

10 YEARS
N F P A
Fluid Power
=VEHICLE
Challenge



NFPA
Education and
Technology
Foundation

Final Presentation & Design Review
Michigan Technological University
David Wanless
04/08/20



Michigan
Technological
University

Meet The Team



Jesse Cummings



Corey Schimmel



Aerial VanAlstine



Reuben Lind



Ethan Wu

Final Vehicle Design Comparison

Construction of our bike was completed by 03/26



Last year's design

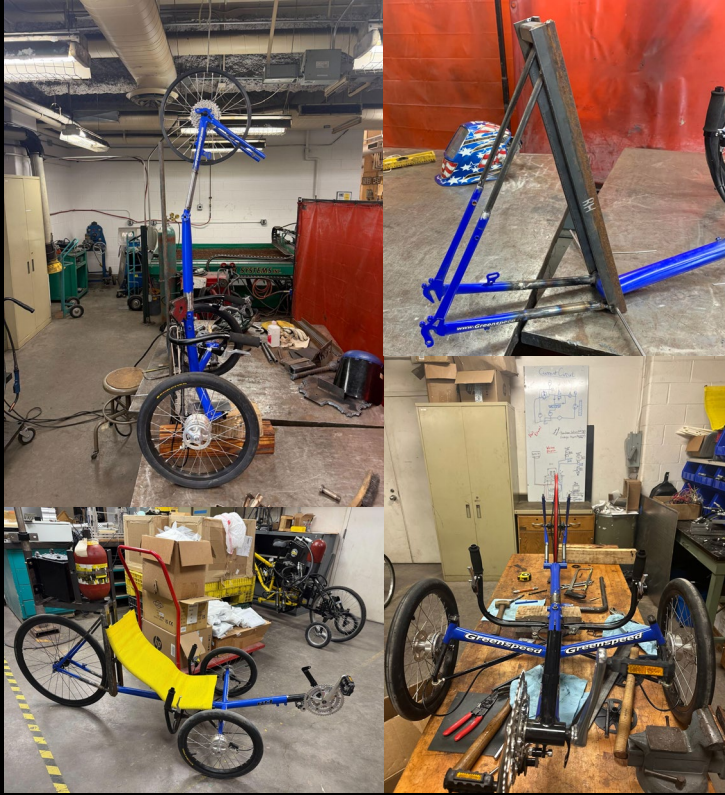


This year's design



Building The Frame

Frame Modifications



- Add in the dual sprocket hub
- Rear frame was extended to increase room for hydraulics
- Designed Frame to be ridden by all riders
- Created rear wheel rack to support accumulator and reservoir
- All manufactured in house



Circuit Design

Last Year's Circuit

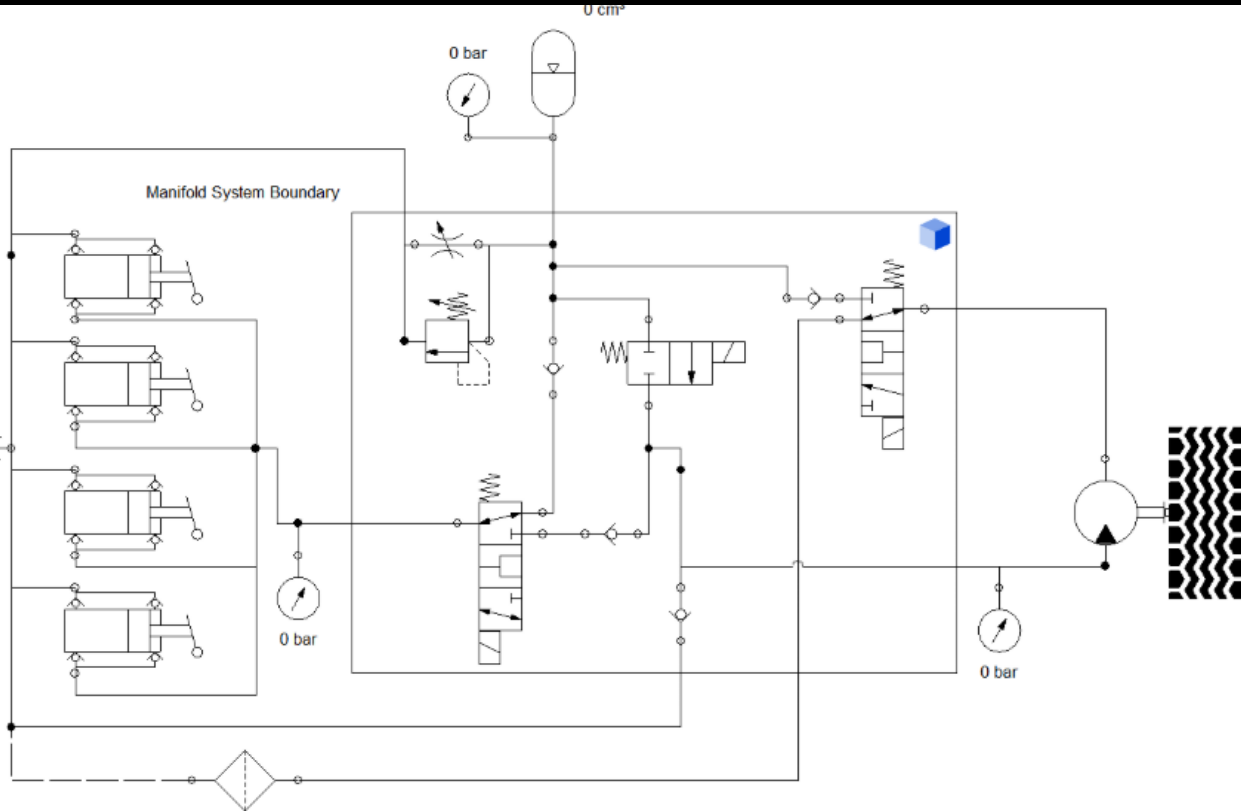


Features:

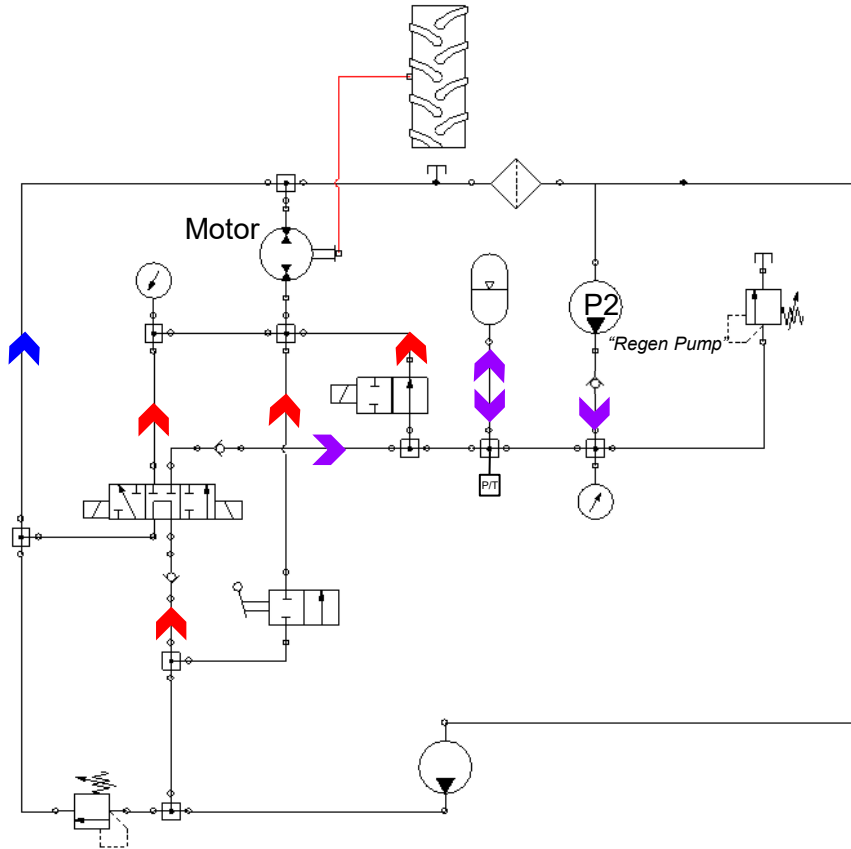
- 4 Cylinder Pumps driving gear motor.
- Gravity driven standing lever pedals

Cons:

- Rear Motor undersized for load
- Busy and Heavy



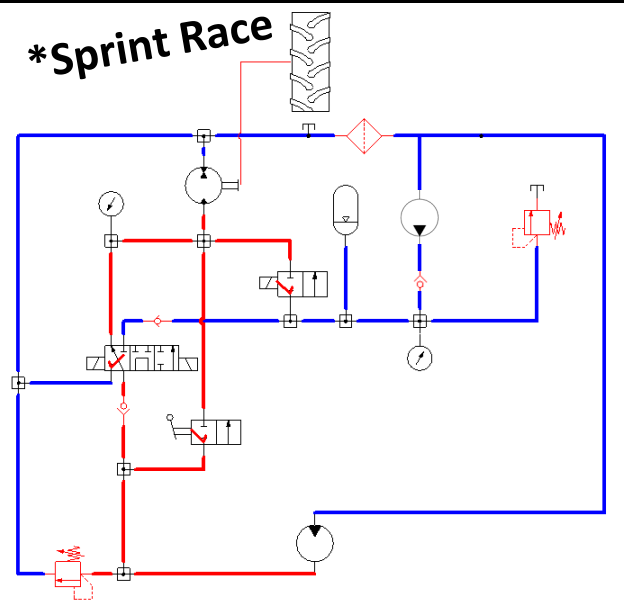
This Year's Circuit



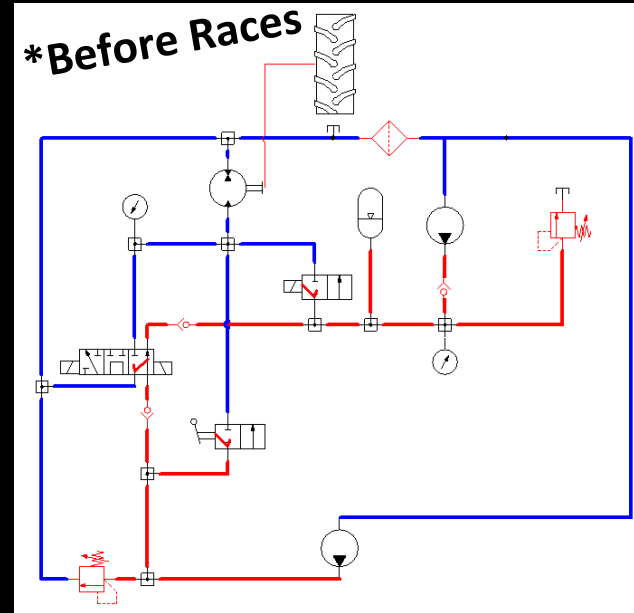
Featuring...

- Three Pedal Modes:
 - Drive
 - Neutral
 - Fill Accumulator

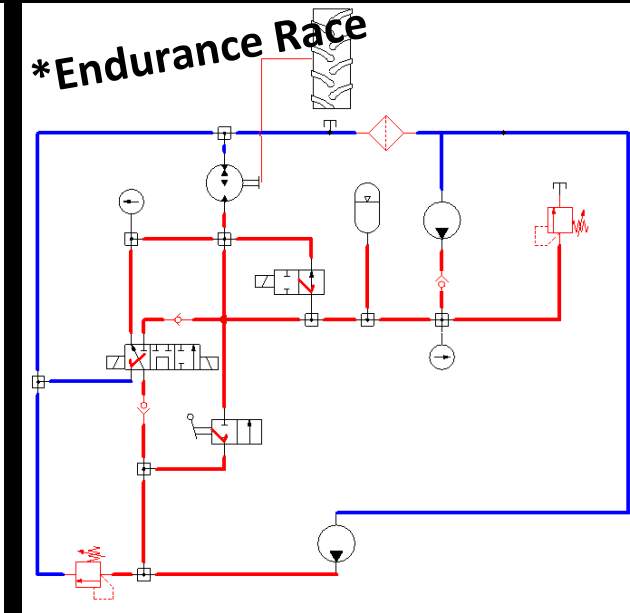
Current Year Circuit



- Direct Drive



- Charge Accumulator



- Accumulator Drive

Pump & Motor Calculations



Pre-Charge	1400 PSI	Pedal Lever Length	6.5 in
Wheel Diameter	29.5 in	Max Motor PSI	2030 PSI
Pedal RPM	60 RPM		

Pump CIR	Motor CIR	Gear Ratio (Pedal / Pump Size)	Speed Ratio (Wheel / Motor Size)	Max Pump Torque (in*lb)	Pedal Torque (in*lb)	Lbs. of Push on Pedal	Wheel RPM	Max Pedaling MPH
0.89	1.21	5 / 4.625	2.3125 / 5.3	288	311	48	109	9.60
0.89	1.21	7/ 4.625	2.3125 / 5.06	288	435	67	146	12.83
0.67	0.76	5 / 4.625	2.3125 / 5.3	217	234	36	131	11.51
0.67	0.76	7 / 4.625	2.3125 / 5.06	217	328	50	175	15.38

Regen Pump

- Higher CIR = Faster fill time
- Lower CIR = less resistance
- Used extra resistance when clutch is engaged as brake assist



Wolverine by Prince Mfg

**1.18 cu in Hydraulic
Gear Pump Wolverine
by Prince Mfg.
WPA19A2L [906935]**

Item Number: 906935

Legacy Part Number: 906935

$$P_1 V_1^n = P_2 V_2^n \rightarrow V_2 = V_1 \cdot \left(\frac{P_1}{P_2}\right)^{1/n}$$

$$V_2 = 231 \cdot \left(\frac{1500}{3000}\right)^{1/1.4} = \underline{\underline{142.1 \text{ in}^3}}$$

$$t = \frac{V \cdot 60}{D \cdot N} \rightarrow t = \frac{142.1 \cdot 60}{175 \cdot D}$$

$$D = 0.73 \quad t = \frac{8526}{175 \cdot 0.73} = \underline{\underline{66.7 \text{ sec}}}$$

$$D = 1.25 \quad t = \frac{8526}{175 \cdot 1.25} = \underline{\underline{38.976 \text{ sec}}}$$

$$D = 1.18 \quad t = \frac{8526}{175 \cdot 1.18} = \underline{\underline{41.29 \text{ sec}}}$$



Regen Circuit

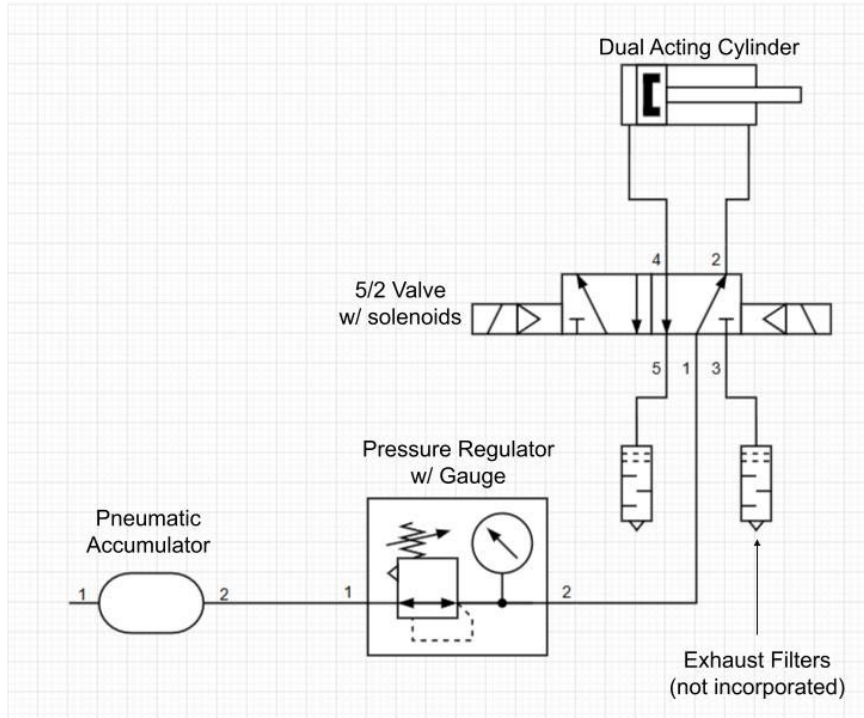
Regenerative Braking



- 3DME Manual Clutch
- Pneumatically engaged and disengaged
- Fixed to rear wheel
- Reduces rolling resistance



Pneumatic Circuit



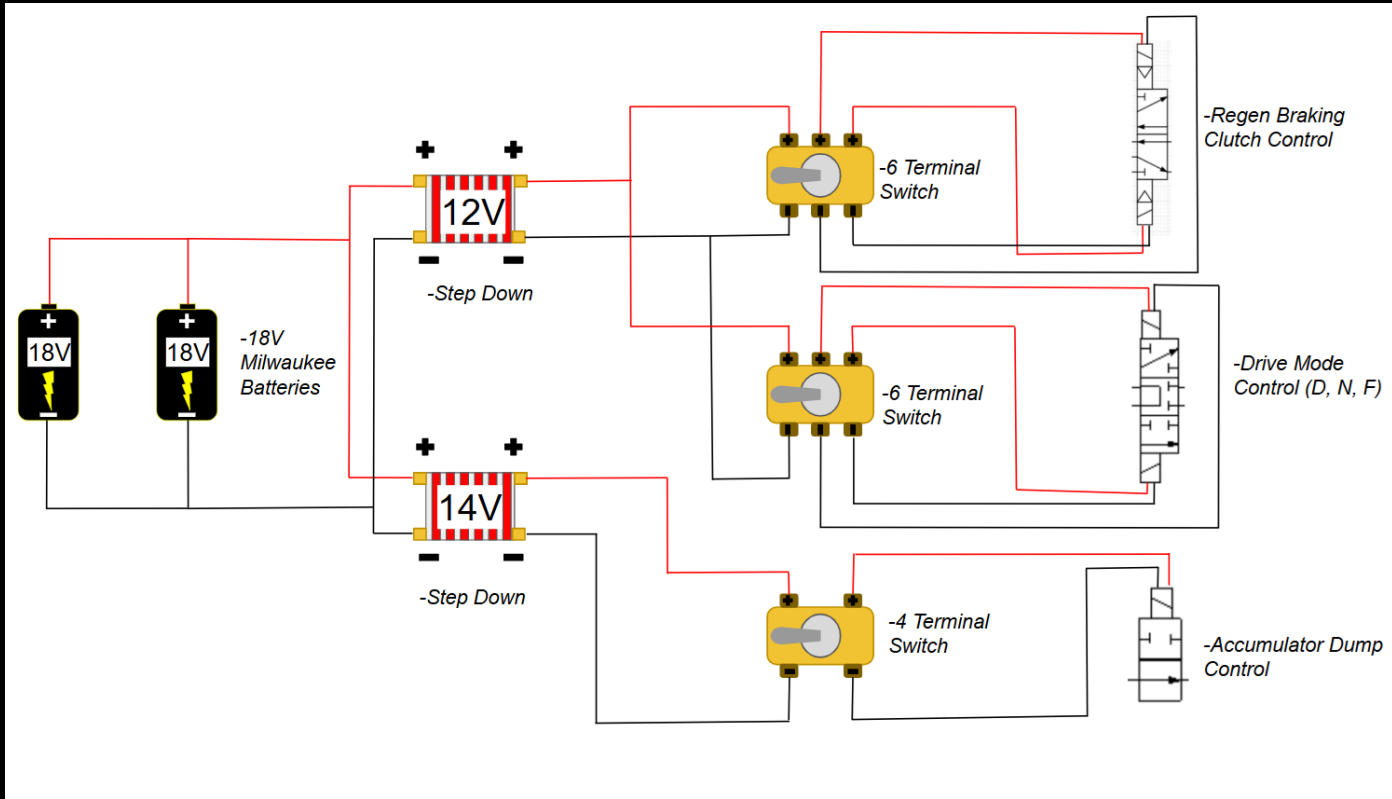
Clutch for Regenerative Braking





Electrical

Switch Circuit





Testing

Testing



Testing = Problems = Solutions

- Hydraulic
- Electronic
- Fixture & Welds
- Rider Metrics
- Track conditions





What We Learned

Lessons Learned



- Using hydraulic schematics & calculations
- Professional help & problem solving
- Material comp. & fixture designs
- Electrical testing before mounting
- Take more pictures/documentation





Questions