NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION
Montana State University
Keith Fisher
4/11/19

MONTANA STATE BOBCATS

Presentation Outline

Introduction

From left to right: Nathan Neal, Jake Smith, Sophia Winfrey

Project Statement

The Montana State University student team will create a fluid powered vehicle that will be able to compete in the NFPA Fluid Power Vehicle Challenge.

Design Objectives

Simple but effective design

Vehicle can be easily controlled by one rider

Create a safe and reliable design

Utilize efficient components

Compact

Target Specifications

Sprint Race

- Accelerate at a variable rate to 13 MPH

Efficiency Challenge

- Discharge to a distance greater than 100 ft
- Controlled release of stored energy

Endurance Race

- Safely complete entire endurance course without needing any repair during the event
- Use regenerative braking system to completely stop bike at least once during race

Design Process

Research

- Past teams
- Hydraulic systems

Alternatives

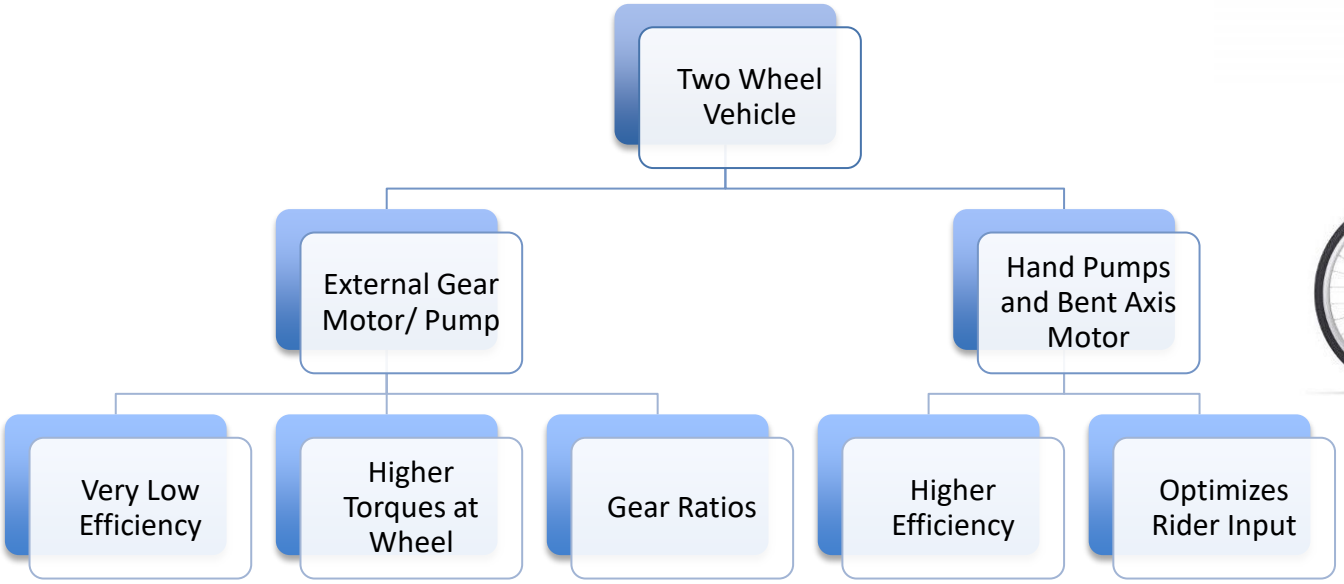


Photo of Vehicle

Selection of Hardware

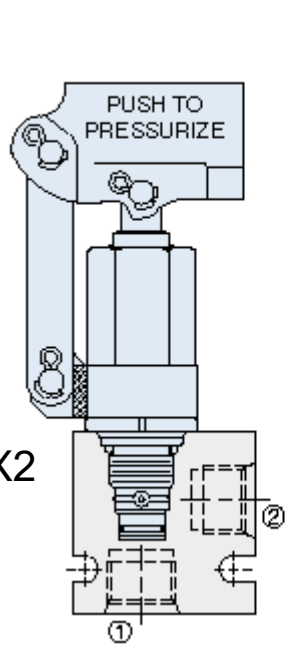
Accumulator Inc.
- 1 pint
- 1 quart

Eaton In-line Axis Motor
- Displacement 2.01 cu in. per rev

HydraForce Handpumps
- Displacement 1.3 cu in. per stroke X2

Controls
- Electrical solenoid Controller
- Proportional control Valve (throttle)
- Directional Control valve (switches)

Manifold
- HydraForce



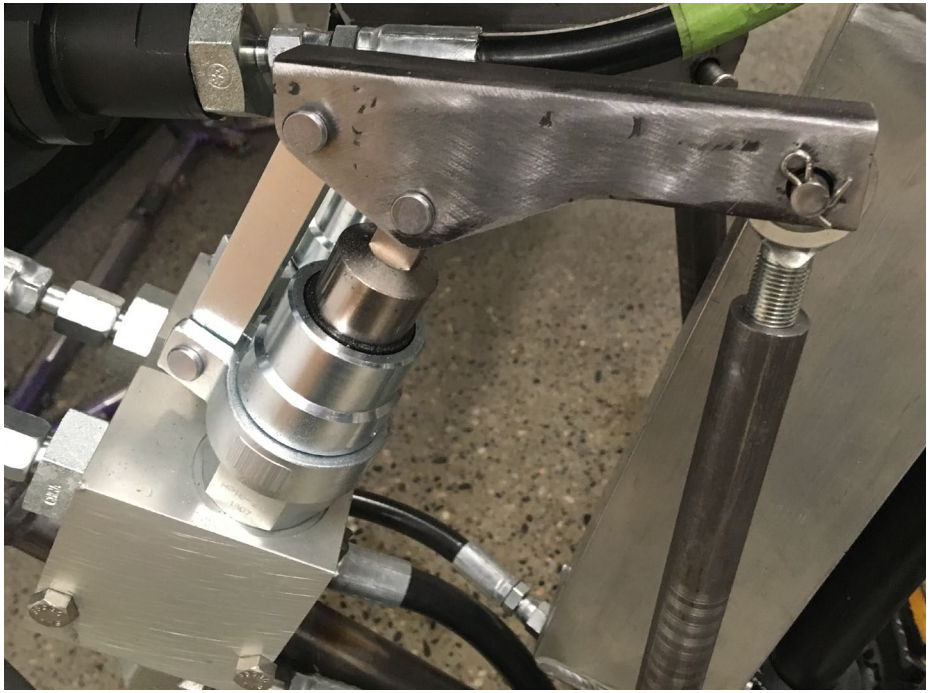
Hand Pumps

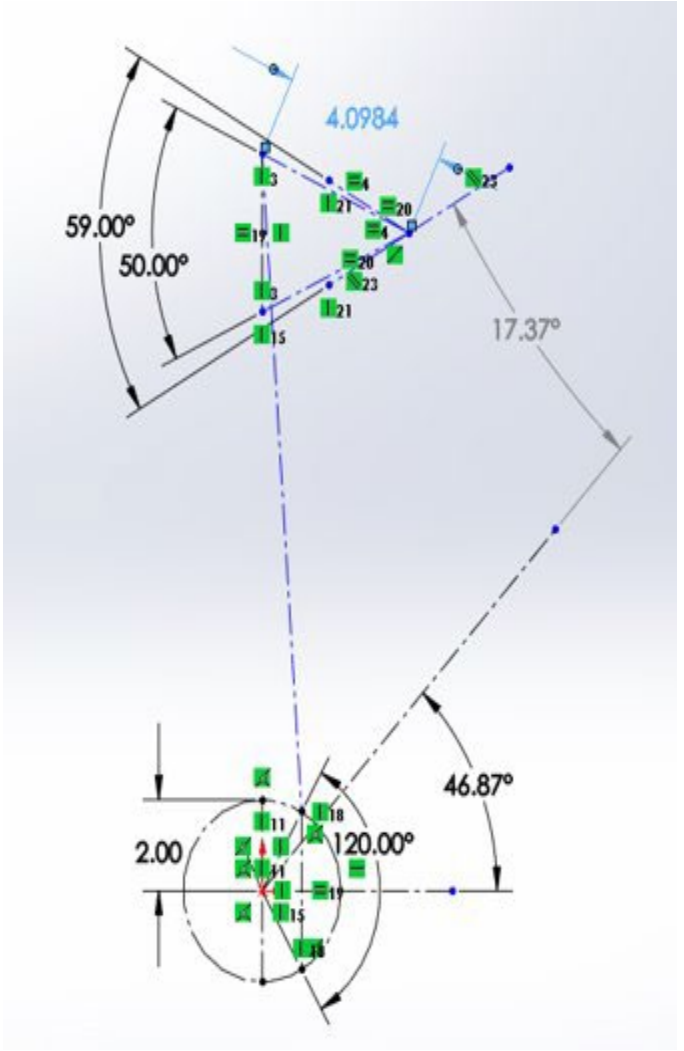
Increased Efficiency

Continuous

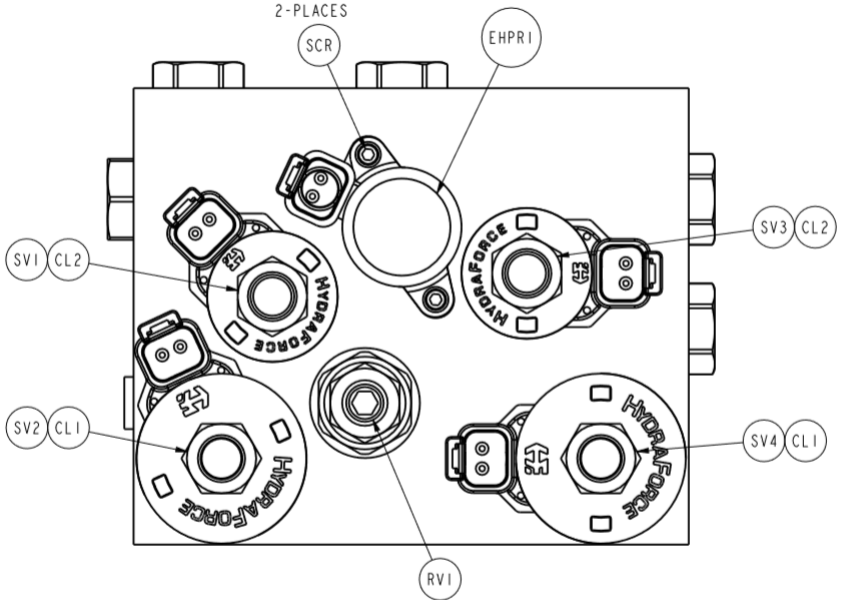
Adjustable

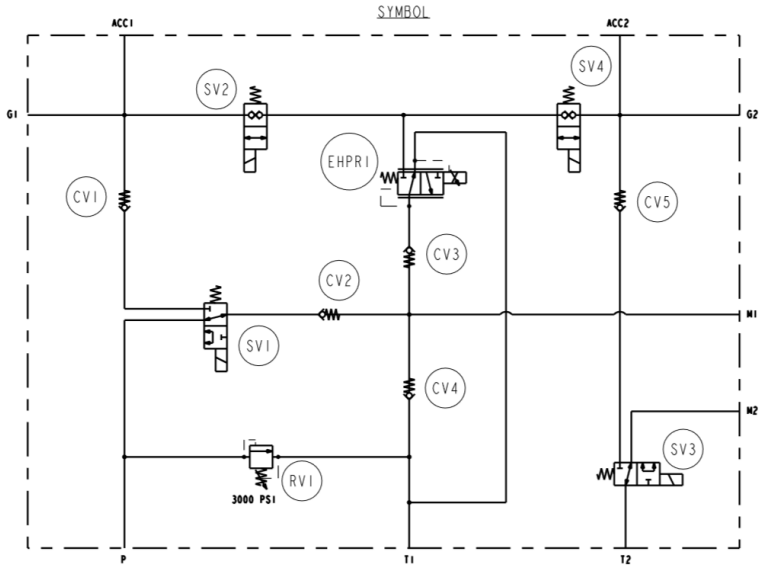
Innovative

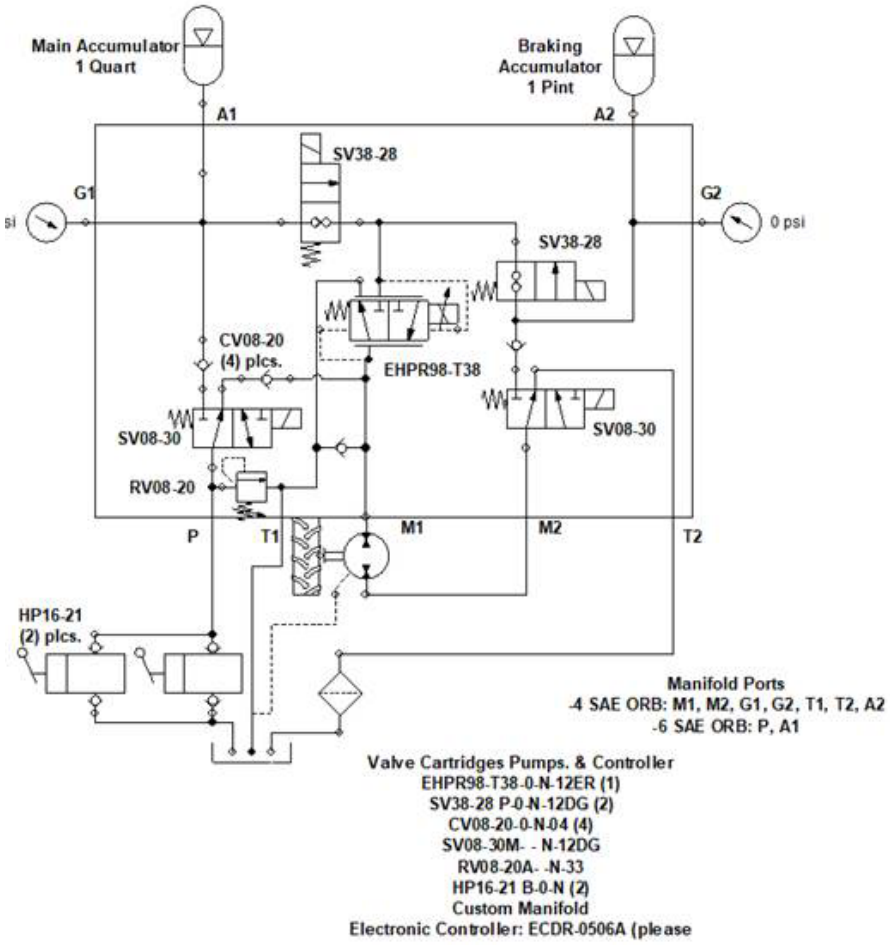




Manifold


2-PLACES
SCR
EHPR1
SV1
CL2
SV3
CL2
SV2
CL1
SV4
CL1
RV1
HYDRAFORCE


SYMBOL
ACC1
ACC2
SV2
SV4
G1
G2
EHPR1
CV1
CV5
CV3
CV2
M1
SV1
CV4
M2
SV3
RV1
3000 PSI
P
T1
T2

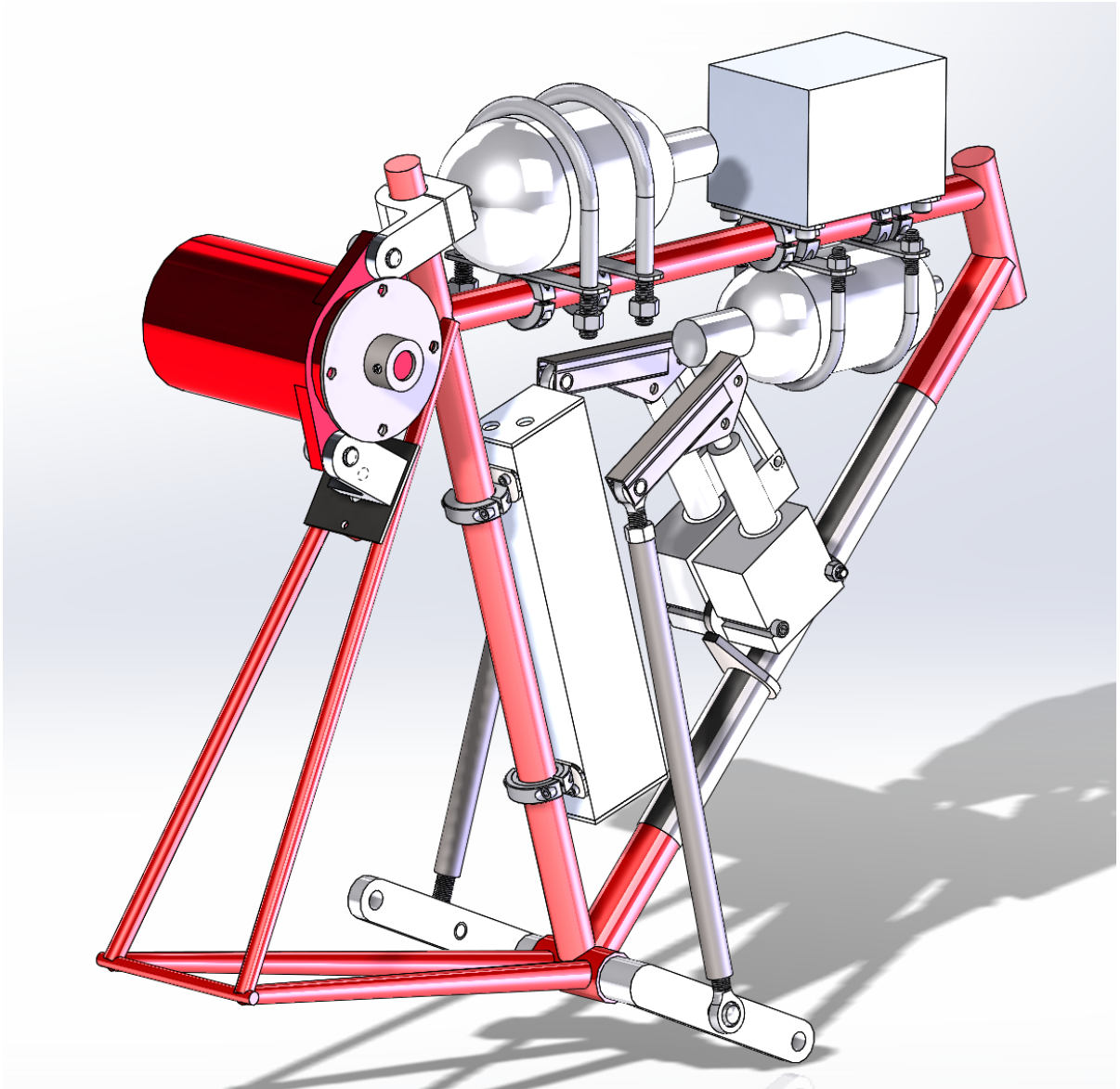

Main Accumulator
1 Quart
Braking
Accumulator
1 Pint
A1
A2
SV38-28
G1
G2
si
0 psi
SV38-28
CV08-20
(4) plcs.
EHPR98-T38
SV08-30
SV08-30
RV08-20
P
T1
M1
M2
T2
HP16-21
(2) plcs.
Manifold Ports
-4 SAE ORB: M1, M2, G1, G2, T1, T2, A2
-6 SAE ORB: P, A1
Valve Cartridges Pumps. & Controller
EHPR98-T38-0-N-12ER (1)
SV38-28 P-0-N-12DG (2)
CV08-20-0-N-04 (4)
SV08-30M- - N-12DG
RV08-20A- -N-33
HP16-21 B-0-N (2)
Custom Manifold
Electronic Controller: ECDR-0506A (please

Design Advantages

- Compact
- Easy to maneuver
- Ease of access to controls
- Braking accumulator optimized for regenerative braking
- Weight

  Estimate: 103 lbs.

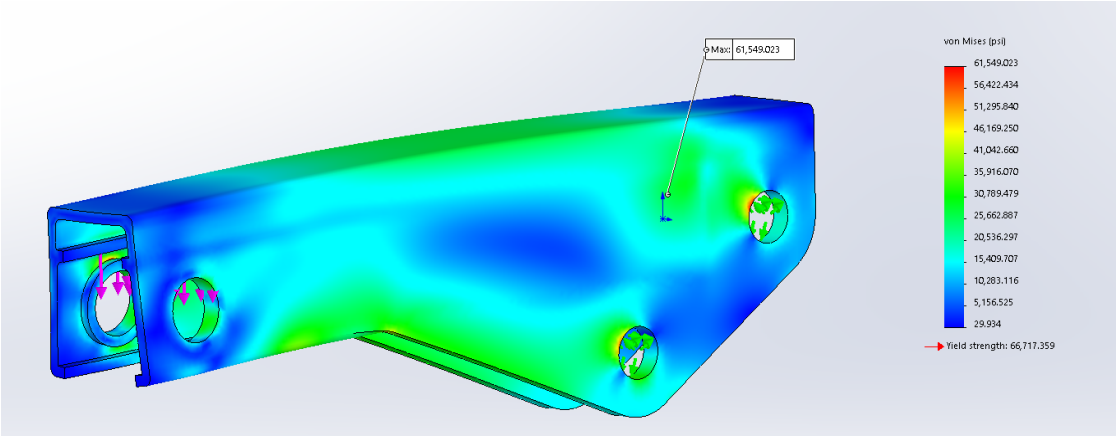
CAD Model



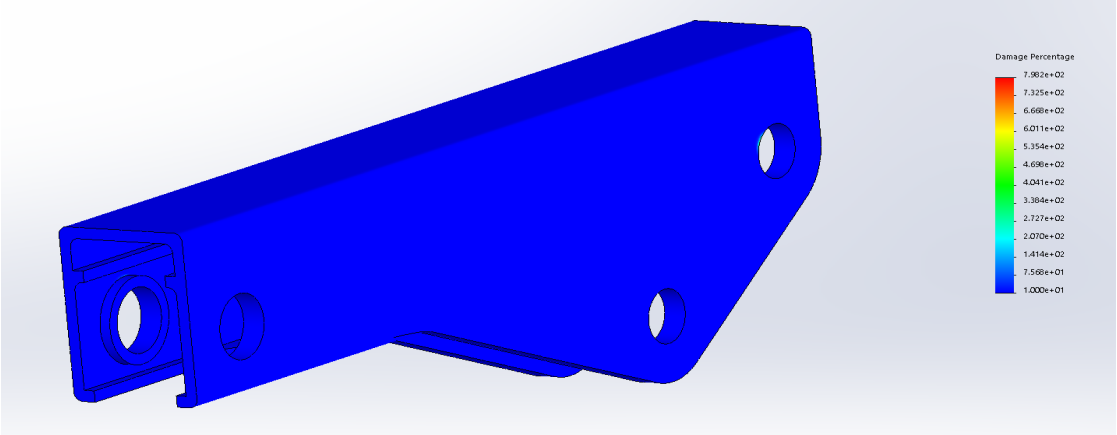
Finite Element Analysis

Hand Pumps

- Static Analysis



- Fatigue study



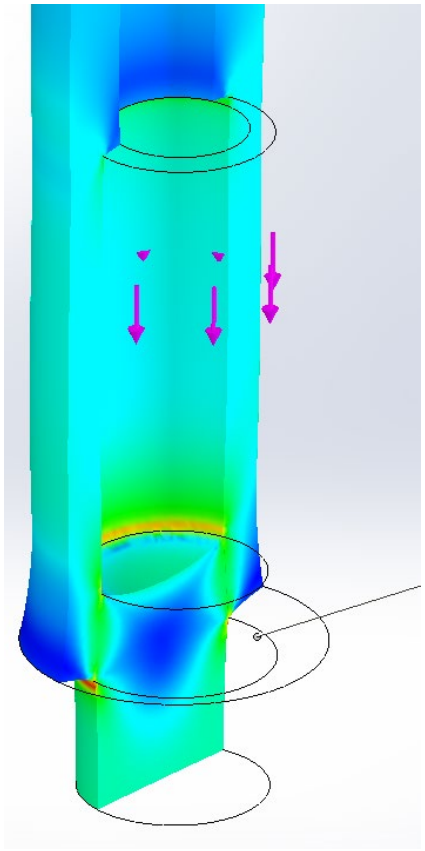
Finite Element Analysis

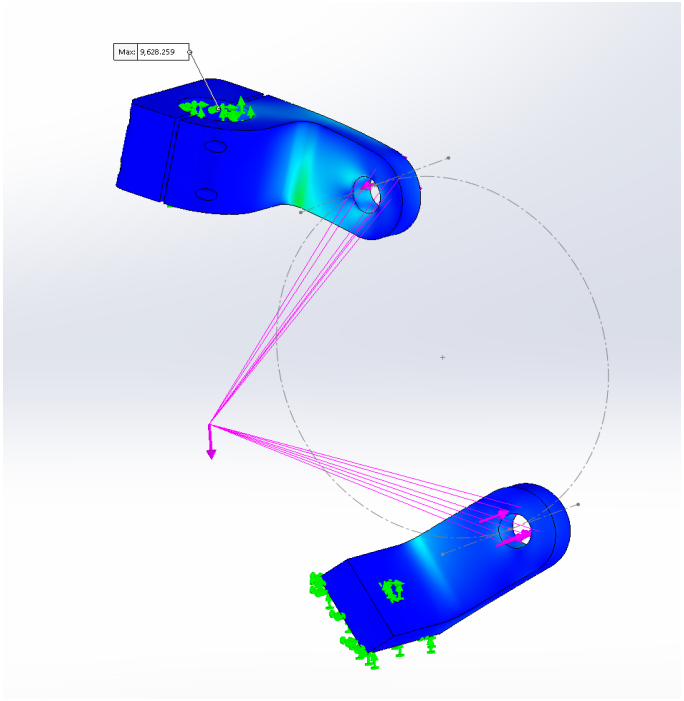
Motor Mount Assembly

- Static Analysis

Linkages

- Static Analysis

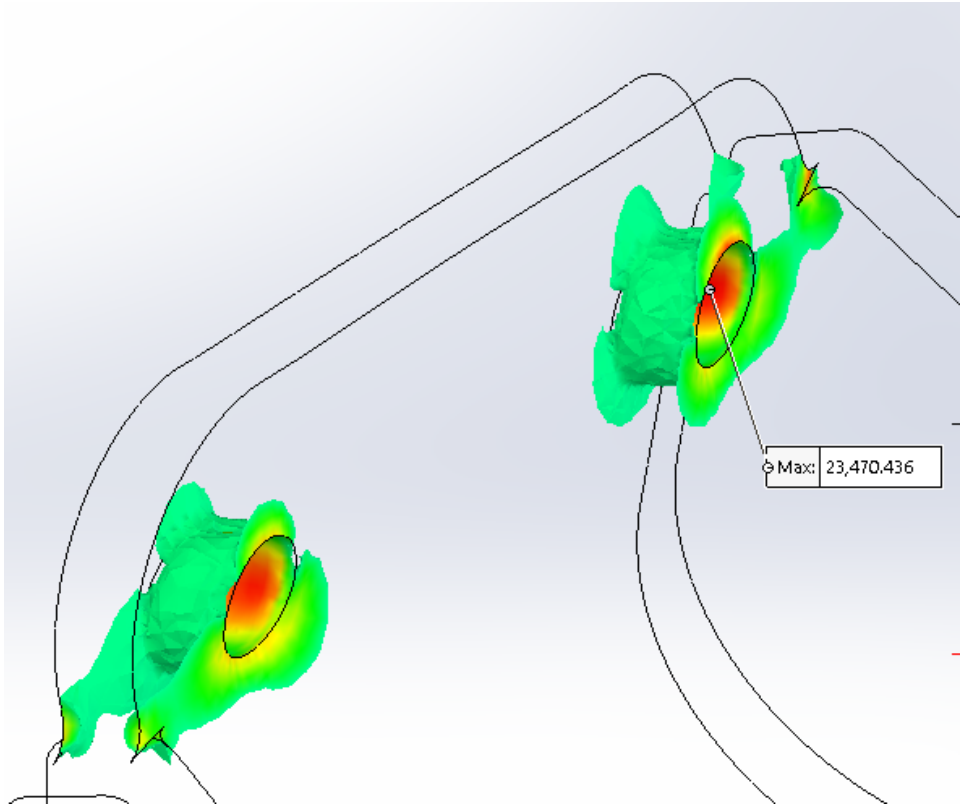


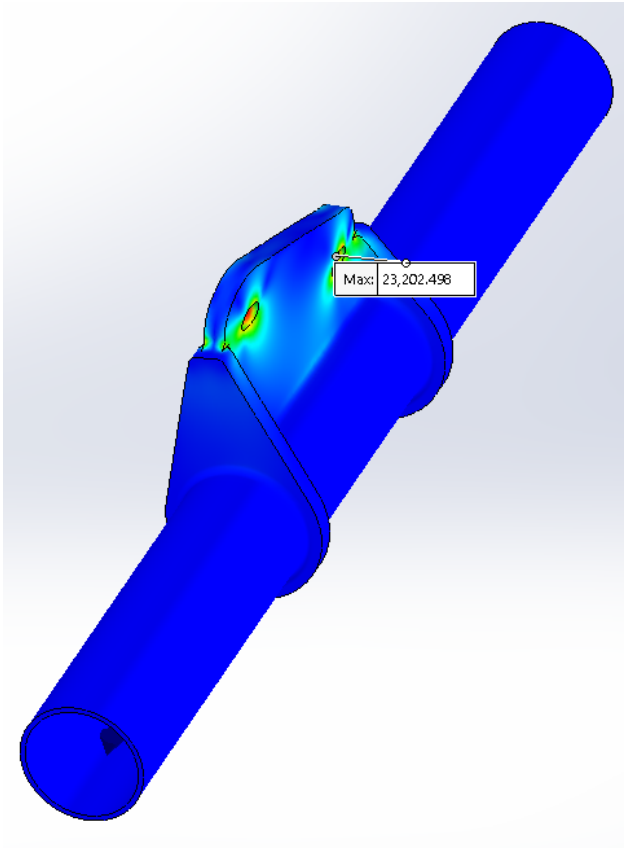


Finite Element Analysis

Pump Mount Support

- Static Analysis





Manufacturing

Fabricated over 30 individual components

Processes:

- Milling
- Turning
- CNC
- Welding

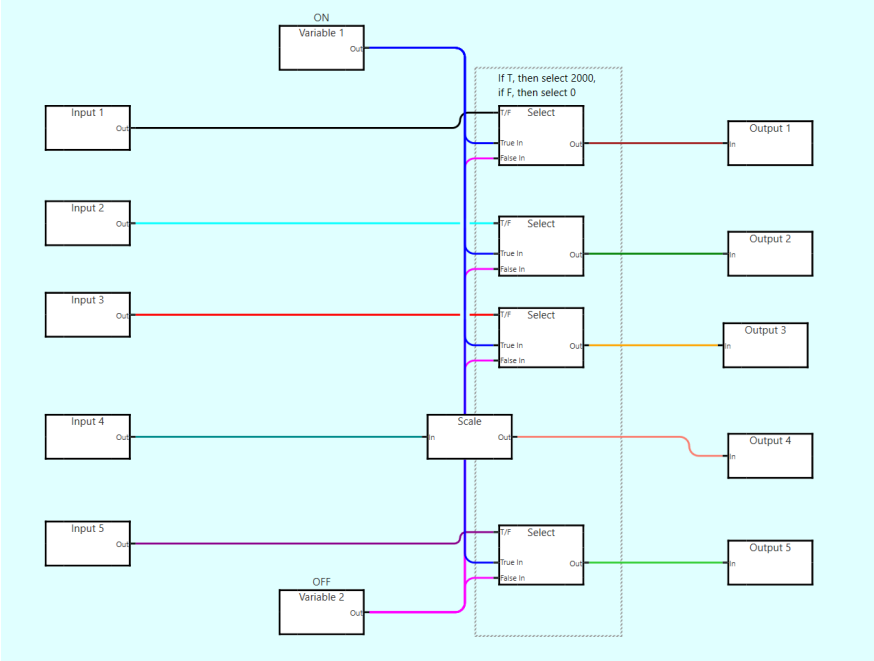
Controls

Electrical solenoid Controller

- Proportional control Valve (Throttle)
- Directional Control valve (switches)

Advantages

- Monitor inputs and outputs
- Easily switch between modes
- Handle bar access



Vehicle Testing

Electronic controls
- Monitor inputs and outputs

Tested all modes
- Direct drive
- Boost
- Regenerative Braking
- Charging

Improvements
- Increase in gear ratio
- Charging mechanism
- Linkage adjustment

Lessons Learned

Organization	Keep track of components to reduce surplus costs
Purpose built frame	Able to have better component placement and avoid interference issues
Hose management	Reduce excess hose lengths to improve system efficiency
Better time management	Extra time to make adjustments and optimize system

Acknowledgments

- A special thanks to our mentors at HydraForce Dave, Jim, and Travis.

Questions?