NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

Final Presentation
University of Utah
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Team Members

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Problem Statement & Objectives

This project's goal is to design a vehicle to compete in the Fluid Power Vehicle Challenge. The vehicle must transmit power via a hydraulic system.

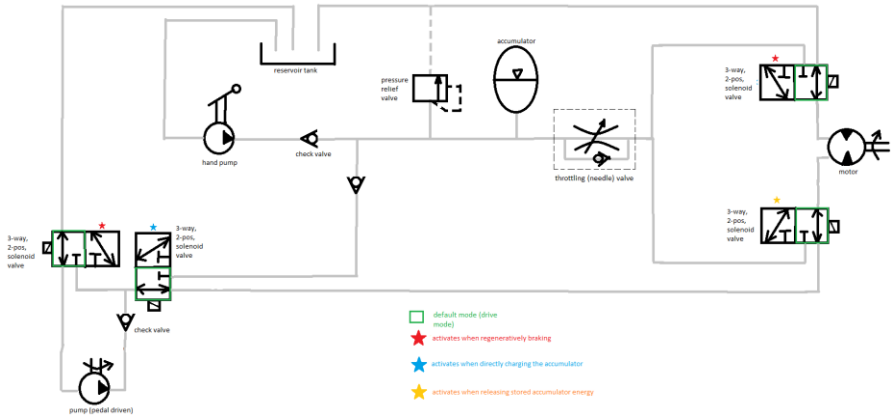
However, the following objectives of this project are important:

- Participate in the Fluid Power Vehicle challenge
- Gain experience and build a good networking with industry
- Give recommendations and suggestions to the next team

Summary of Midway Presentation

The objectives of Midway Presentation:

1. Design a vehicle to compete in a Fluid Power Vehicle Challenge.
2. Learn more about Hydraulics



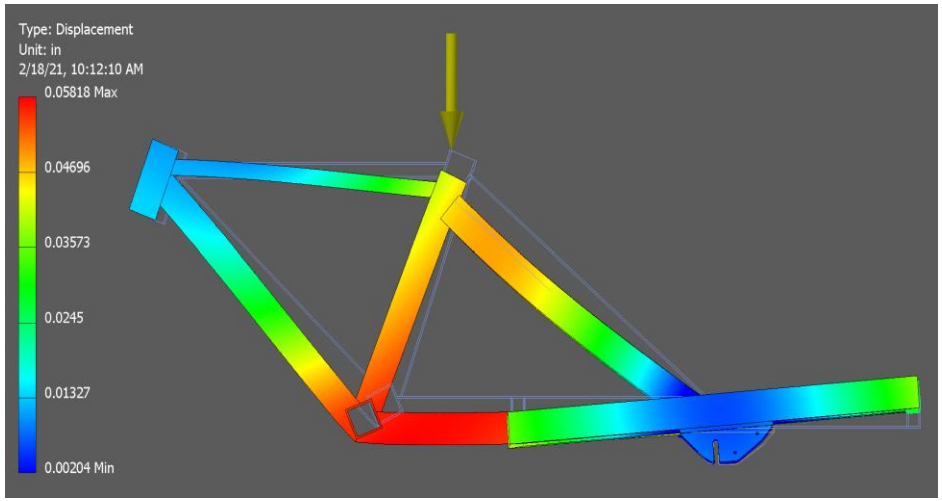
component	quantity	unit price	total price
Free flow nose to side check valve (30 PSI to open)	4	$22.63	$90.52
Fully adjustable needle valve with reverse flow check	1	$48.61	$48.61
3-way, solenoid-operated directional spool valve (Includes 12VDC Coil)	4	$89.41	$357.64
Additional 12VDC Coils for Sun Valves listed above. Includes transient voltage diode.	4	$23.81	$95.24
DCJ T-5A Cavity with -8 (1/2") ports	1	$31.91	$31.91
ACI T-162A Cavity with -6 (3/8") ports	8	$22.63	$181.04
Bladder accumulator, 1 gallon	1	$565.50	$565.50
Clamp type mount for SB330-4A1/112S-210C	1	$41.78	$41.78
Gear Pump Aluminum SAE AA (2-Bolt) (CW) .12 CID Keyed Shaft (1/2")	1	$77.81	$77.81
Gear Pump Aluminum SAE AA (2-Bolt) (CW) .16 CID Keyed Shaft (1/2")	1	$77.81	$77.81
Gear Pump Aluminum SAE AA (2-Bolt) (CW) .20 CID Keyed Shaft (1/2")	1	$77.81	$77.81
Gear Pump Aluminum SAE AA (2-Bolt) (CW) .25 CID Keyed Shaft (1/2")	1	$84.63	$84.63
Gear Pump Aluminum SAE AA (2-Bolt) (CW) .31 CID Keyed Shaft (1/2")	1	$84.63	$84.63
Bent Axis Piston Motor CETOP Flange (2 bolt) .305 CID with Keyed Shaft	1	$653.25	$653.25
Pump, Lever Operated, Push to pump, .46 CID, cartridge only (1/2" Handle Needed Max 36")	1	$64.12	$64.12
Aluminum line body for MP10-01-C-N	1	$14.27	$14.27
1/2" 6061 Aluminum Round 36" $4.24	1	$5.51	$5.51
Test Point Connector, -6 SAE	1	$8.71	$8.71
Dynamic Test Probe adapter 1/4-NPT	1	$20.02	$20.02
		grand total:	$2,580.81

Vehicle Construction

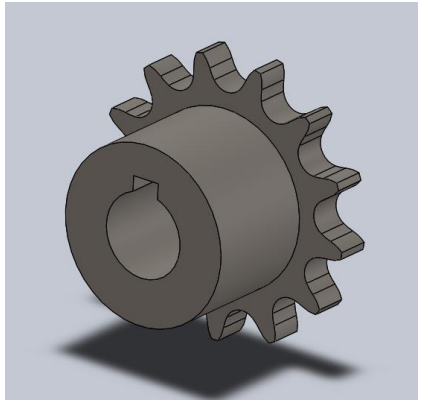
- Custom frame - allows flexibility for component placement
- 3 wheels - adds stability and space for components
- Rectangular aluminum - lightweight and easy to manufacture
- Recycled our old bike parts - saved money and time

Vehicle Construction Cont.

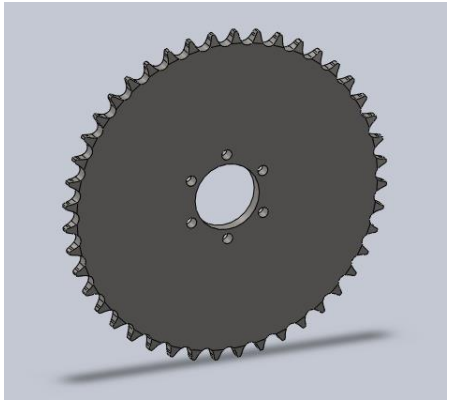
- Safety factor of 8
- Modular rear rack mount
- Custom sprocket mounts
  - Motor- 3.4:1
    - Safety Factor: 2 @ 1000 lb/in
  - Pump- 8:1
    - Safety Factor: 4 @ 1000 lb/in
- Size 40 chain
  - Safety Factor 2 @ 1000 lb/in



Motor Sprocket (13 teeth)

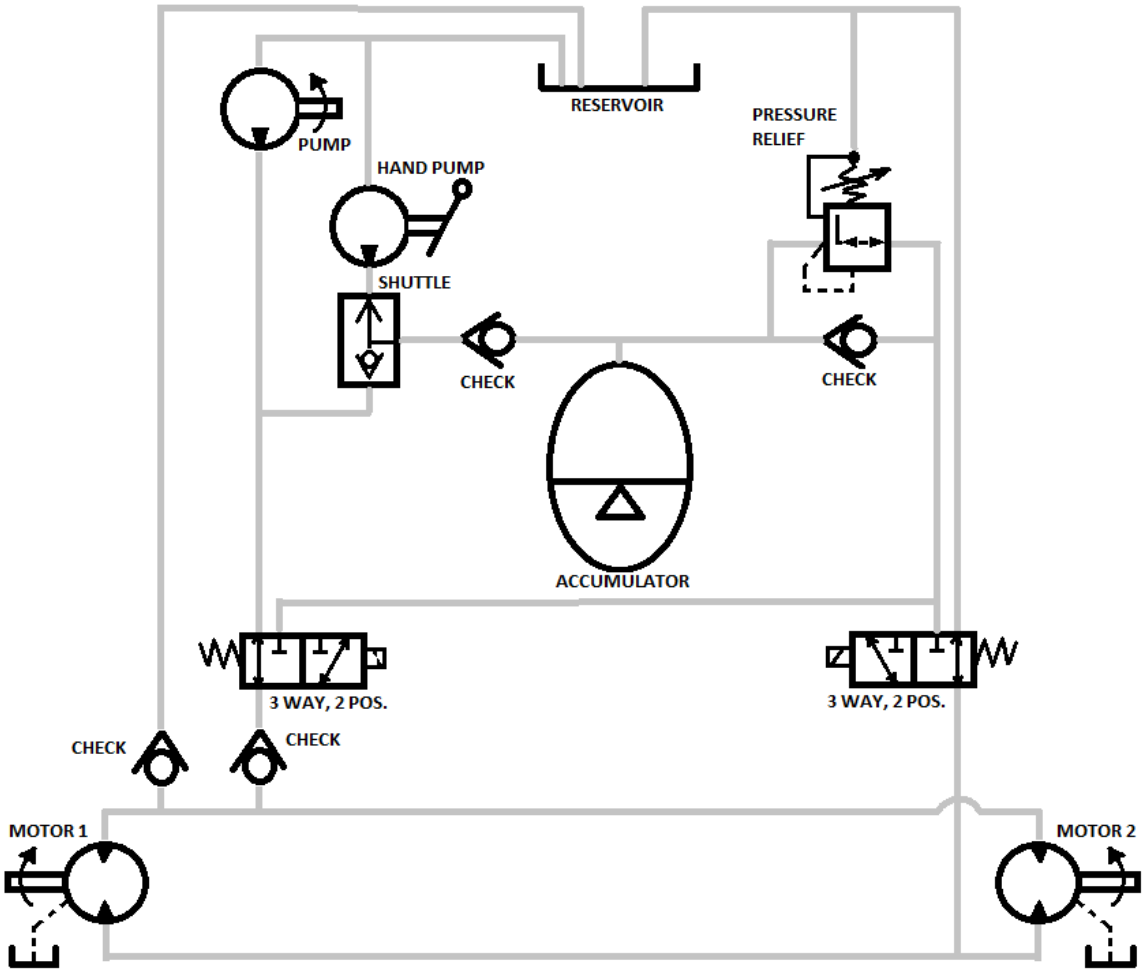


Wheel Sprocket (44 teeth)



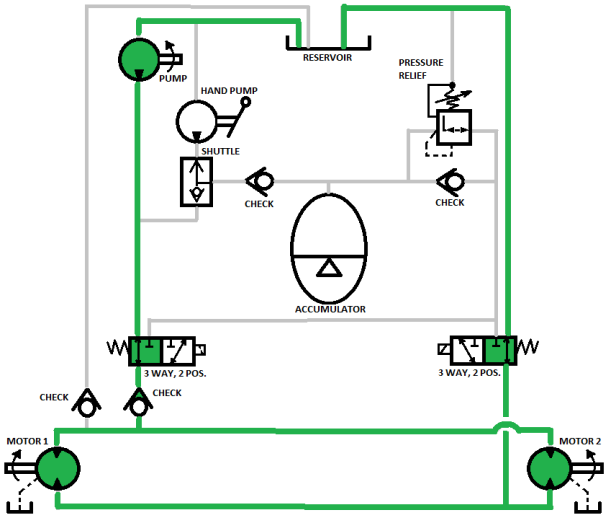
Vehicle Construction Cont.

Fluid Power Circuit Design

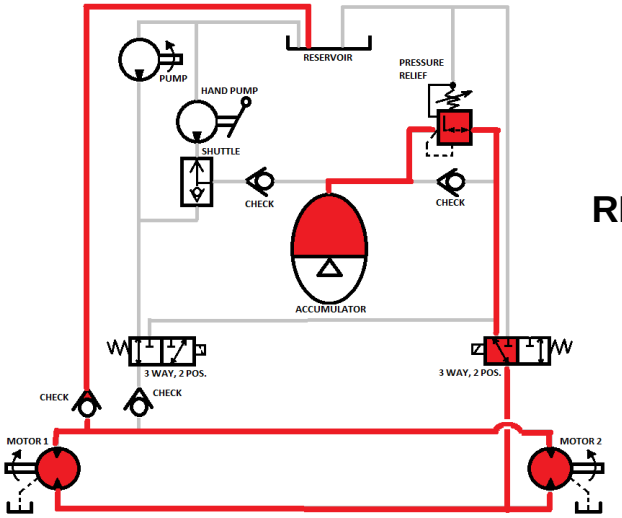


Fluid Power Circuit Design

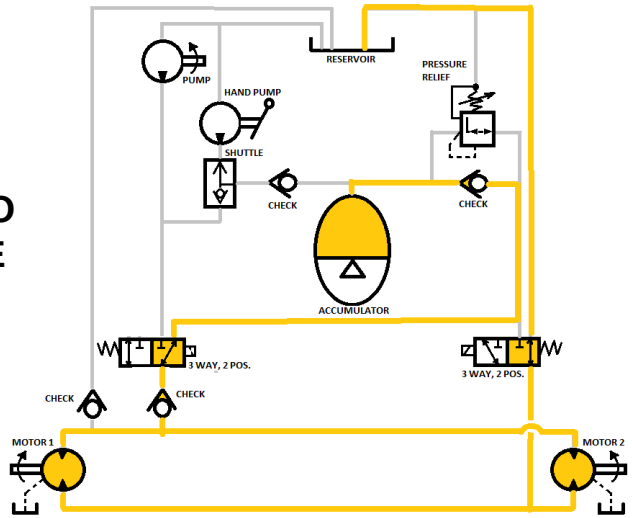
PEDAL DRIVE



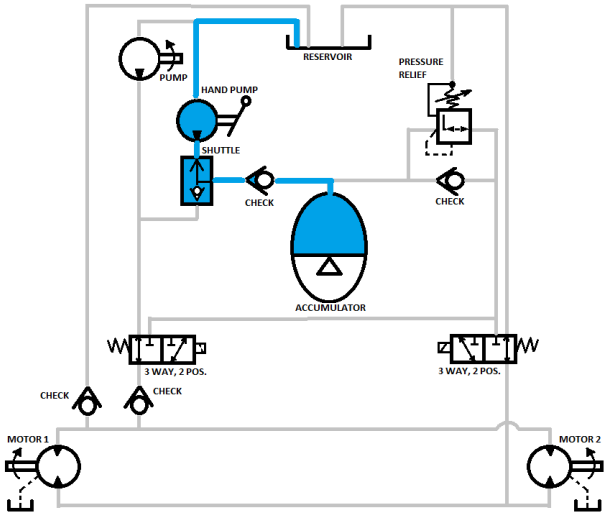
REGENERATIVE BRAKING



TURBO DRIVE

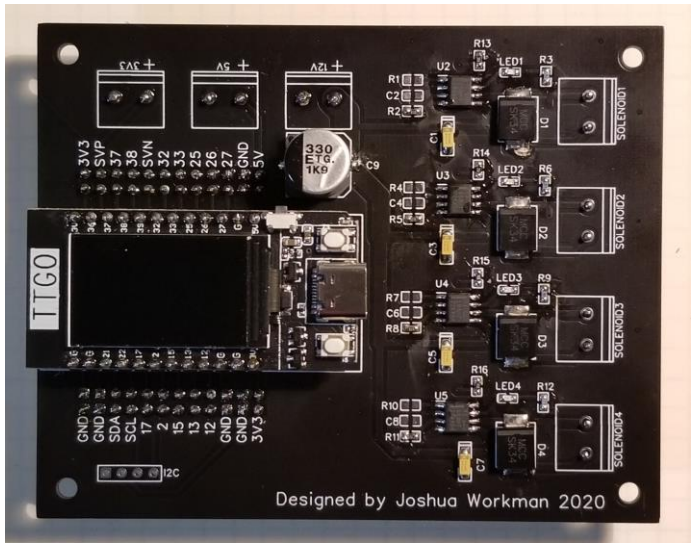


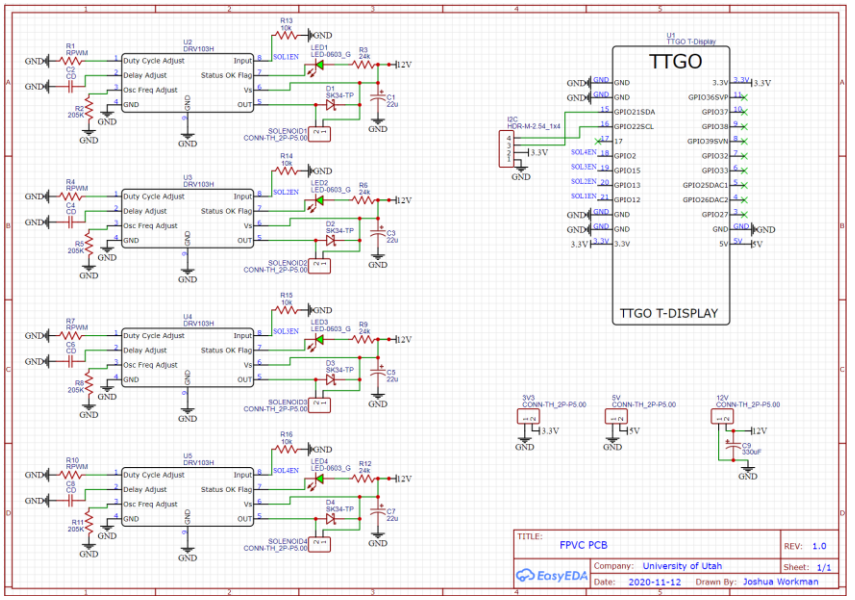
DIRECT CHARGE

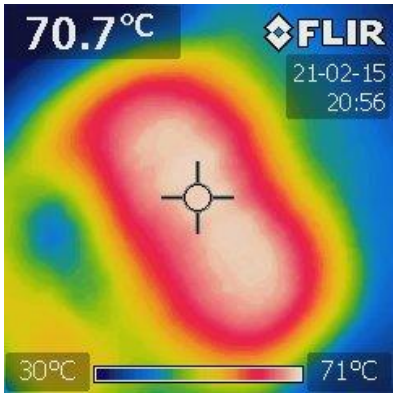


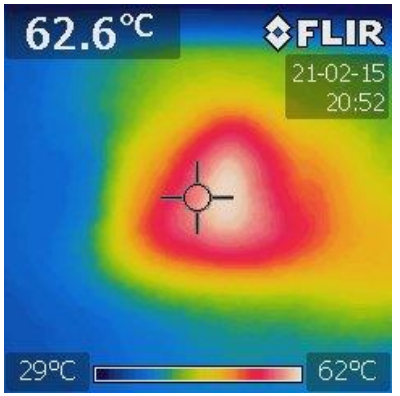
Electronics

- Custom PCB
- DRV103H Solenoid Drivers
- TTGO T-Display Microcontroller
- Dewalt 20V Max Battery









Vehicle Testing

Setbacks:

- Leaks
- Motor stiffness
- Hand pump inlet/outlet mixup
- Sprocket unscrewing from hub

Solutions:

- Re-tightened jam nuts
- Ran motors at high psi
- Re-hose configuration
- Interfaced sprocket with spokes

Final Vehicle

Race Results

Endurance Challenge

- Final Time - 24 minutes, 50 seconds
- Distance traveled after regenerative braking - 5ft

Sprint Race

- Final Time - 34 seconds

Efficiency Challenge

- Distance traveled - 590 ft
- Efficiency score - 0.03

Lessons Learned

- Build your own frame - easier overall
- Use three wheels - adds stability and space for components
- Design for low/medium speed and high/medium torque (don’t use 8:1 ratio)
- Distribute the weight between the wheels
- Use one rear wheel driven by a single motor, and two front wheels
- Use ball valves and pneumatics to control them
- Don’t buy components until you confidently understand their pros/cons.
- Look into buying a used a motor. Less stiff.
- Design for ergonomics. Not shortcuts.

Shout Outs

- ERIKS North America
- Interwest Mfg. & Waterjet Cutting
- Hydraulic Controls, Inc.
- Ernie Parker

Questions?