NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

Final Presentation
The University of Akron
Dr. Scott Sawyer
04/20/2022

Overview

- Team Introduction
- Problem statement and Objective
- Summary of Midway presentation
- Vehicle Construction
- Vehicle Testing
- Final vehicle and Lesson learned
- Conclusion

Team Members

Nelson Custer
5th year Mechanical Engineering Student

AbdulMuizz KamalMuili
5th year Mechanical Engineering Student

Michael Nagel
5th year Mechanical Engineering Student

Todd Styer
Mentor, Parker Hannifin

Dr. Scott Sawyer
Advisor, University of Akron

Problem Statement and Design Objectives

- Build a bike utilizing hydraulic components
- This year's bike focused on four objectives

MINIMIZE WEIGHT

MAXIMIZE EFFICIENCY

IMPROVE BIKE LAYOUT

SAFETY

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Summary of Midway presentation-Vehicle design

Bike Design

Component Selection

- Manifold
  - Minimize pressure drop within the hydraulic circuit
- Carbon Fiber Accumulator
  - Help with weight reduction
- Custom Reservoir
  - Lightweight, 3D printed
- Parker F-11 Pump and Motor

Calculations

Bike Speed: $110.88\text{rpm}\ x\ \frac{26in*3.14}{rev} * \frac{1\,ft}{12in} * \frac{1\,mi}{5280\,ft} * \frac{60\,min}{1\,hr} = 8.57\text{mph}$

8.57mph = 754.16ft/min

$$\text{Power}_{out} = \frac{P*Q_{out}*\eta_m}{1714} \qquad P(\text{psi}) = \frac{\text{Power}_{out}*1714}{Q_{out}*\eta_m}$$

$$P(\text{psi}) = \frac{0.25 * 1714}{0.144 * 0.99} = 3005.8\ psi$$

$$P = \frac{T_t*2\pi}{V_d} \qquad T_t = \frac{P*V_d}{2\pi}$$

$$T_t = \frac{3005.8 * 0.3\,\frac{in^3}{Rev}}{2\pi} = 143.5\ in * lbf$$

$$T_t = F_a * R_{pedals} \qquad F_a = \frac{T_t*\eta_m}{R_{pedals}}$$

$$F_a = \frac{143.5in * lbf(0.99)}{6.7in} = 21.2lbf$$

Factoring out the gear ratio

$$4 * F_a = 4 * 21.2 = 84.81\text{lbf}$$

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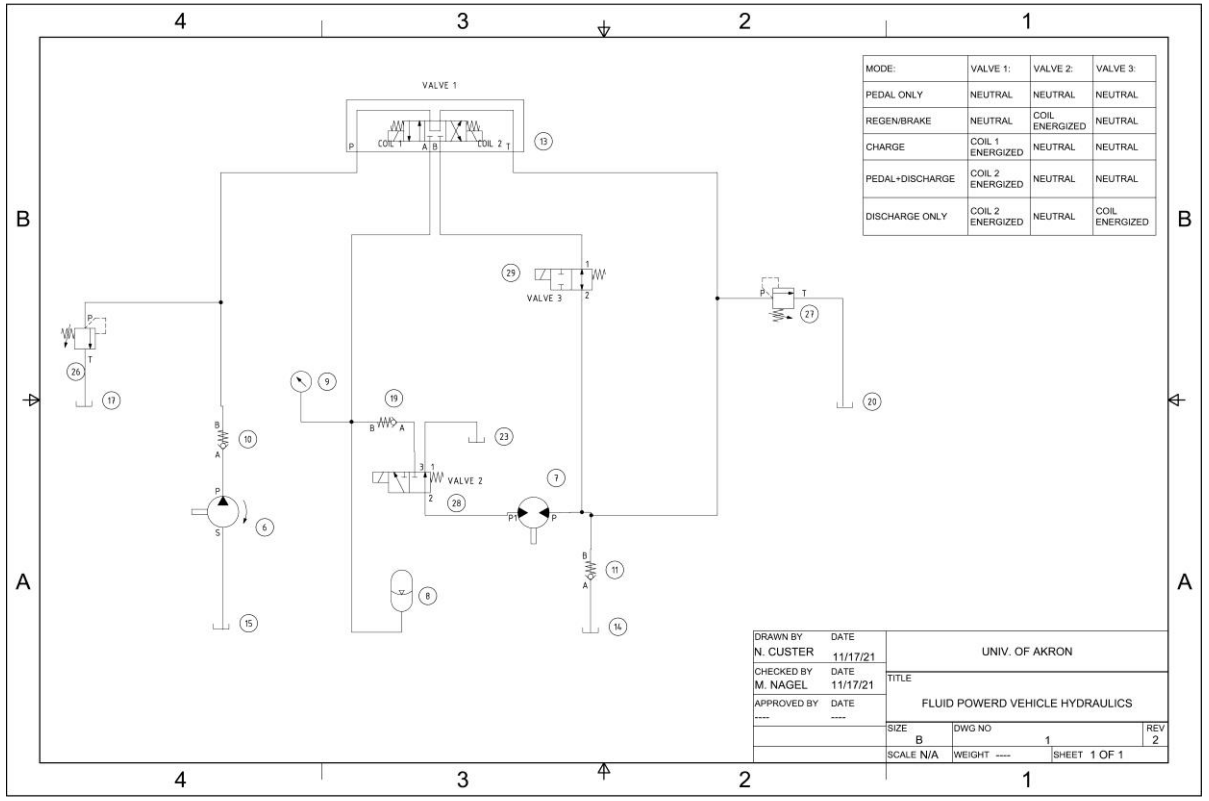
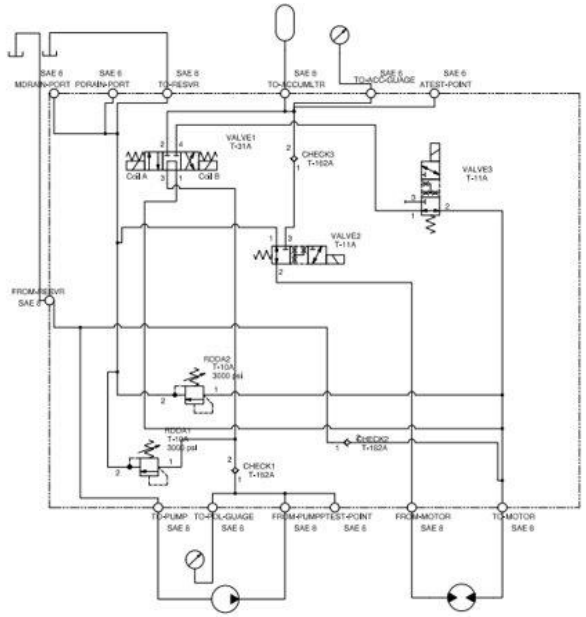
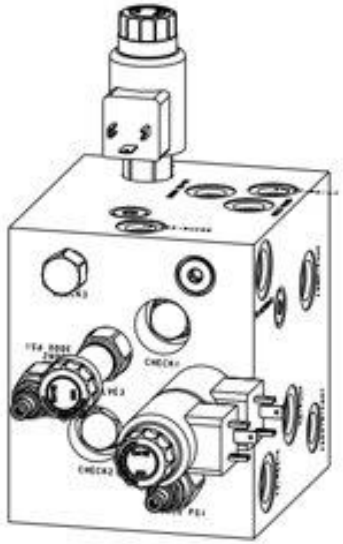
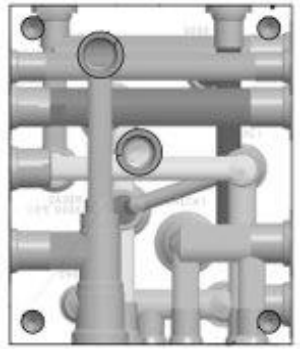
Hydraulic circuit & Manifold Design

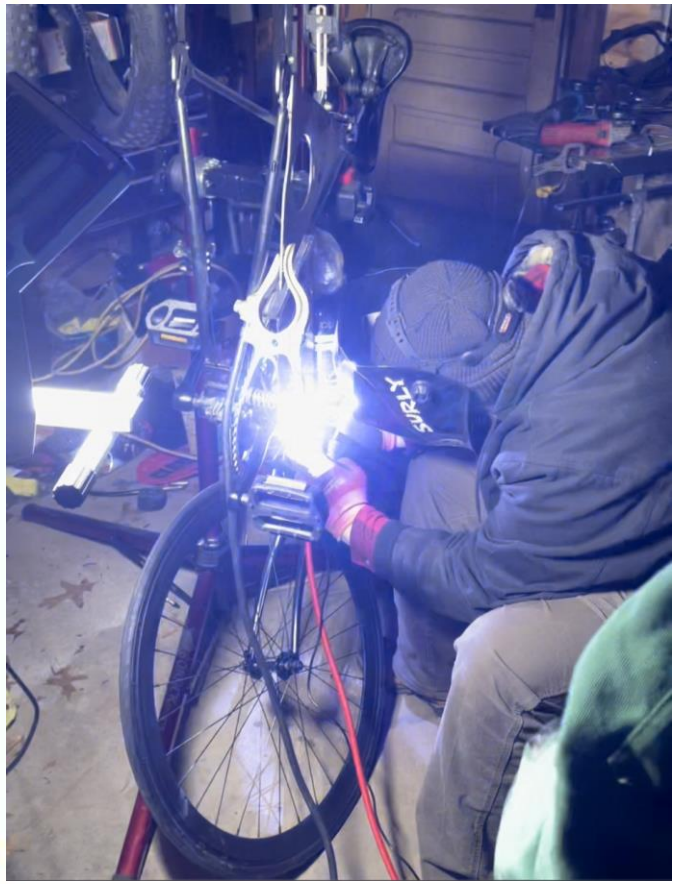


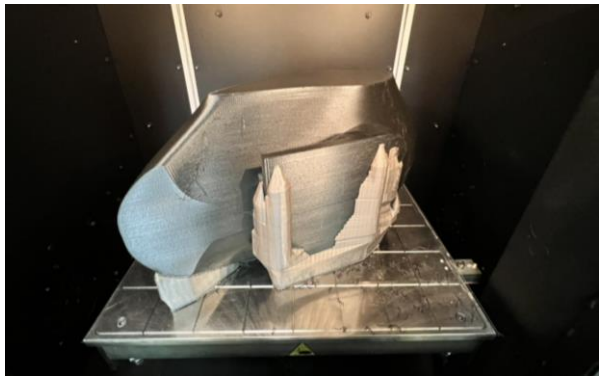


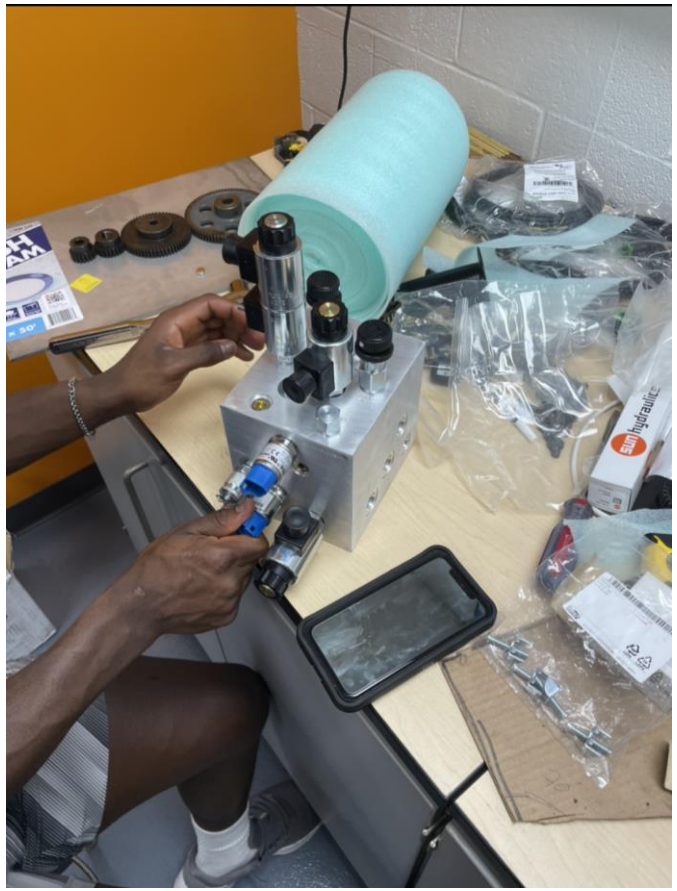


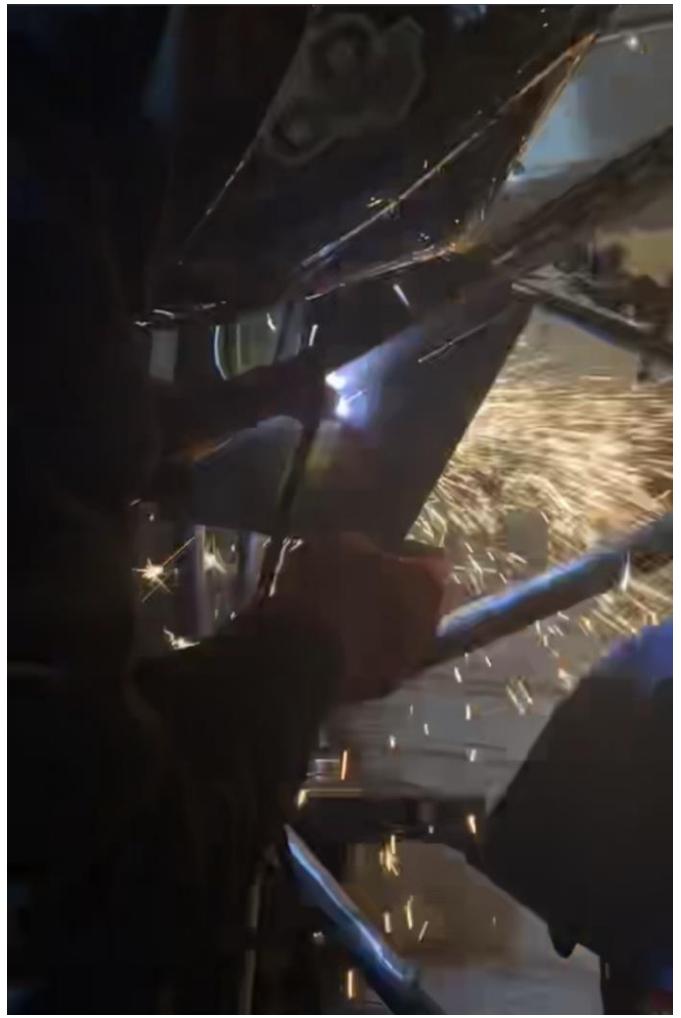


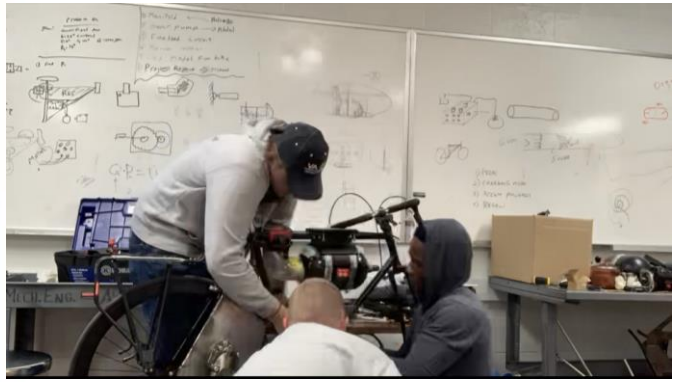
Vehicle Construction











Vehicle Testing

Metric:	Observed data:
Pedaling speed	8 mph max
Accumulator-propelled speed	14 mph max
Maximum distance without pedaling	2,000 ft

Final vehicle comparison

Last year’s Bike

MINIMIZE WEIGHT

MAXIMIZE EFFICIENCY

IMPROVE BIKE LAYOUT

SAFETY

Cost

Part	Cost
Bike	$80
Components (including donated parts)	$3,300
Fab work	$500
Hardware & Misc	$1,200
Total	**$5,080**

Lessons Learned

- Hydraulics fundamentals
- Programming PLC
- Advanced CAD and 3D modeling
- Design and manufacturing Experience

Conclusion

Special Thanks to:

- **NFPA**
- **Josh Scarbrough - IFP Rep**
- **Todd Styer-Team Mentor**
- **Dr. Scott Sawyer - Team Advisor**
- **Aaron Trexler - UA Engineering Technician**

Thank You to Our Sponsors!

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