NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION
Iowa State University
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Team Introductions

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Overview

- Vehicle Construction
  - Component Design
- Final Vehicle
- Hydraulic & Pneumatic Circuits
- Bike Changes & Improvements
- Electronic Controls & Instrumentation
- Lessons Learned

Failure Investigation

- Last year we suspected one or more components failed during the competition.
- Micro Pump, 2.8cc motor, reservoir design

Goals

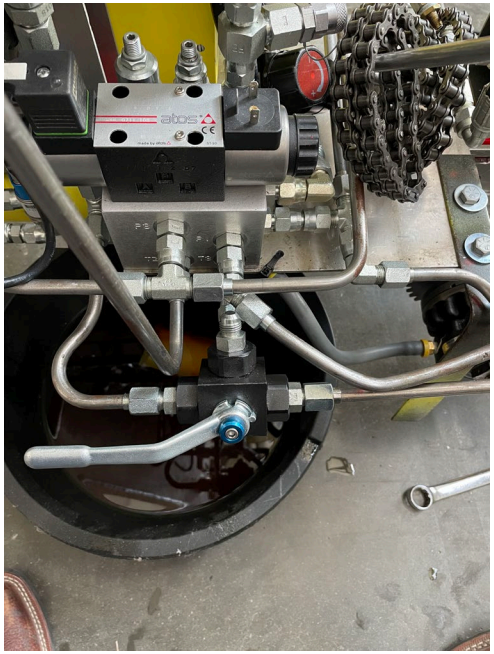
- Minimize Pressure Losses
  - Change size and orientation of solenoids
- Maximize Direct Drive Efficiency
  - Resize human input pump
  - Replace the large chain reduction with a gear box for better packaging.
- Finish on the Podium in the Competition
  - Finish first in efficiency test
  - Finish in top three in regen and sprint test

Design Choices

- Design of new frame
  - Use extruded aluminum T-Slot channel framing | 80/20 brand
  - Enhanced rigidity where it was needed to maintain chain alignment
  - Redesign the fluid revisor and reintroduce a seat to the frame
  - Transfer several components from old frame to new frame
- Design of New Circuit
  - Use of 4 2/2 normally closed DCV's in parallel
  - Increase available flow rate to reduce pressure drop
- Design of New Gear Box
  - 1:19.75 Gearbox ratio
  - 1:82 Overall ratio

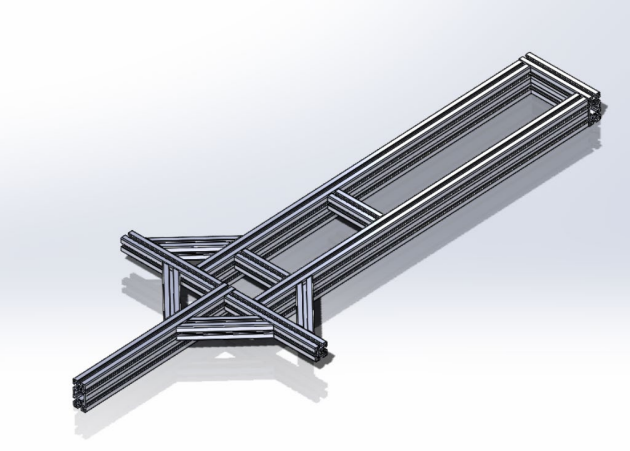
Testing

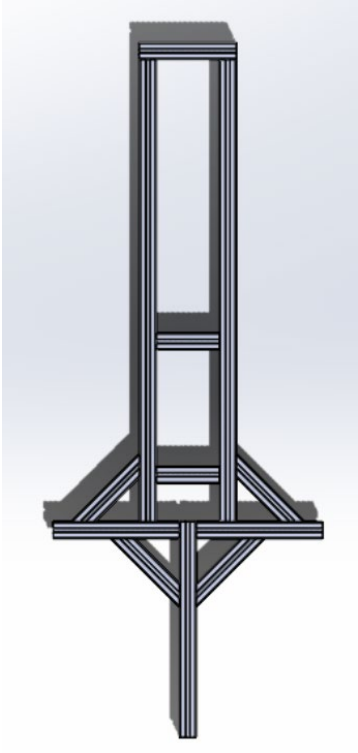
- Disassembled 0.3cc/rev micro pump
- Tested micro pump with the old reservoir
- Straight lined directly connected to 2.8cc/rev motor



Vehicle Construction

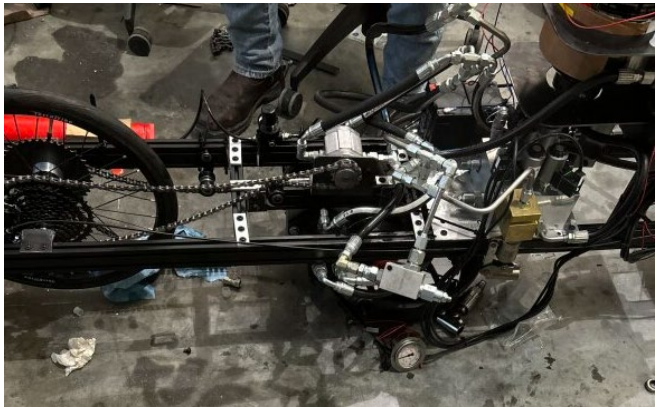
New Frame Design



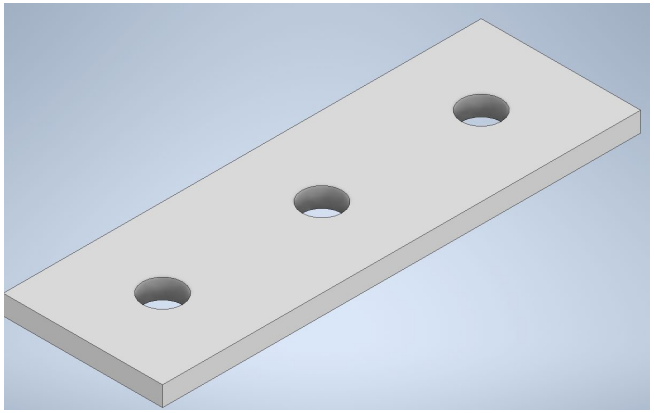


- Members made of 45x90 and 45x45 extruded aluminum
- Makes for easy placement and chain alignment

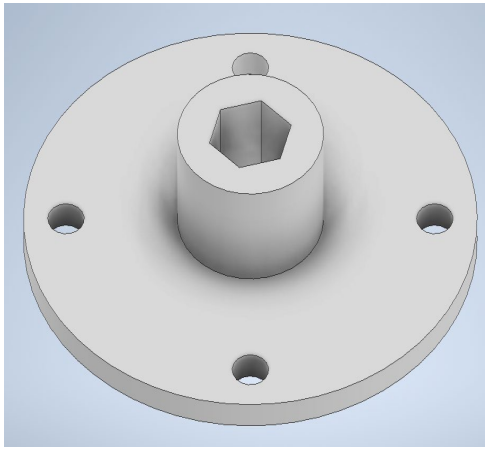
Construction in progress



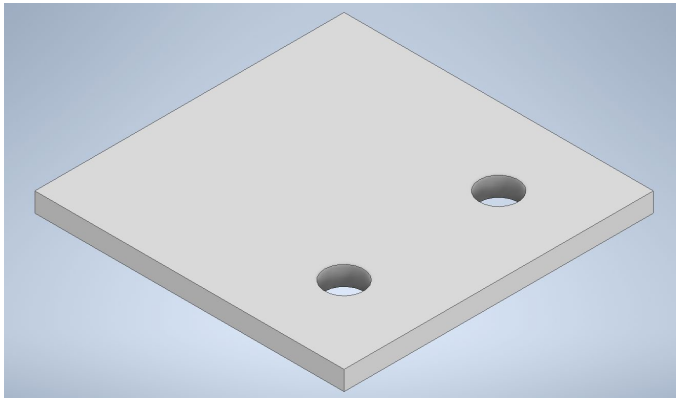
Designed Components



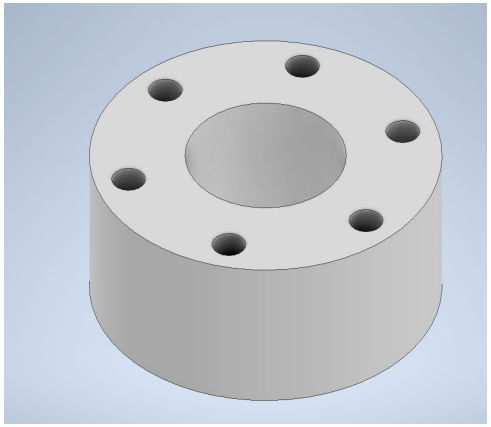
80-20 Bracket



Bike Sprocket Adapter

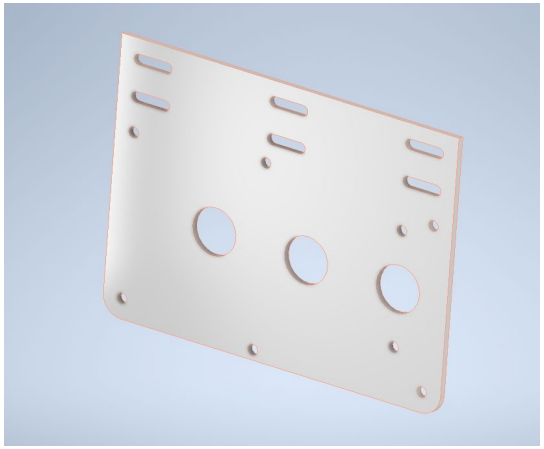


Back Tire Bracket

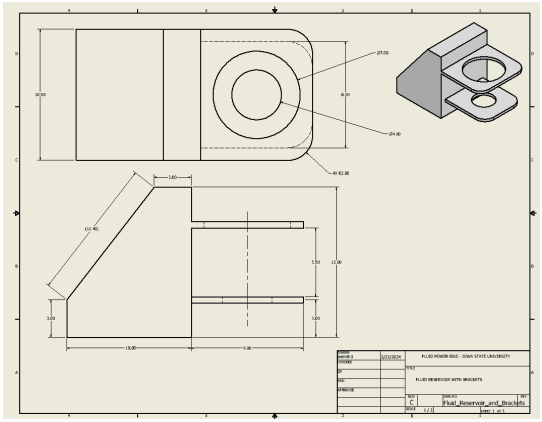


Axle Spacer

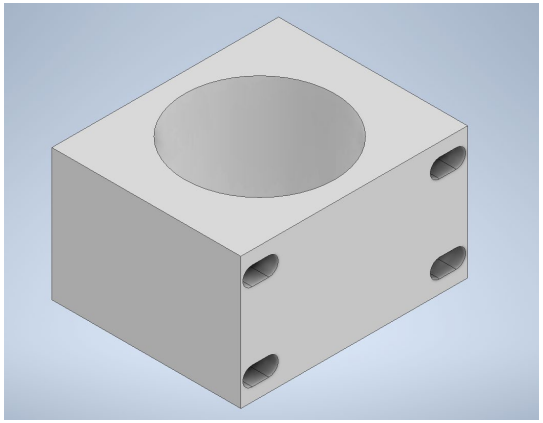
Designed Components



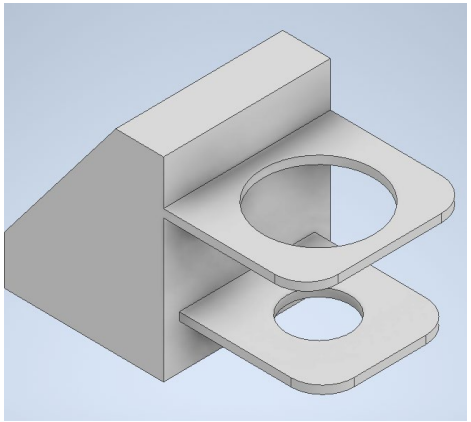
Gearbox – Final Side 1/8th" thick steel. Dimensions are 6.75 x 9 inches



Fluid Reservoir DWG



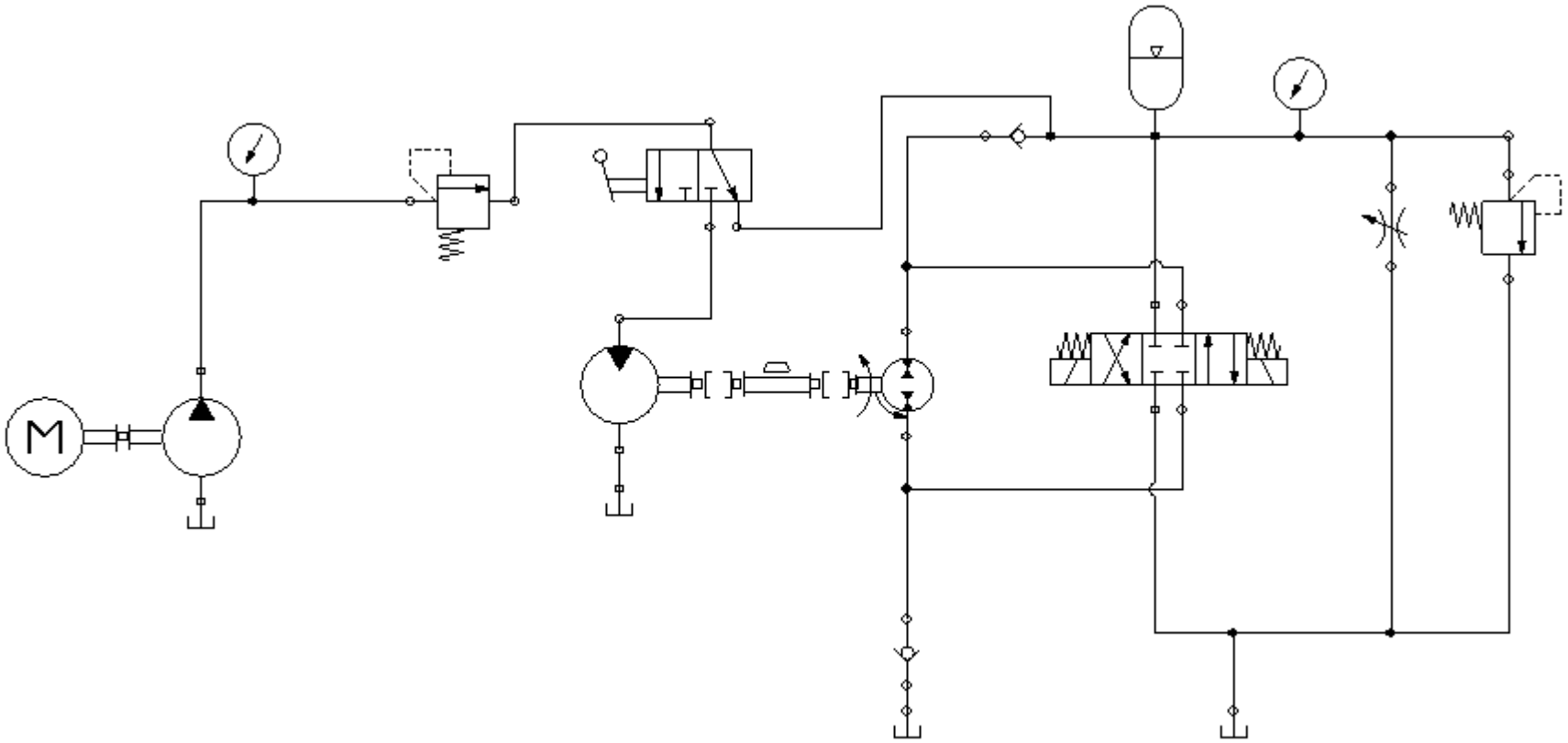
Pump Mount



Fluid Reservoir and Bracket. (Initial thought)

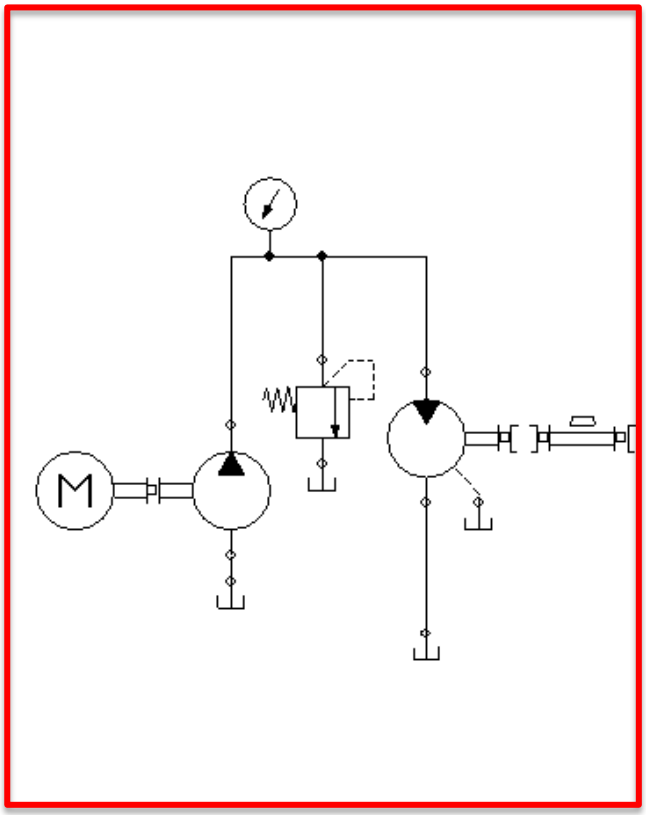
Current Vehicle State

Previous Hydraulic Circuit

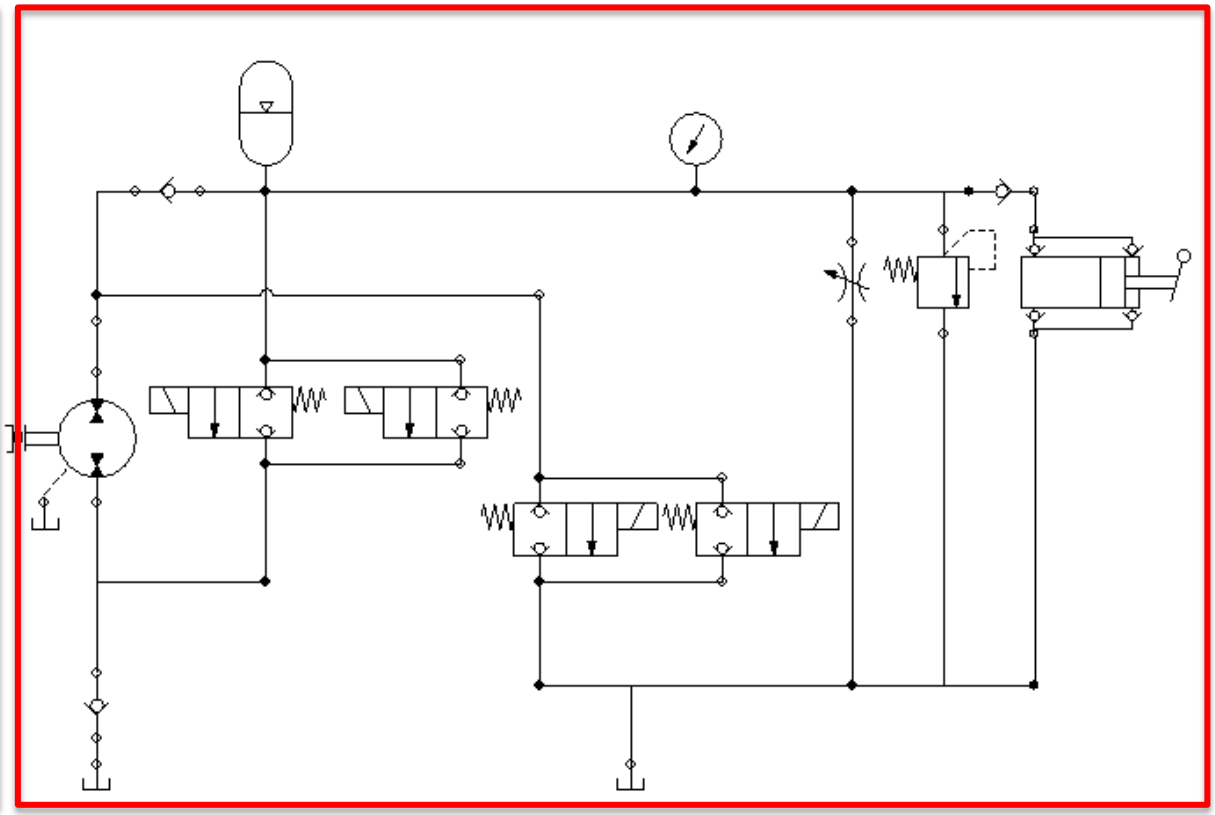


Current Hydraulic Circuit

Pedal Circuit

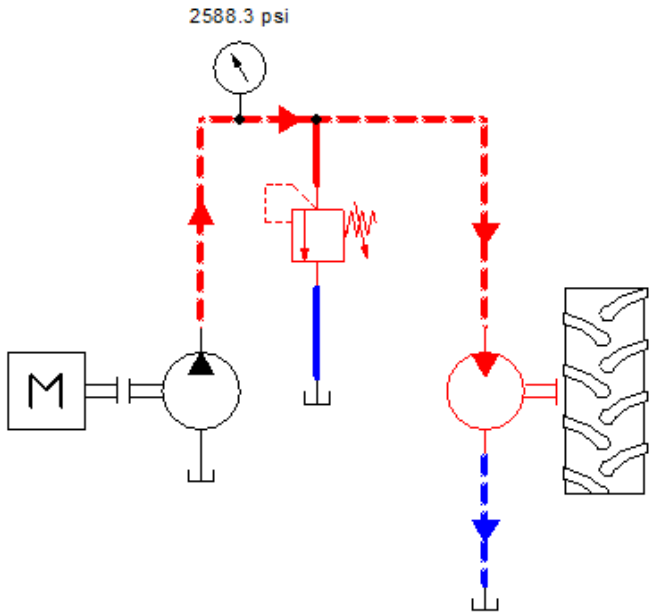


Accumulator and Regen Circuit

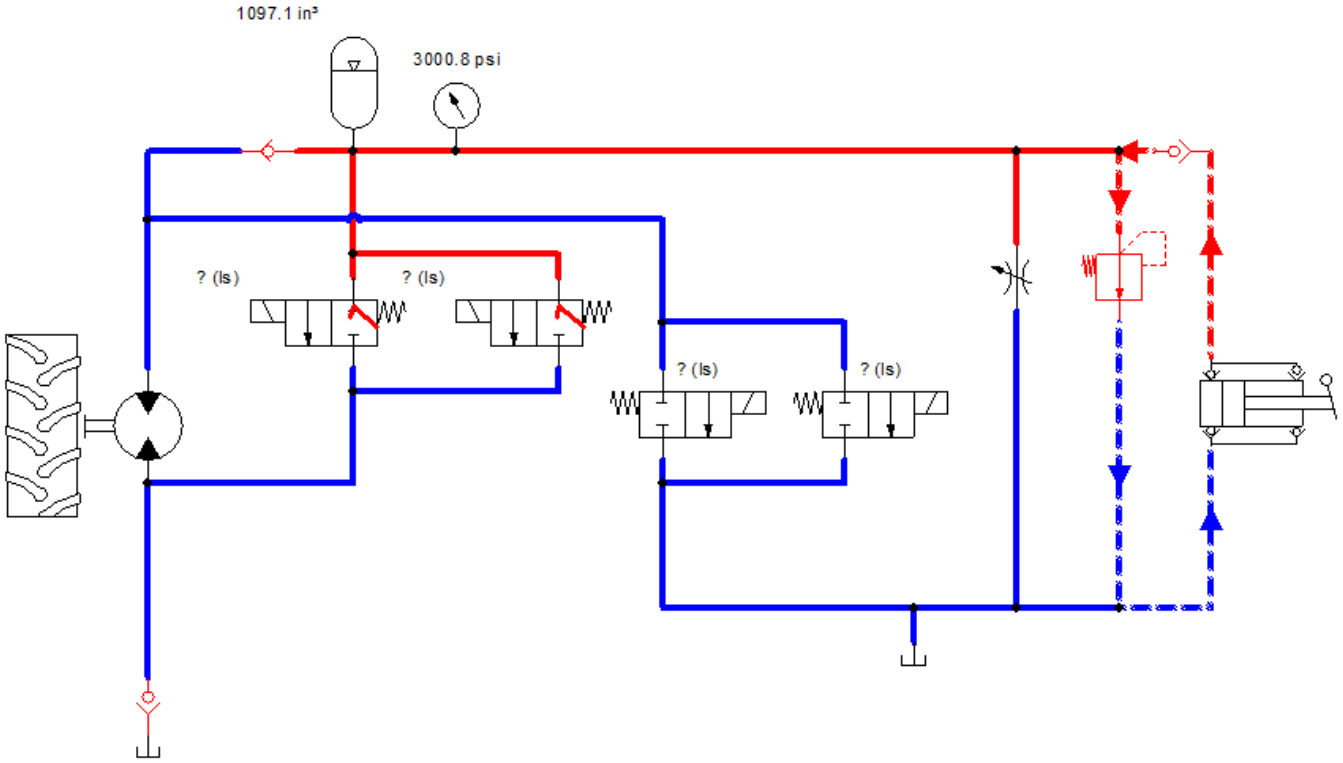


- Improvements: One 4/3 DVC replaced with 4 2/2 DCV in parallel
- Manual valve taken out of circuit
- Added hand pump

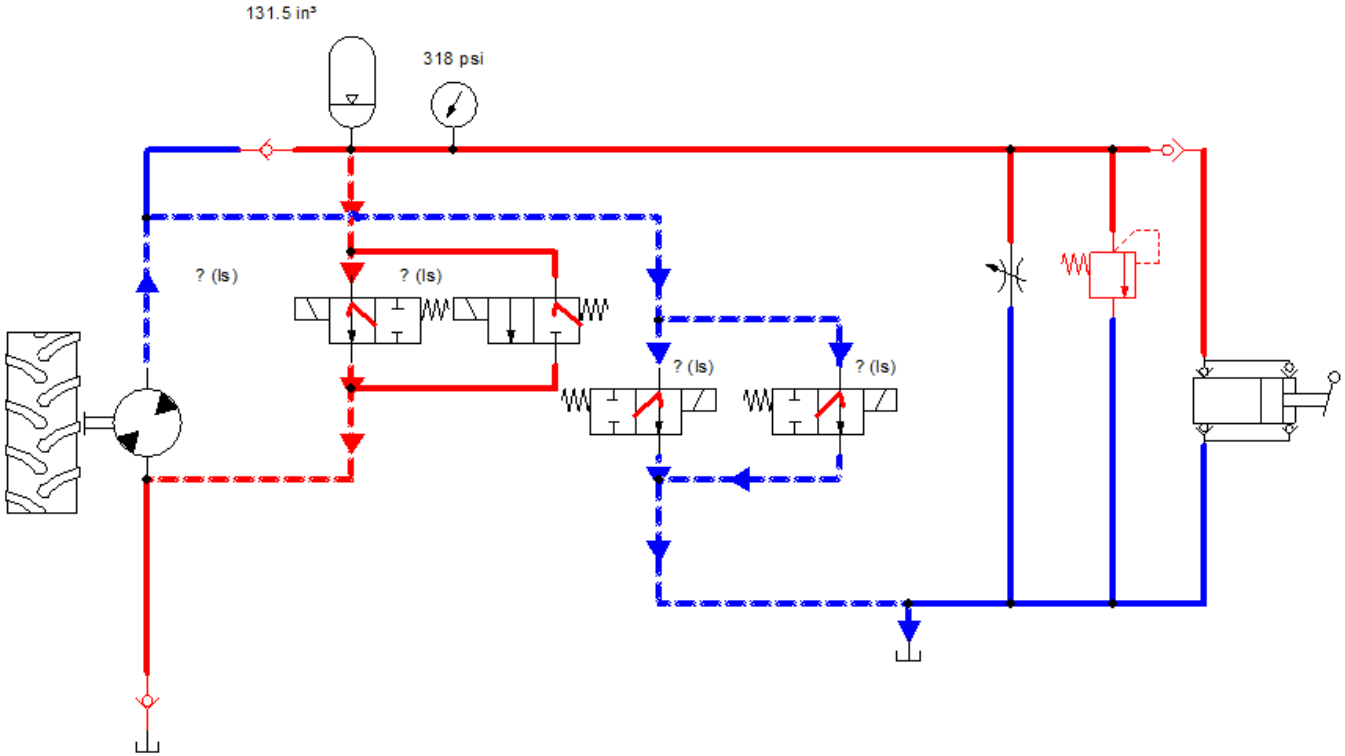
Pedal Power



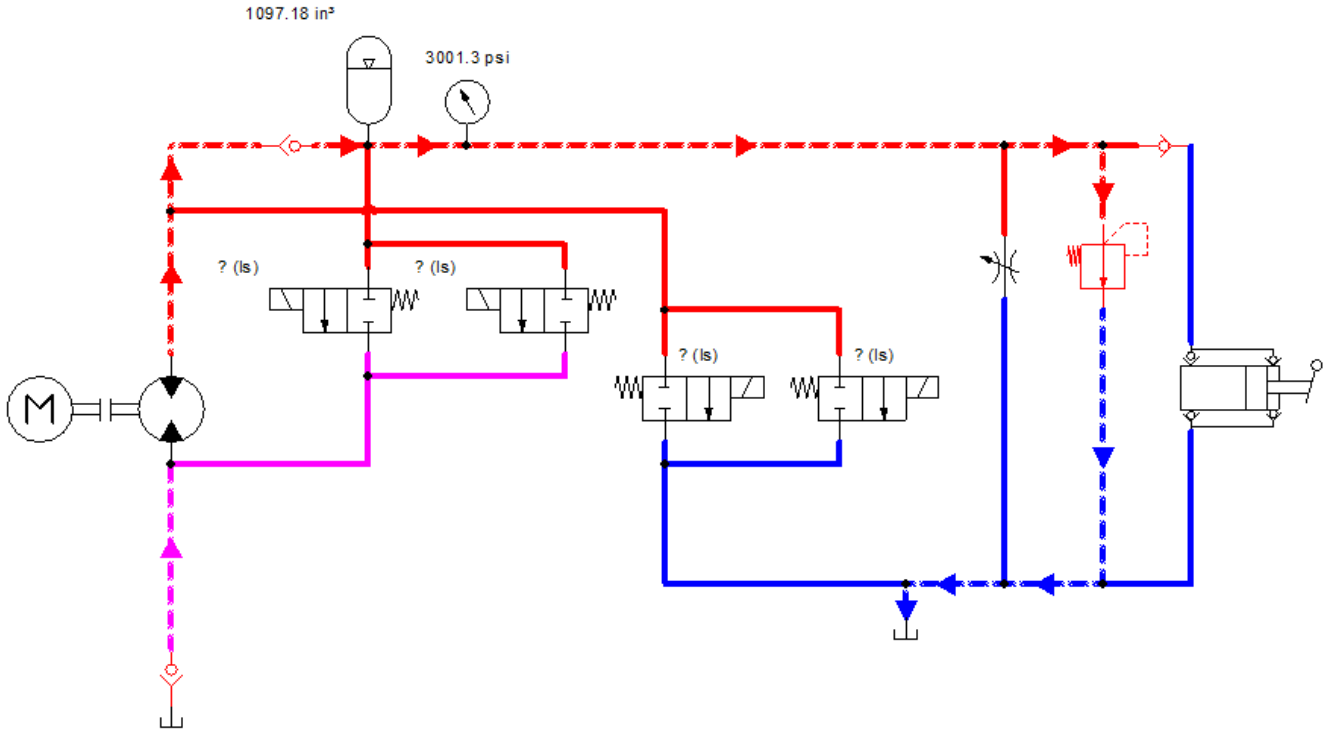
Accumulator Pressurization



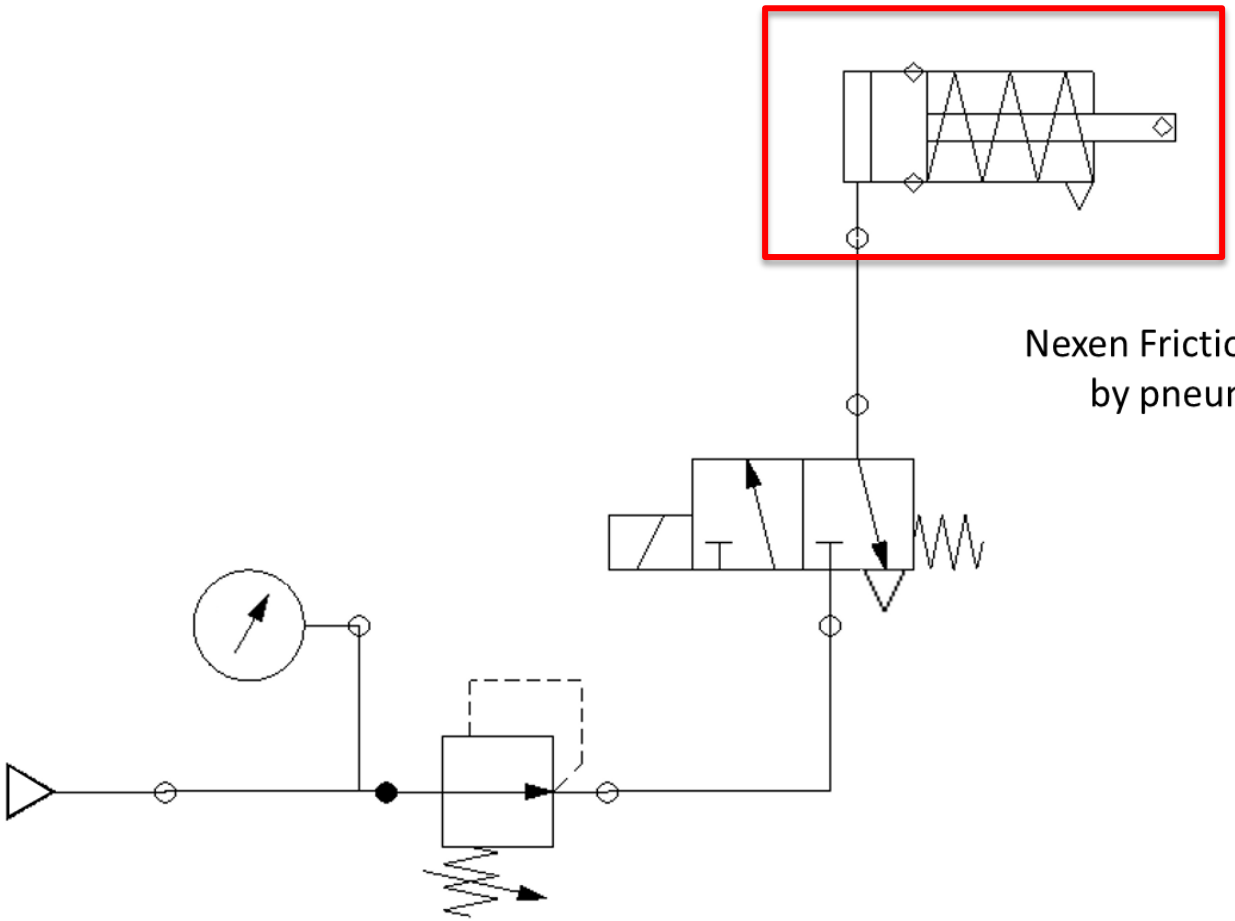
Accumulator Power



Regen Power



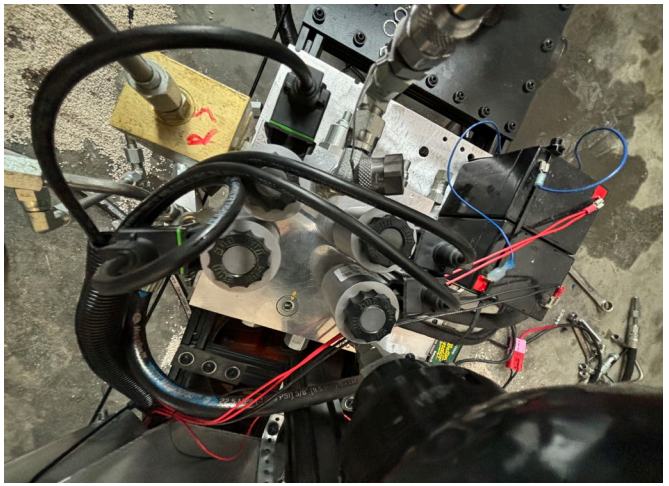
Pneumatic Circuit



Nexen Friction Clutch actuated by pneumatic pressure

Electronics

- 2 – 12-volt interstate batteries (total 24 volt) powering four solenoids above the manifold connected by switches in the front of the bike.
- Our original plan was to utilize the controller from previous team designs but have faced issues with software and time constraints. The use of the switches achieved the same goal with a simpler approach.



Hardware Selection

Description	Company	Part Number	QTY	Comments
T-Slotted Framing Fasteners	McMaster-Carr	3136N405	13	pack of 4 ea.; nuts & screws
1/4-20 3/8" thread button head screws	McMaster-Carr	91355A080	1	pack of 25
High-strength steel hex head screws	McMaster-Carr	92620A542	1	1/4-20 1" (pack of 100)
High-strength steel hex head screws	McMaster-Carr	92620A550	5	same as above - 2" long; pack of 10
High-strength steel hex head screws	McMaster-Carr	92620A552	5	same as above - 2.5" long; pack of 10
High-strength steel hex head screws	McMaster-Carr	92620A553	25	same as above - 3" long; pack of 1 only
High-strength steel hex head screws	McMaster-Carr	92620A555	25	same as above - 4" long; pack of 1 only
T-Slotted Extended Corner Bracket	McMaster-Carr	47065T239	10	1 ea. ; 3" long 1" high
T-Slotted Extended Straight Bracket	McMaster-Carr	47065T259	10	4" long 1" high - pack of 1
T-Slotted Straight Bracket	McMaster-Carr	47065T255	10	2" long 1" high - pack of 1
Unthreaded spacers	McMaster-Carr	92510A398	10	1/16"
Unthreaded spacers	McMaster-Carr	92510A760	10	1/8" length
Unthreaded spacers	McMaster-Carr	92510A762	10	1/4" length
Unthreaded spacers	McMaster-Carr	92510A765	10	1/2"
Unthreaded spacers	McMaster-Carr	92510A767	10	3/4"
Unthreaded spacers	McMaster-Carr	92510A769	10	1"
High-strength steel hex head screws	McMaster-Carr	92620A633	2	Pack of 10; 2.25" length; 3/8"-16
Steel alloy round tube	McMaster-Carr	89955K159	5	3' length
nylon insert locknut	McMaster-Carr	97135A230	1	Pack of 20; 1/4"-20
nylon insert locknut	McMaster-Carr	97135A210	6	pack of 25; 1/4"-20
Uncoated High-Speed Steel General Purpose Tap	McMaster-Carr	2521A572	1	1 ea. ; Taper Chamfer, 5/16"-18 Thread Size, 1-1/8" Thread Length
Uncoated High-Speed Steel General Purpose Tap	McMaster-Carr	2521A642	1	1 ea. ; Bottoming Chamfer, 5/16"-18 Thread Size, 1-1/8" Thread Length
Uncoated High-Speed Steel General Purpose Tap	McMaster-Carr	2521A573	1	1 ea. ; Taper Chamfer, 3/8"-16 Thread Size, 1-1/4" Thread Length
Uncoated High-Speed Steel General Purpose Tap	McMaster-Carr	2521A643	1	1 ea. ; Bottoming Chamfer, 3/8"-16 Thread Size, 1-1/4" Thread Length

Lessons Learned

- Long lead times for components
- Chain alignment and hardware must be precise
- Utilize knowledge of industry professionals
  - Establishing mentors
  - Fostering relationships
- Setting deadlines is essential
  - Planned worktimes and meetings
- Communication with group members and mentors is important

NFPA Fluid Power Vehicle Challenge

Thank you!