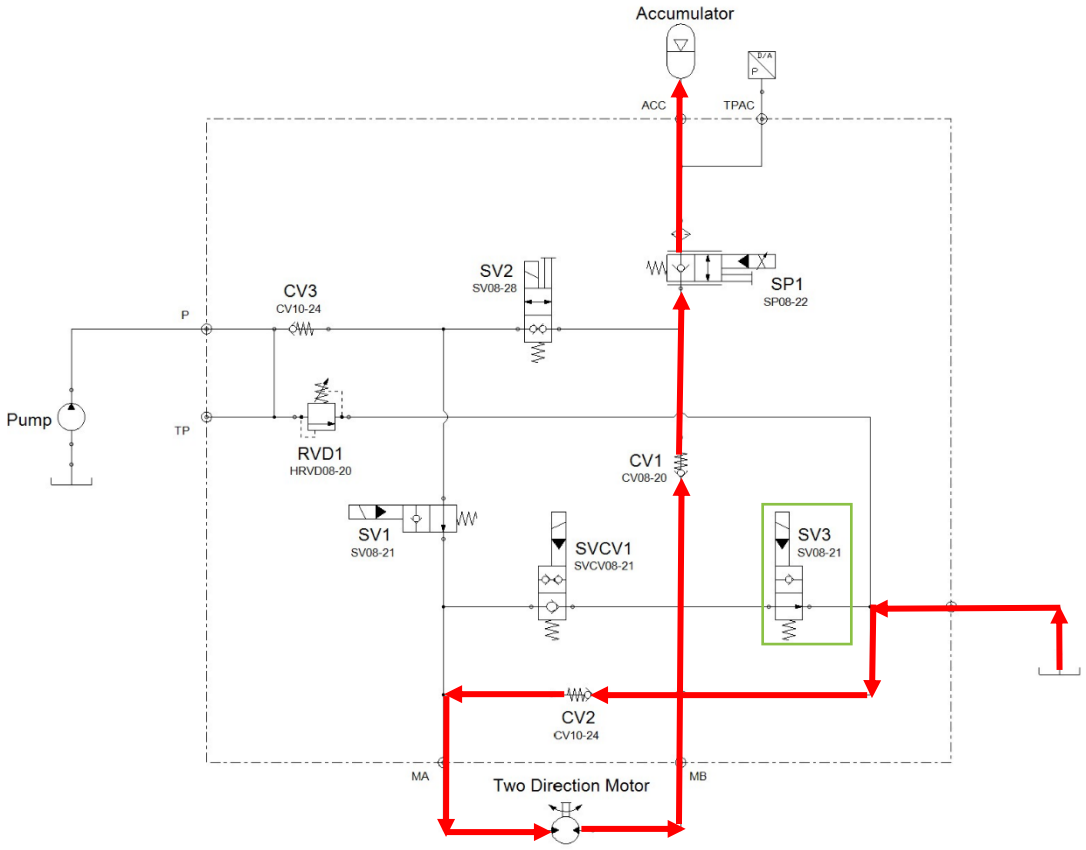


Key
Fluid Flow
Active Valve

Boost & Regen Mode



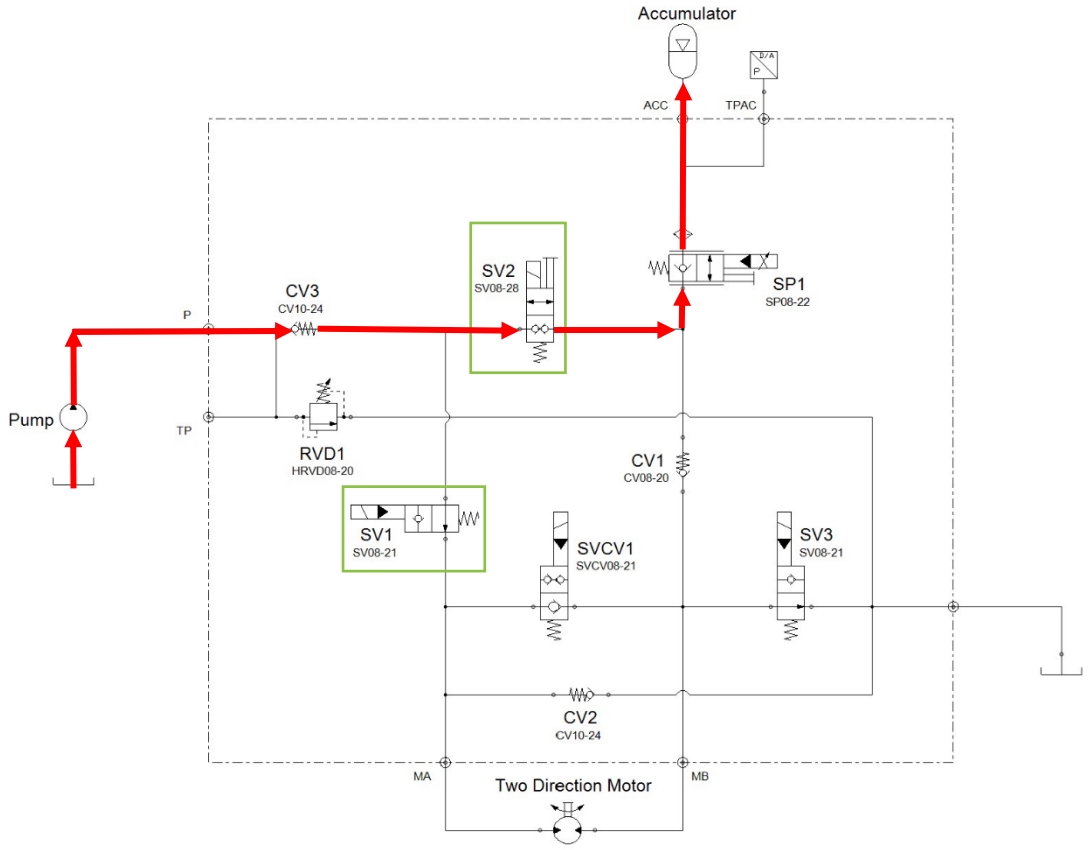
Boost Mode



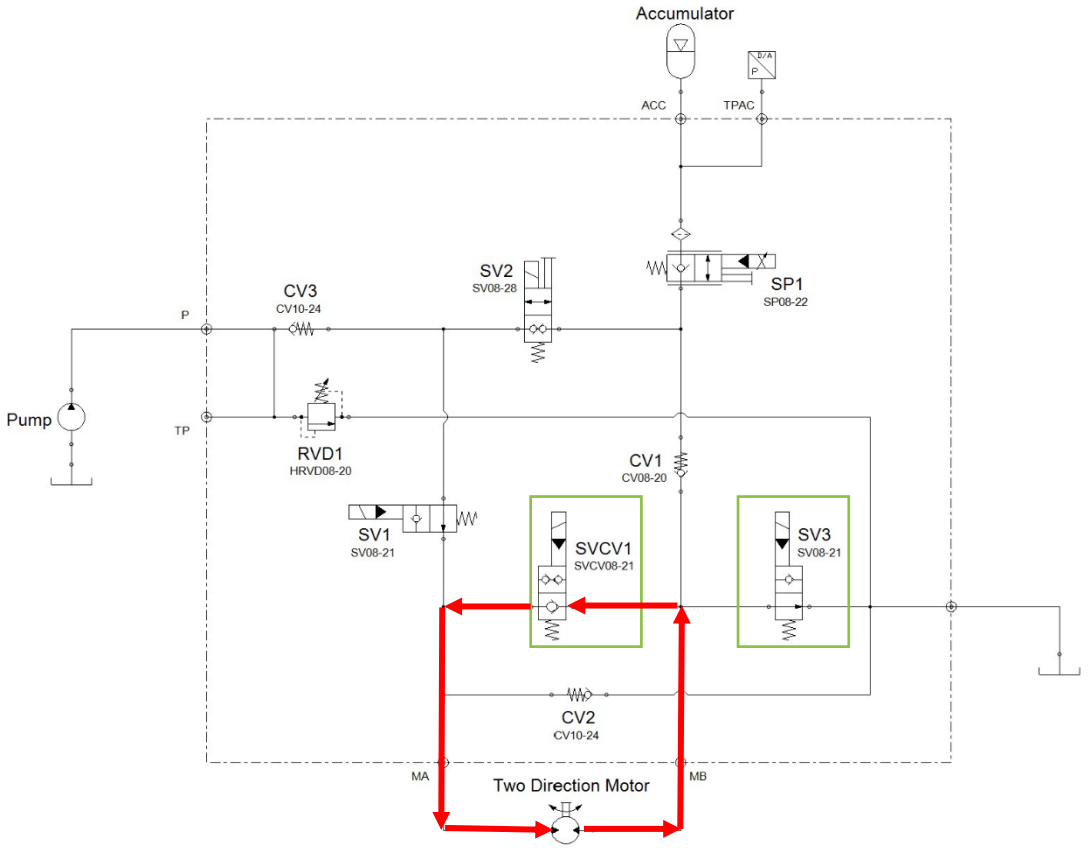
Regen Mode

Key
- Fluid Flow
- Active Valve

Pedal to Charge & Coast Mode



Pedal to Charge Mode

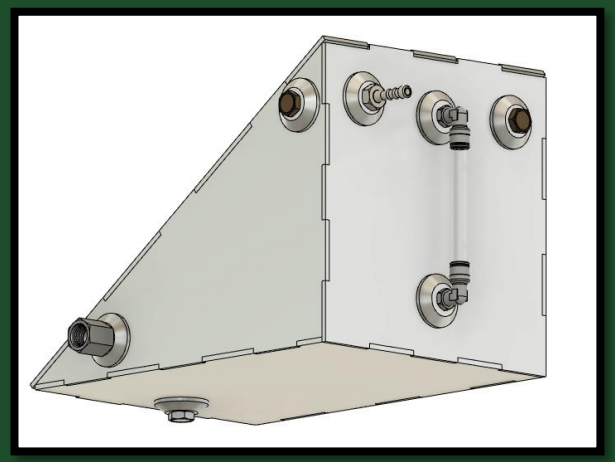


Coast Mode

Key
Fluid Flow
Active Valve

Reservoir Manufacturing

Previous Design



New Design

- Larger capacity of 1.8 gallons
- 6061-T6 Aluminum, 6” nominal pipe with water jet top & bottom for TIG Welded Assembly
- Made to minimize leak points on Reservoir

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Front Pump Conversion

Old Pump

Bosch 5CC Bent Axis Pump:

- Weight: 5 lbs
- 5 cc/rev displacement
- Apex Dynamic Hypoid Gearbox 4:1 Ratio (10:1 overall from crank to pump)

New Motor

Hydro Leduc M 5_093840 Motor:

- Weight: 9.7 lbs
- 5 cc/rev displacement
- Front gear ratio from crank to pump 5:1

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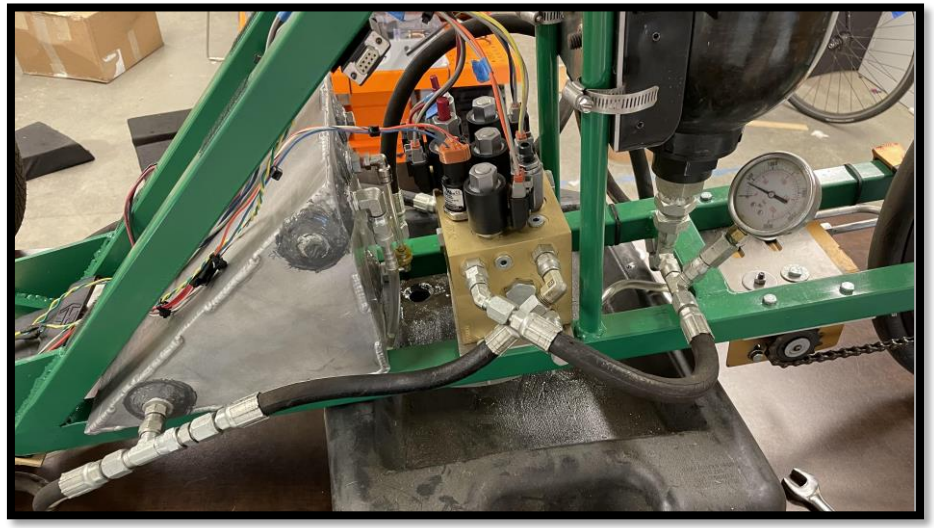
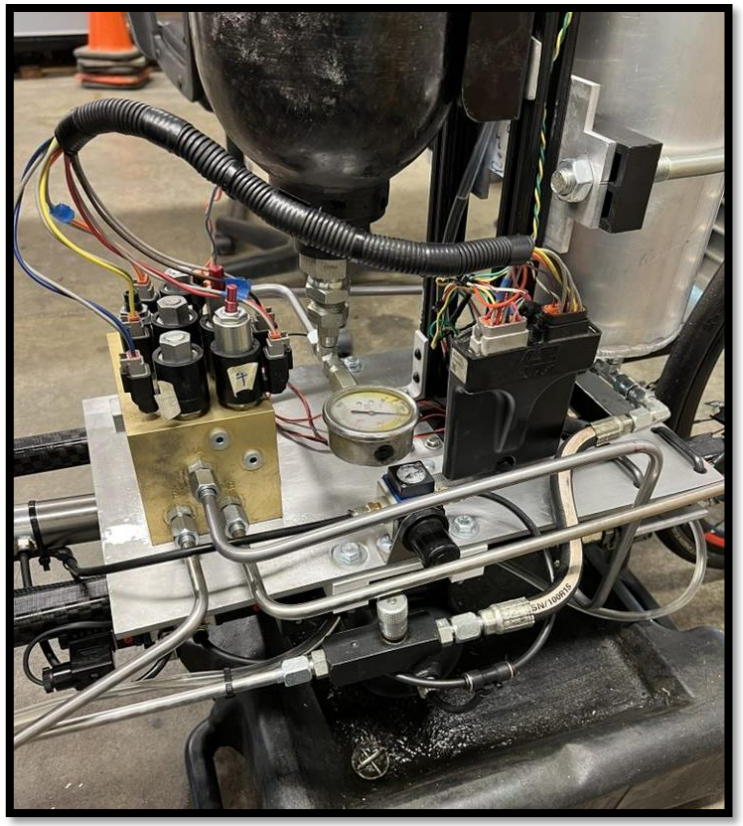
Hydraulic lines Manufacturing

Flexible Lines



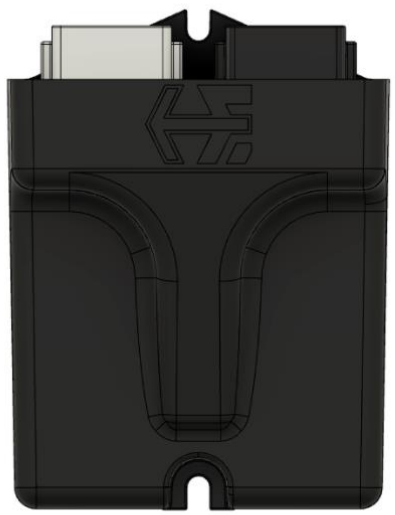
Hardlines



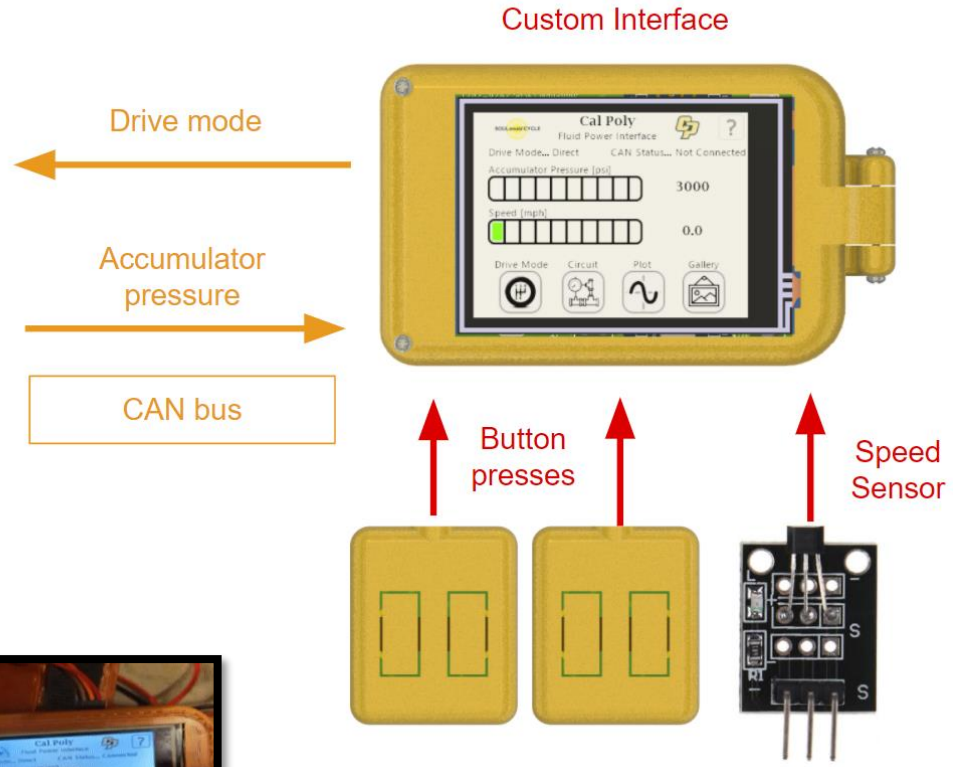
Mechatronics Sub-Assembly

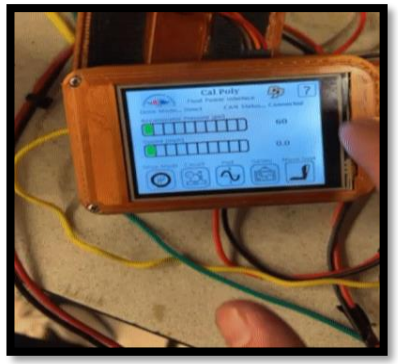
Mechatronics Implementation

- Touch screen display to adjust drive mode
- CAN protocol used to communicate with hydraulic controller
- Hall-effect and pressure sensors for real time speed and pressure readings



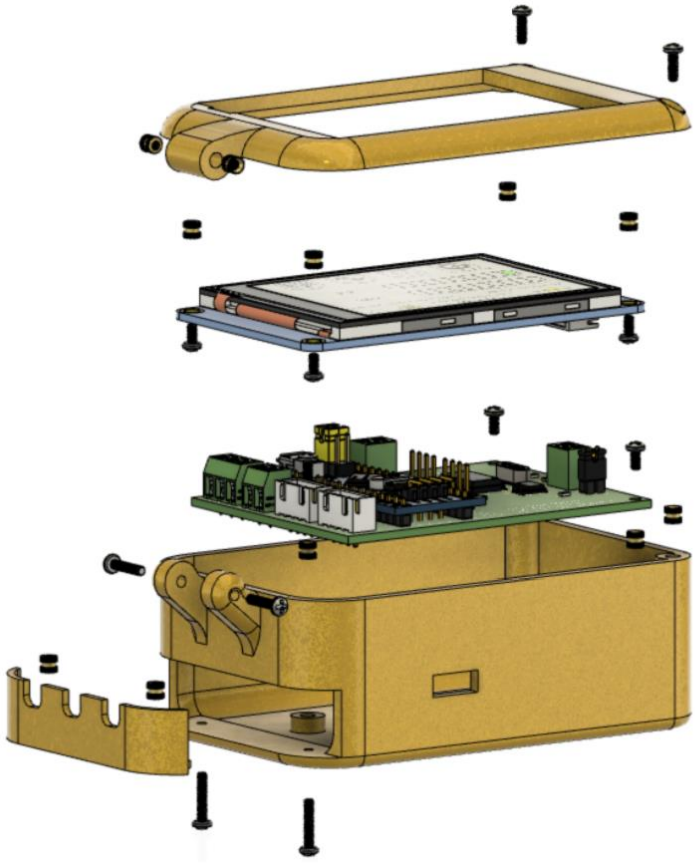
Hydraforce Valve Driver





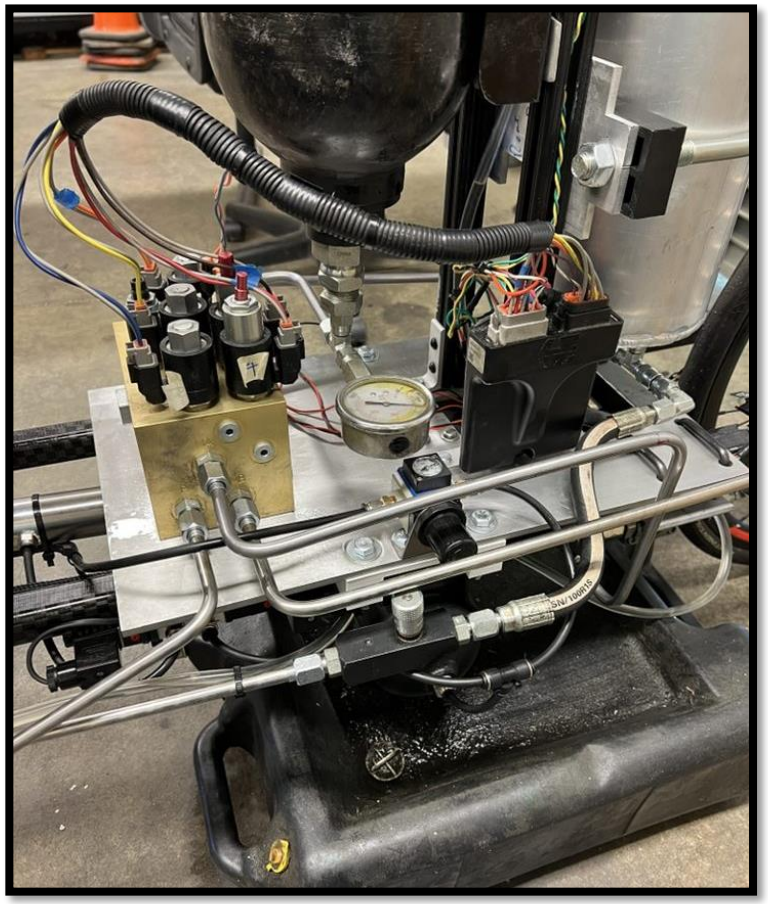
System Design

- Position Controlled Pneumatic Actuation
- Handlebar Mounted Hard Switches
- Electronic Relays for 12V power to solenoids connected to Nucleo development board.



Final Vehicle & Test Results

Fully Assembled Vehicle



Testing Results

Test	Distance	Result
Sprint I	500 ft	29 sec
Sprint II	500 ft	31 sec
Endurance I	1.45 miles	20 min
Endurance II	1.50 miles	20 min
Accumulator Charge Time	-	5 min

Lessons Learned

Final Reflection

Biggest Challenges

- Design Iteration
- Manufacturing Time

Recommendations for Next Year's Team

- Optimize rear section of composite frame design
- Add Accumulator Dump by replacing CV1
- Focus on improving Pneumatic and Hydraulic systems
- Include touch controls for pneumatic seat with UART communication.

Lessons Learned

- Everything Takes Longer Than Expected
- Divide and conquer, but maintain good design communication
- TEST, TEST, TEST

Questions?

NFPA Fluid Power Vehicle Challenge

LEARN BY DOING

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