

N F P A

Fluid Power

VEHICLE

Challenge



NFPA
Education and
Technology
Foundation

FINAL PRESENTATION
ARIZONA STATE UNIVERSITY
DR. WENLONG ZHANG
4/12/23



Team Members:

Mikel Brodie, Cheng Chi Tsai, Memphis Graham,
Jacob Pfutzenreuter, Eduardo Gomez





Problem Statement

- Our team has been assigned with developing a fluid powered vehicle for competition in order to demonstrate knowledge of fluid systems.
- Design objectives:
 - Incorporate electronics
 - Improve the efficiency
 - Simplify fluid path

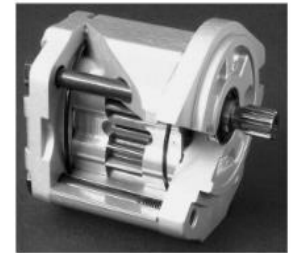
Midway Summary: Components



- Product number
 - Part #: 26002-RZJ
- 0.50 cubic inch per rotation displacement (CIR)
- Inlet size
 - 1-1/16 in
- Outlet size
 - 7/8 in
- Powered mechanically by bike pedals



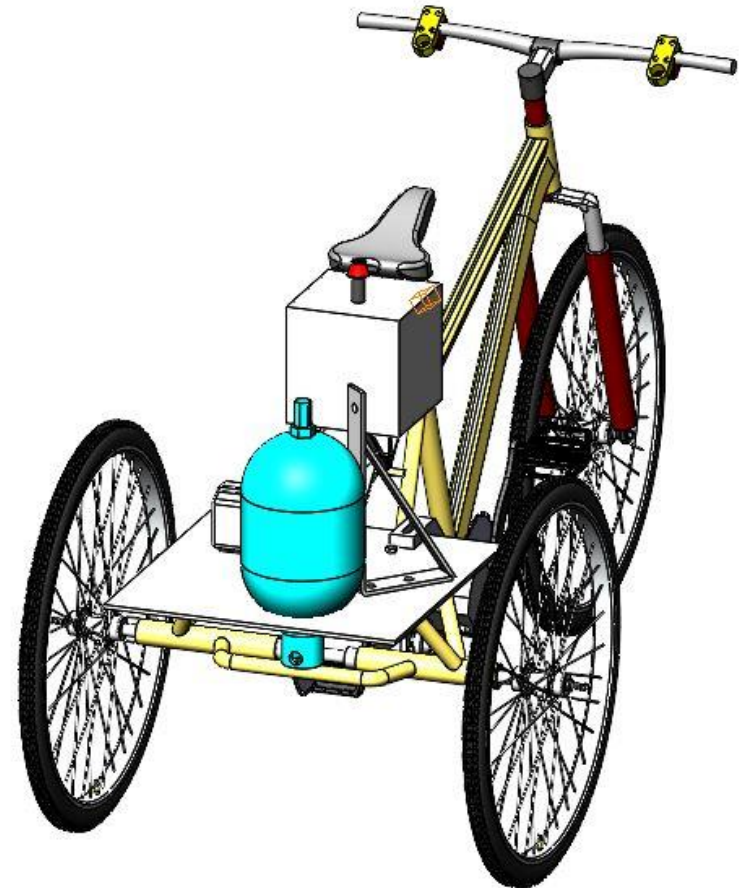
- Danfoss/Sunsource
 - Part #: SNM2NN-06GA
- 0.659 cubic inches per rotation displacement (CIR)
- Bidirectional Gear Motor
- 1- 1/16 in inlet/outlet size



- Steelhead Composites
 - Part #: AB30CN010G0N
- Composite, single, 1 gallon bladder
- 1 in SAE #16 port
 - Inlet and outlet
- Check Valve ensures unidirectional flow
- Operates at a max charged pressure of 3000 psi



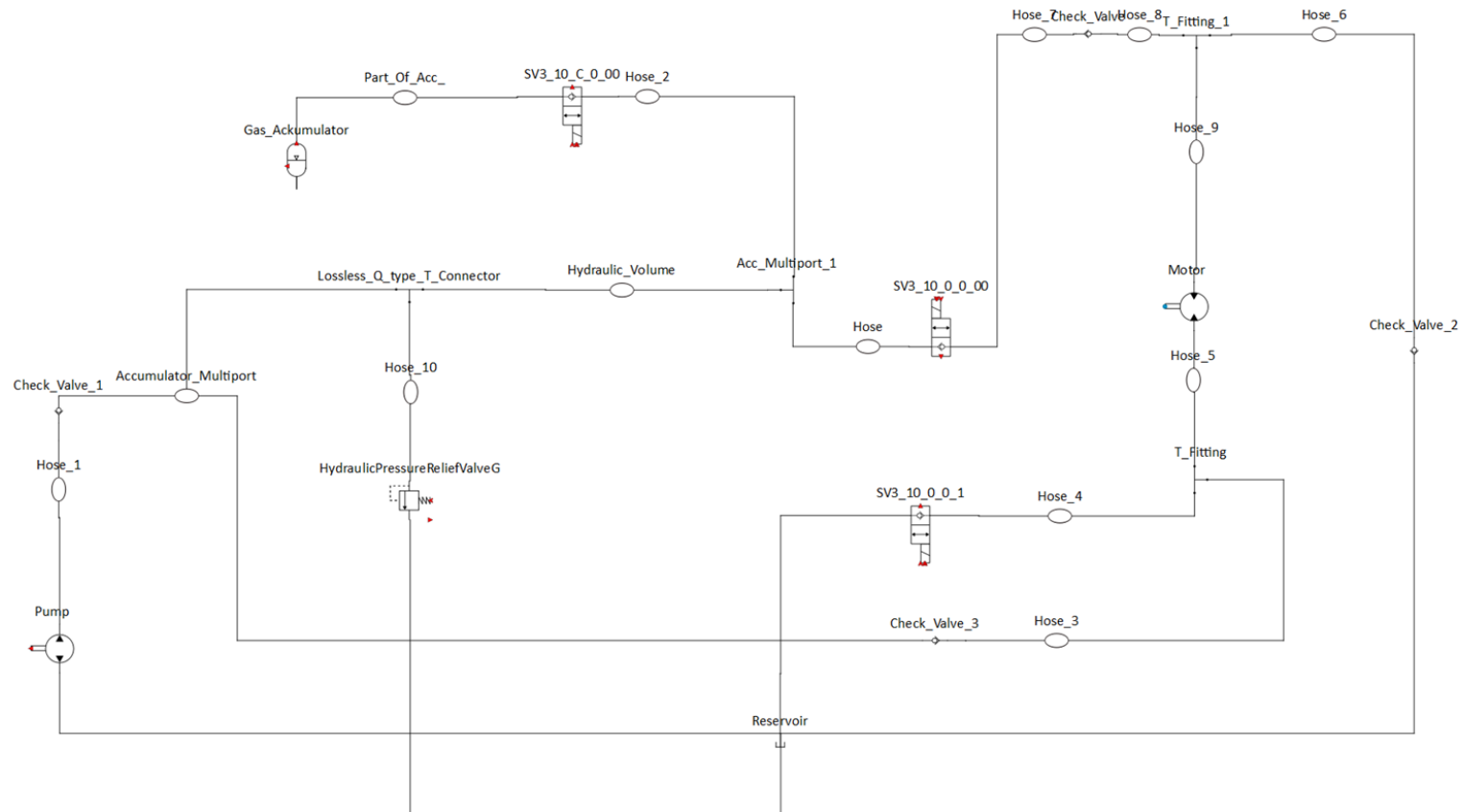
Vehicle Design



Final Vehicle Design

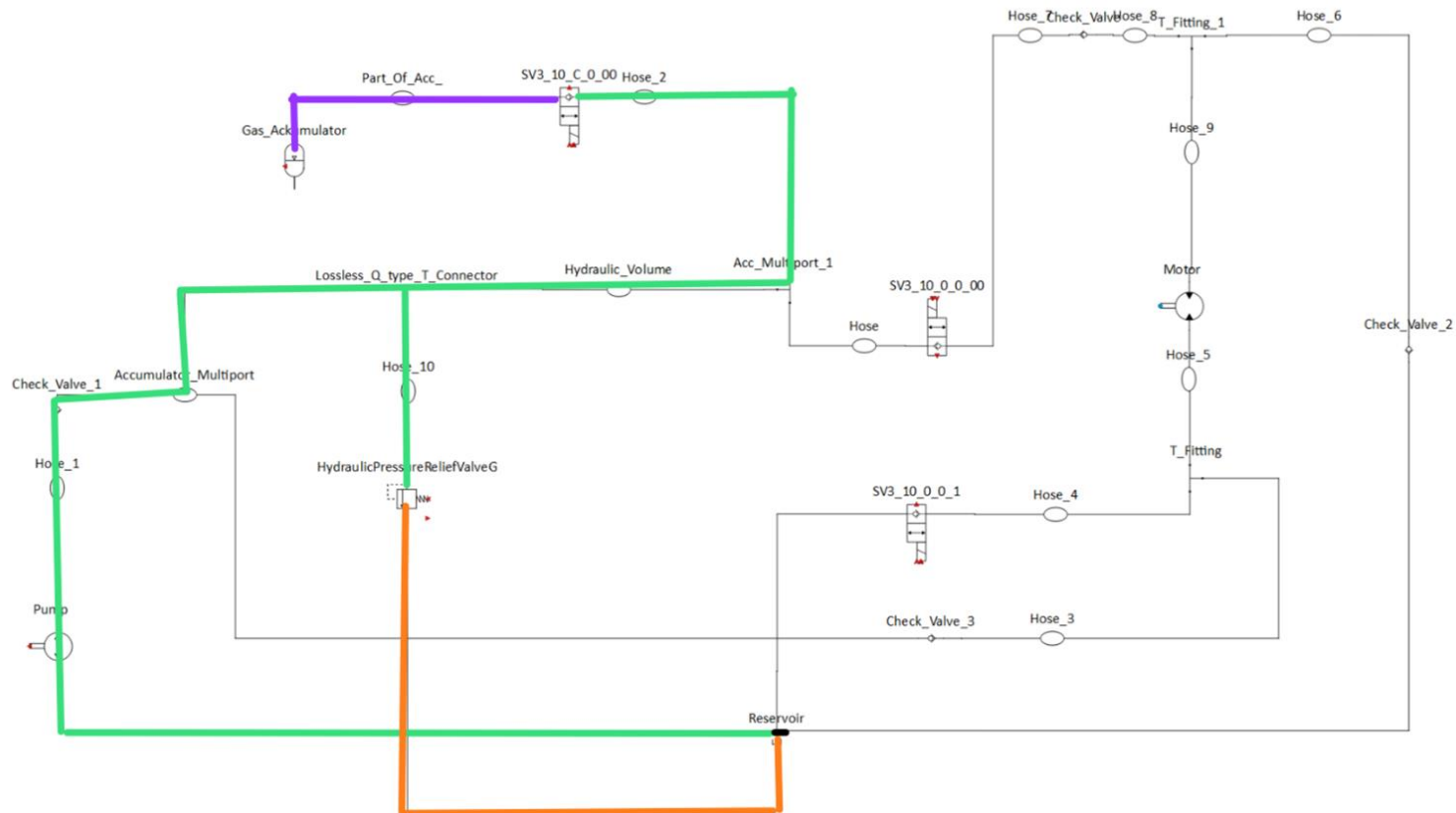


Fluid Pathway



Final Vehicle Design

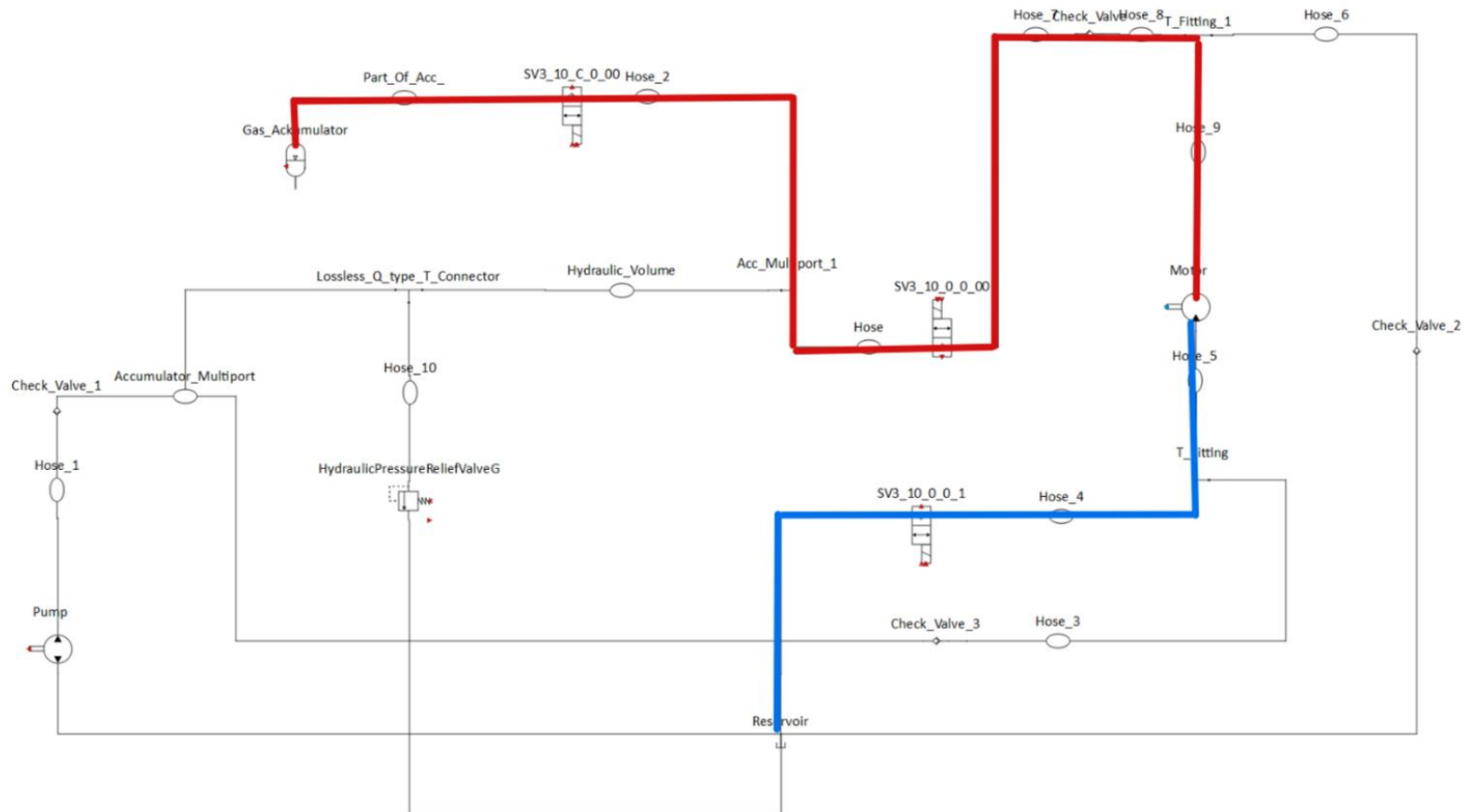
Fluid Schematic - Charging



Final Vehicle Design



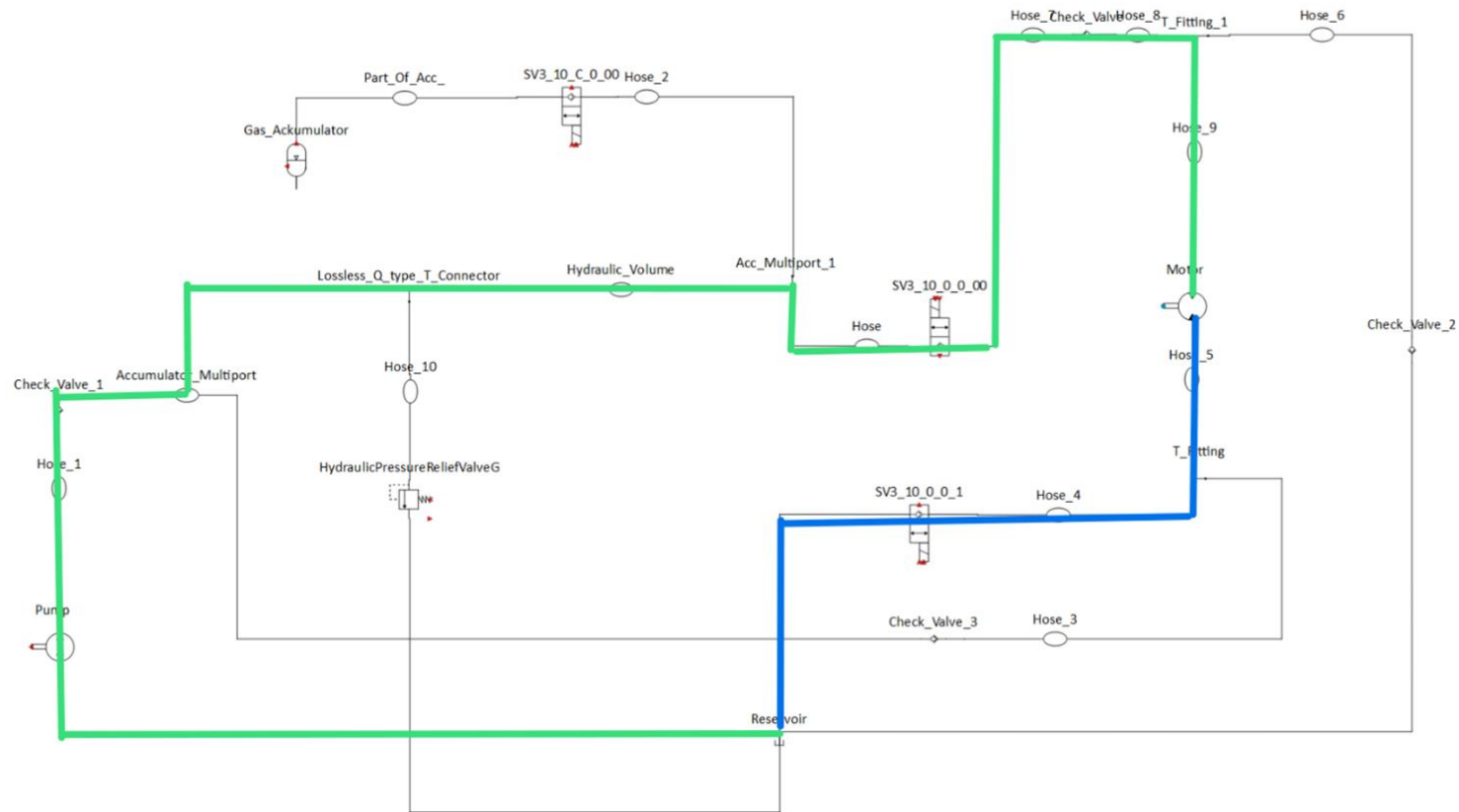
Fluid Schematic - Discharging



Final Vehicle Design



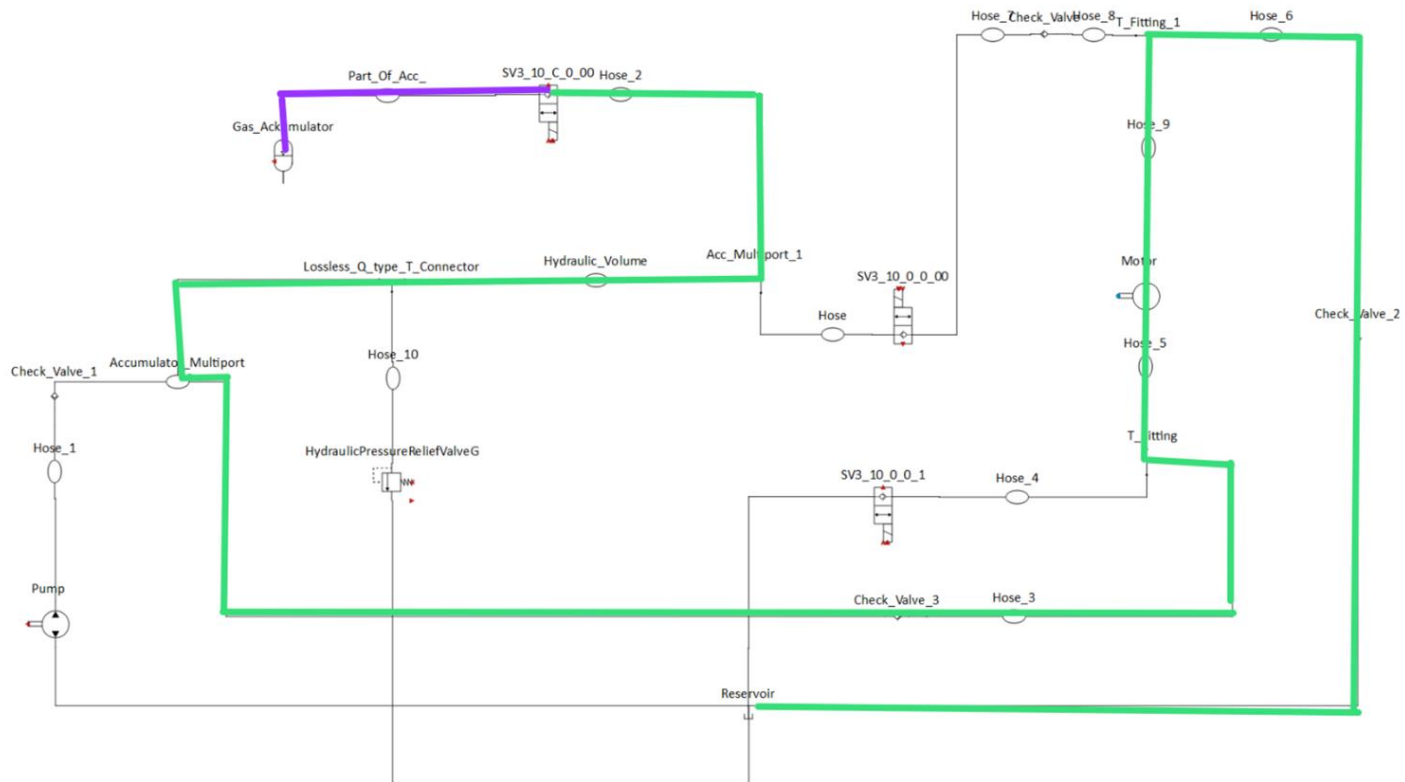
Fluid Schematic - Direct Drive



Final Vehicle Design



Fluid Schematic - Regen



Vehicle Performance Improvements



- Top Speed: 11 MPH → 15 MPH
- Acceleration: 0.5975 ft/s² → 0.88 ft/s²
- Wheel RPM: 154 RPM → 210 RPM
- Motor RPM: 462 RPM → 630 RPM
- Motor Flow Rate: 1.318 GPM → 1.813 GPM

Selection of hardware: Reservoir

- Custom made
 - Steel
 - 1 gallon volume
- Air filter
- Baffled
- 2 inlets
 - $\frac{3}{8}$ in SAE #6
 - Relief from accumulator
 - Return from motor
 - Relocated to bottom to ensure proper fluid flow
- 1 outlet
 - $\frac{3}{8}$ in SAE #6 (to pump)

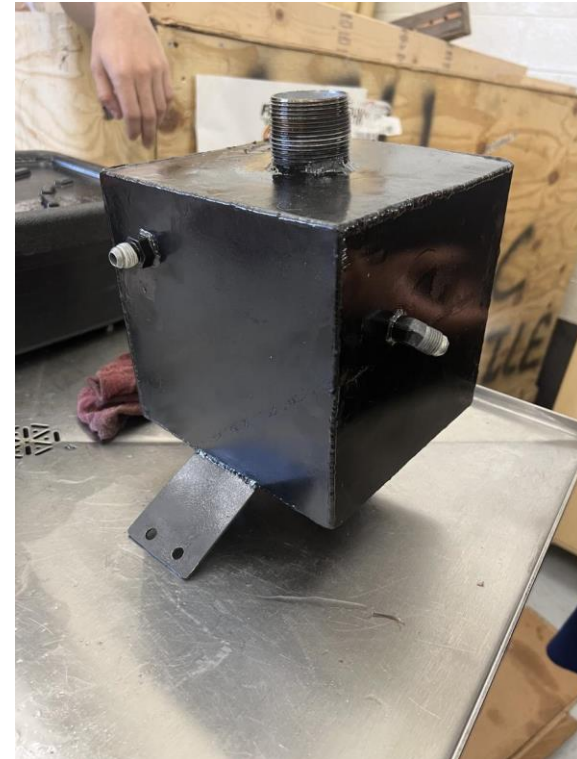


Figure 19: Reservoir

Selection of hardware: Electronics



Figure 21: Normally Open Solenoid

- SV3-10-0-0-00: Electronic Solenoid by Vickers
- 2-Way/ 2-Position
- normally open/normally closed
- Rated Flow: 12 GPM

Figure: HIC block

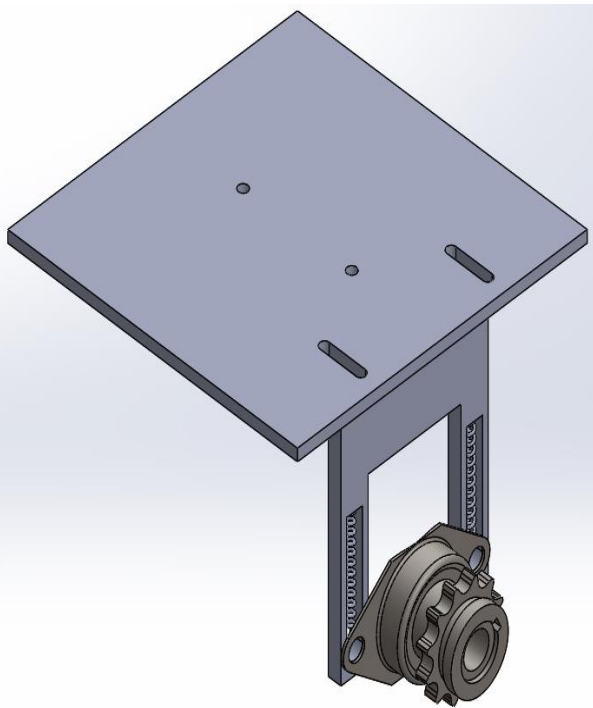
- Hydraforce Series 10 2-Way Housing 7024260
- SAE -6
- Aluminum

Figure: 12 v Battery

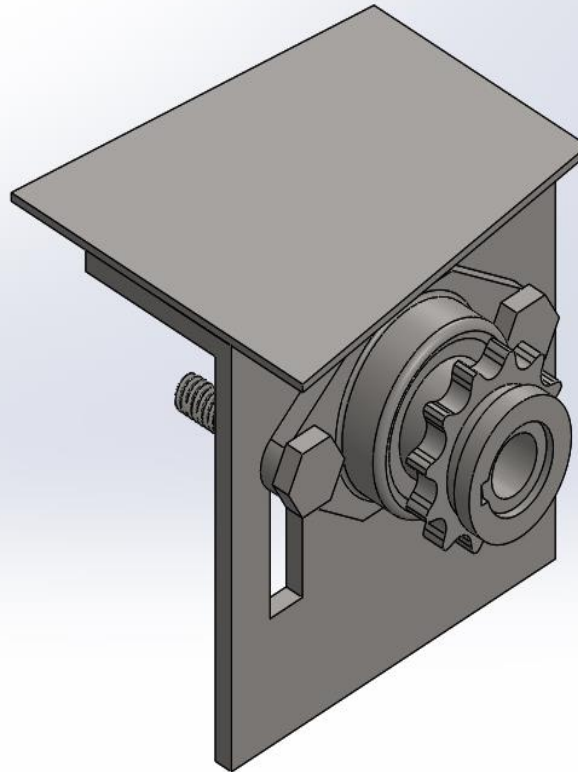
- 12v 18ah battery
- 20 ga wire
- 12v 10 amp rocker switches

Chain Tensioner

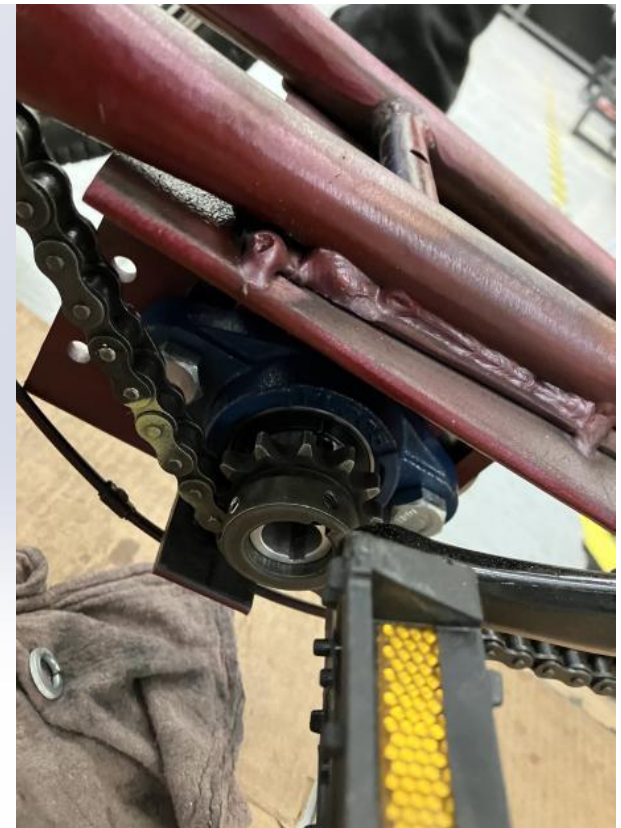
Prototype



Final Concept



Final



Vehicle Testing



- Optimal chain tension
- Brakes adjusted
- Leak test
- Accumulator Precharge
 - Charged to 500 psi
 - System charged to 1700 psi
 - Distance Traveled 1049 ft

Efficiency calculation:

$$E = (280\text{lb} * 12588 \text{ in}) / (500 \text{ psi} * 231 \text{ in}^3)$$

$$E = 30.516$$

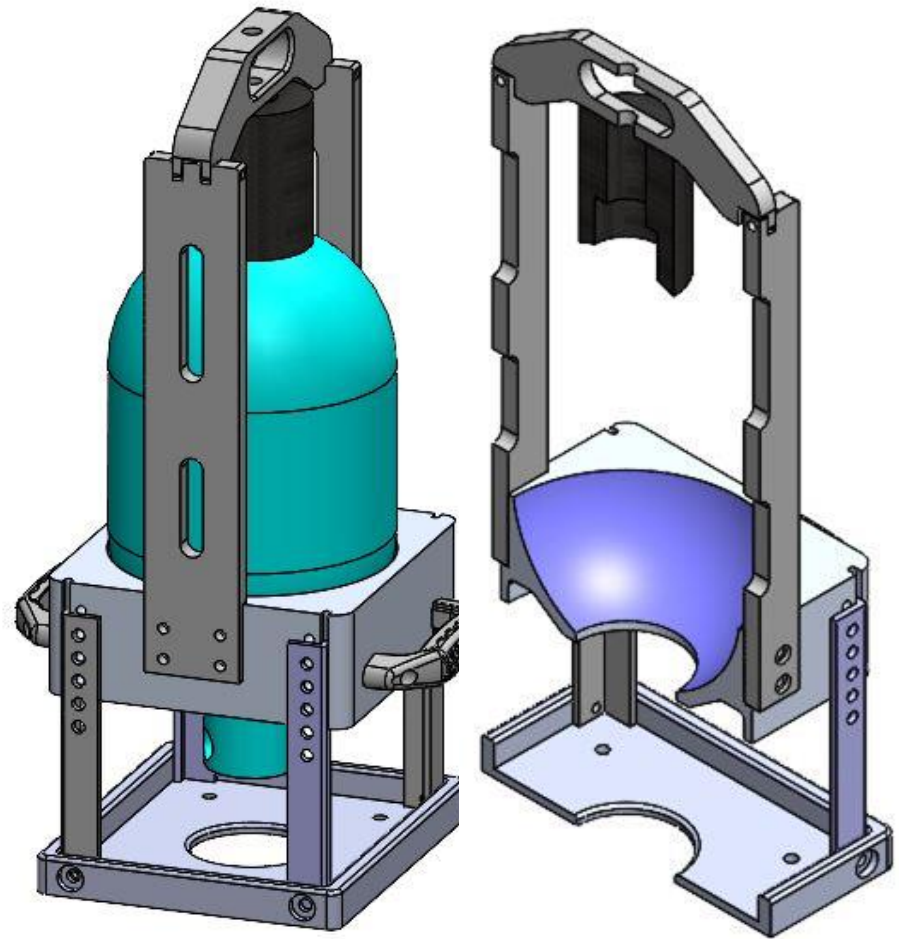


Lessons Learned

- Order components well in advanced
- Do not release Accumulator Nitrogen below 50 psi or charge up to max. rated psi
- Design for simplicity and functionality
- Test as early as possible
- Right Hand Rule
- Welding takes practice

Future considerations

- Accumulator holder to improve safety
- The force of impact is reduced by the damper, which dissipates the force on the bottle over a longer time period. Reduces the amount of force that is seen by the accumulator.
- Adjustable mounting configurations for future teams designs
- Ensures safety of the riders as future fluid powered vehicle design get faster



Questions?

