

N F P A

Fluid Power **VEHICLE** **Challenge**



NFPA
Education and
Technology
Foundation

Final Review
Cleveland State University
2018-2019 FPVC Team
Advisor: Professor Kozul
April 11-12, 2019



Overview

- 🚲 Introductions
- 🚲 Midterm Summary
- 🚲 Vehicle Construction
- 🚲 Vehicle Testing/ Improvements
- 🚲 Lessons Learned
- 🚲 Final Vehicle
- 🚲 Questions



Meet the Team



Midterm Recap



Midterm Summary

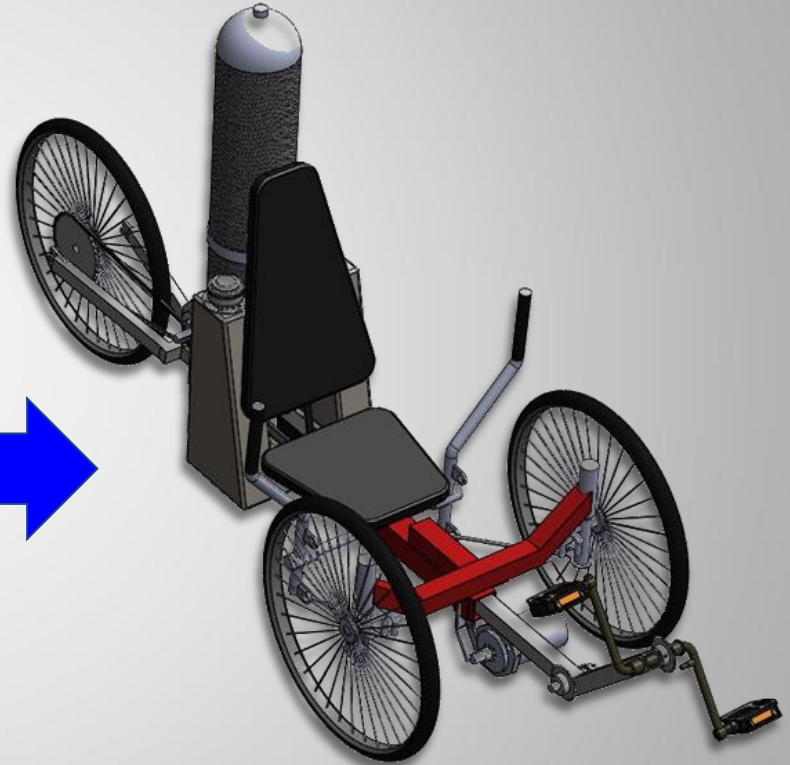
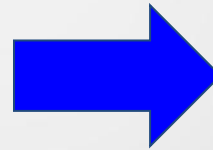


- 🚲 Design objectives
- 🚲 Vehicle design
- 🚲 Fluid power circuit design
- 🚲 Selection of hardware
- 🚲 Results/ Analyses



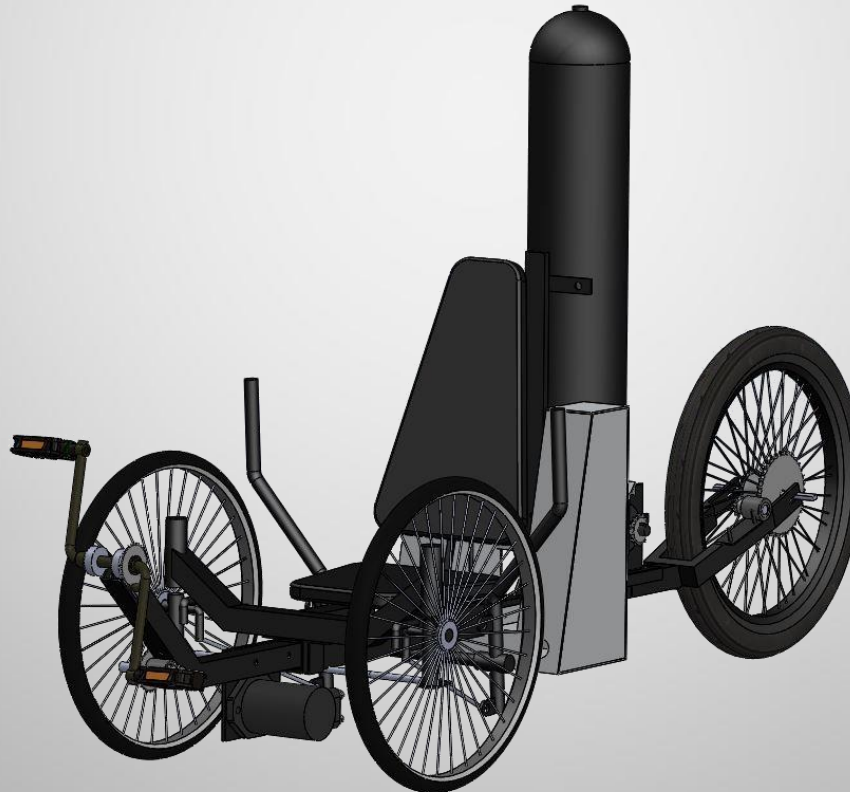
New Design: Design Objectives

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Design Objectives

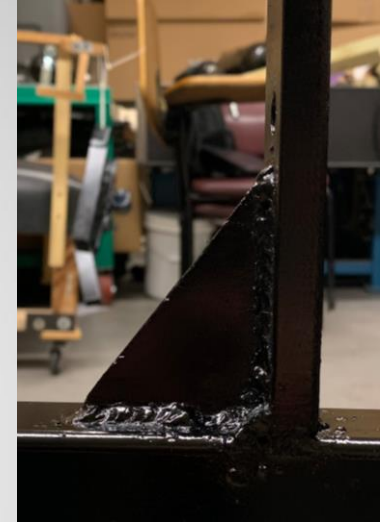
- 🚲 Easier to operate
 - **56.43 lbf min force**
- 🚲 Increase amount of stored energy



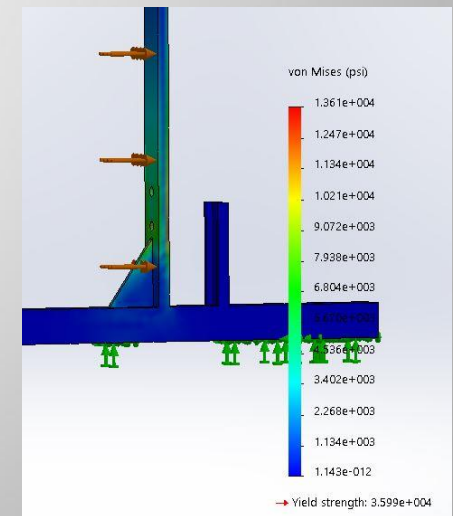
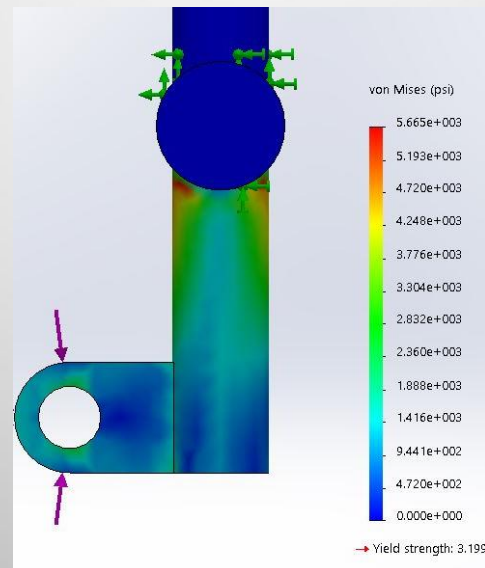
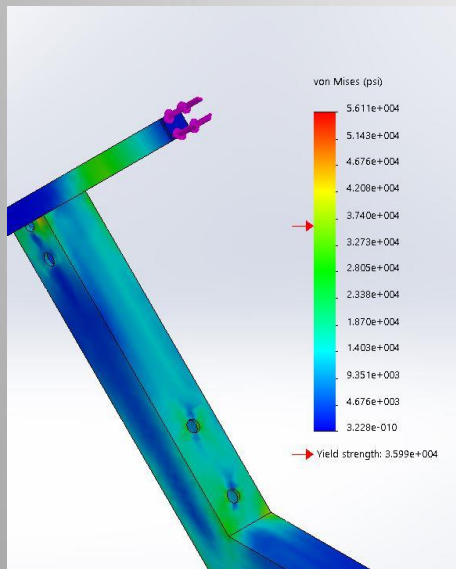
Vehicle Design



Welds



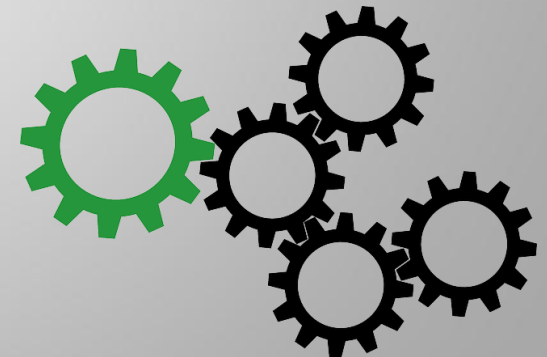
FEA



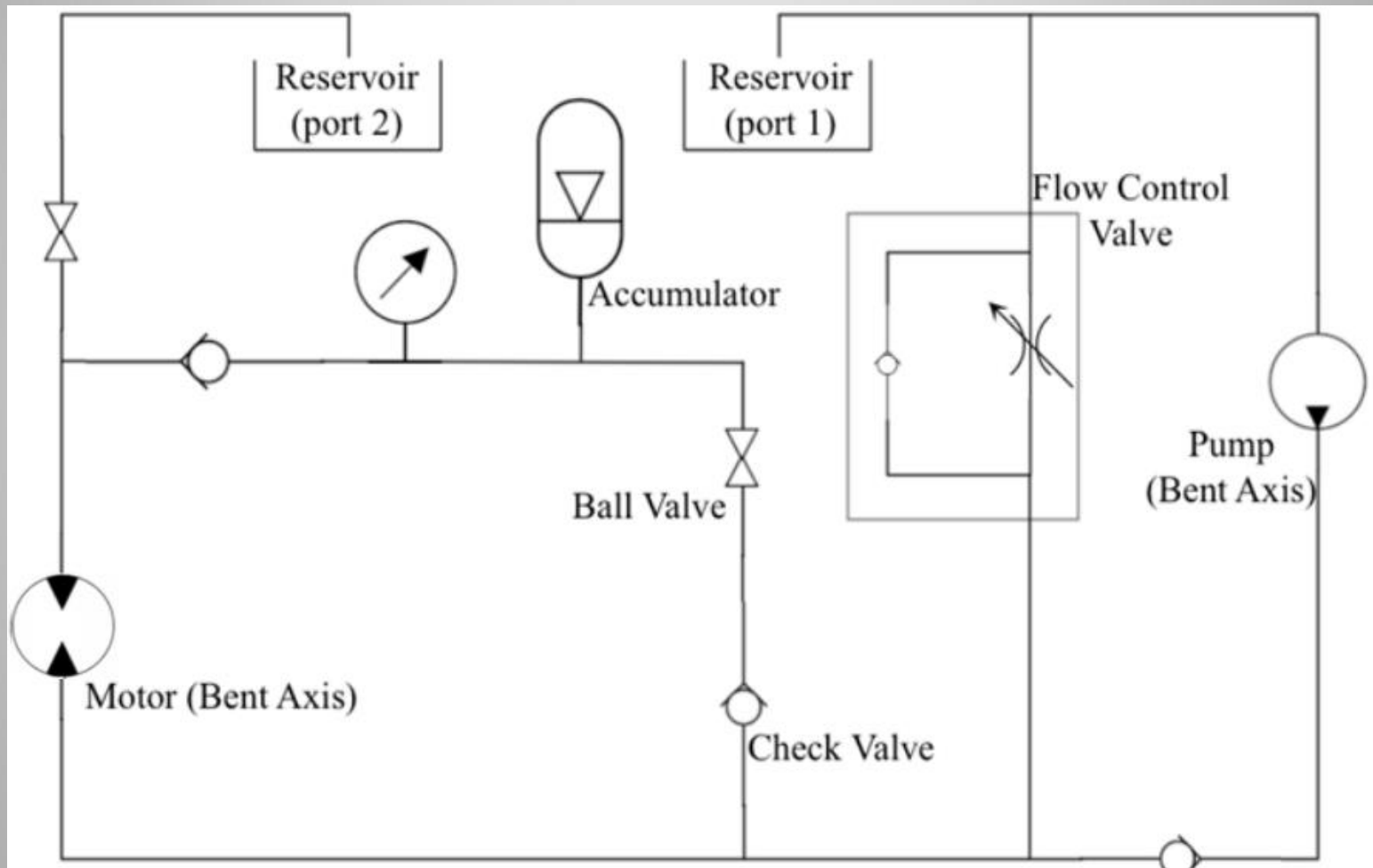
Vehicle Design



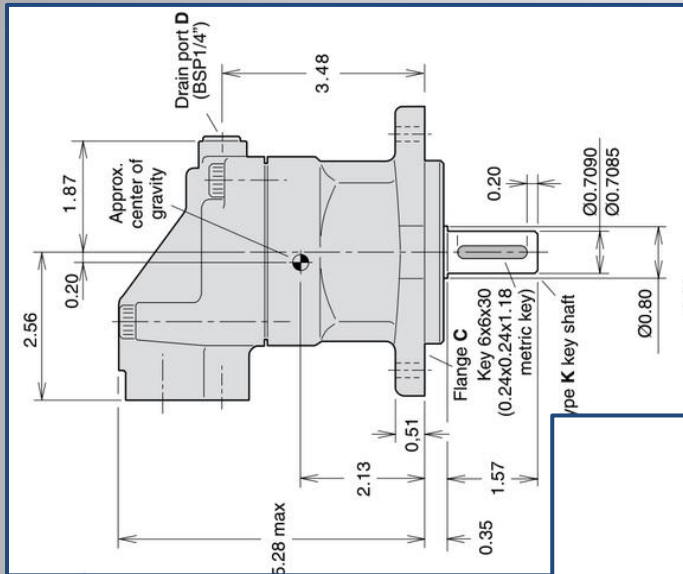
	Nominal Diameter (Inches)	Pitch Diameter (Inches)	No. of Teeth	Shaft Diameter
Drive Sprocket 1 (at Pedal)	4.03	3/8	32	5/8"
Sprocket 2	1.38	3/8	10	5/8"
Sprocket 3	4.03	3/8	32	5/8"
Sprocket 4 (at Pump)	1.38	3/8	10	5/8"



Fluid Power Circuit

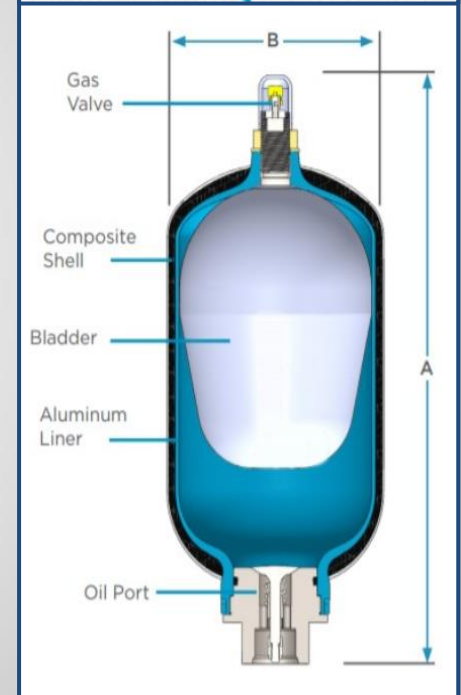
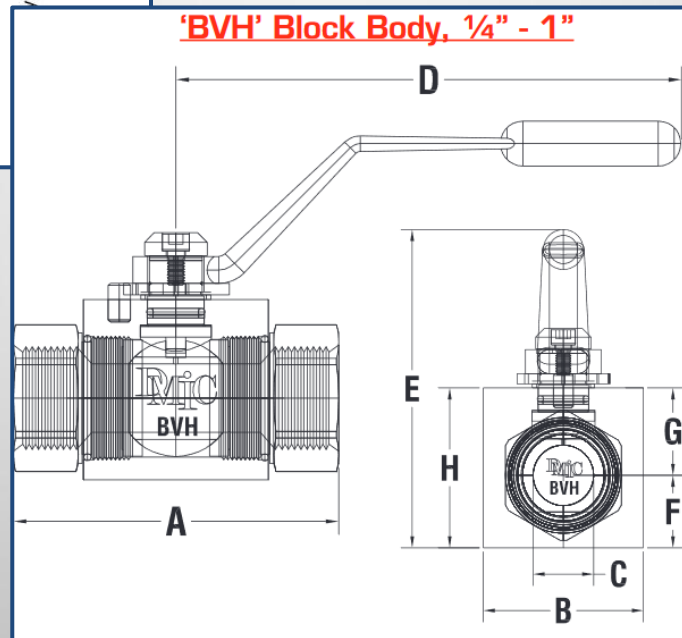


Component Selection:



**Bent Axis
Displacement
Pump**

Manual Ball Valve



**2.5 Gallon
Carbon Fiber
Accumulator**

Calculated Results



 Estimated Sprint Time

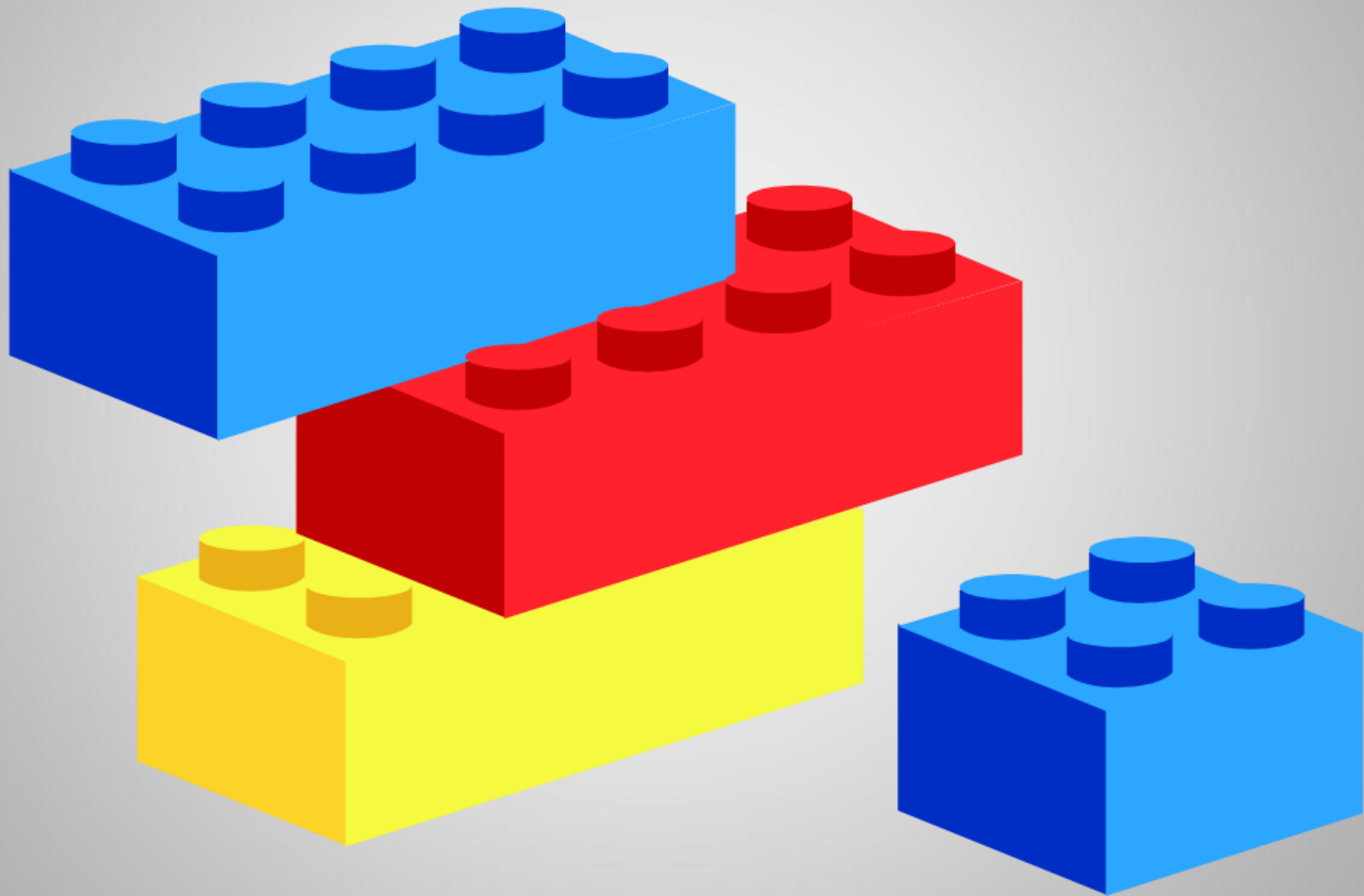
- **25.62 seconds** (KE/ Accumulator Power)

 Estimated Distance Traveled

- **3660.38 ft** (2.5 Gallon)
- **695.42 ft** ($\frac{1}{2}$ Gallon)

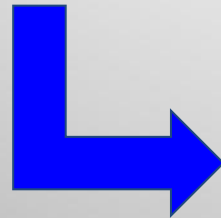
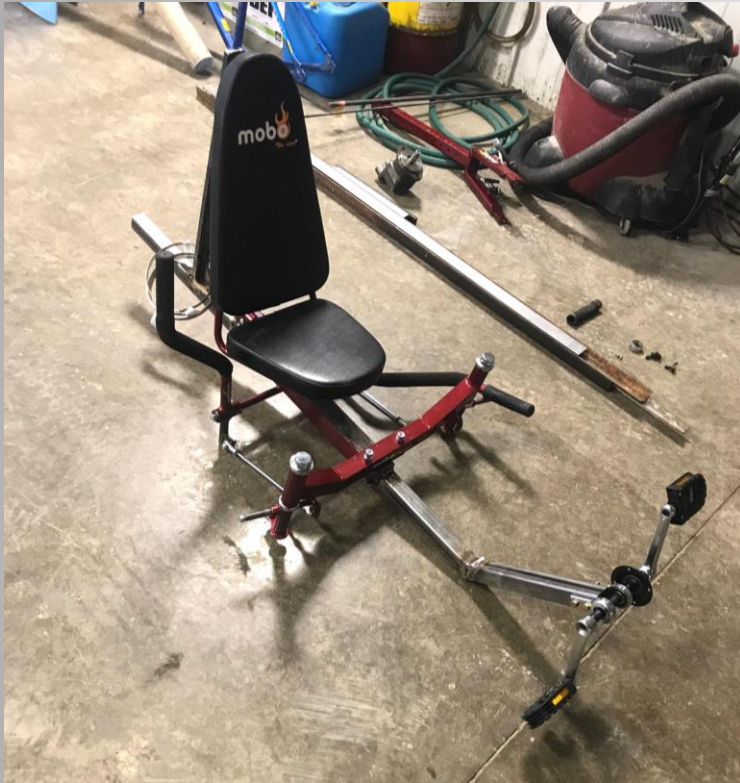


Vehicle Construction



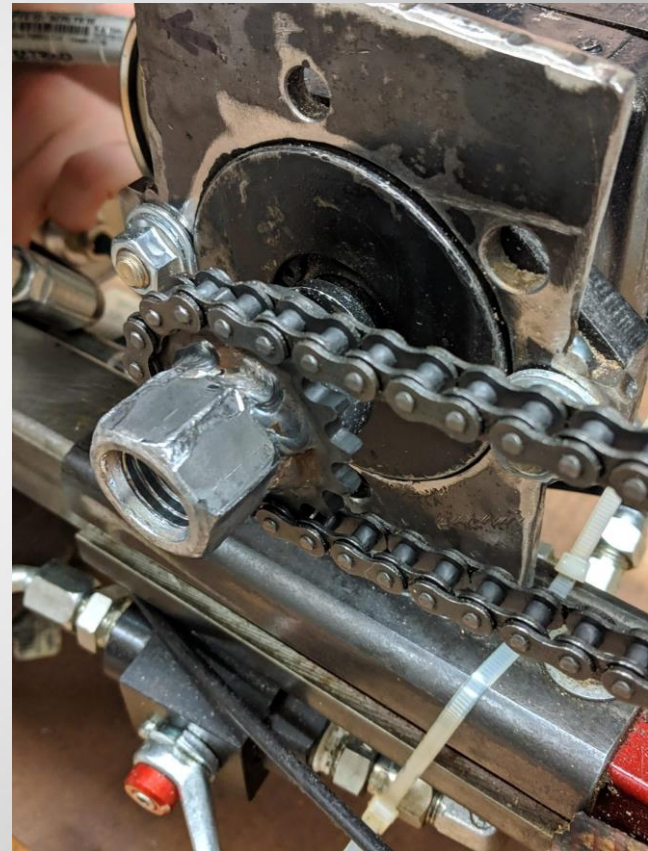
Vehicle Construction

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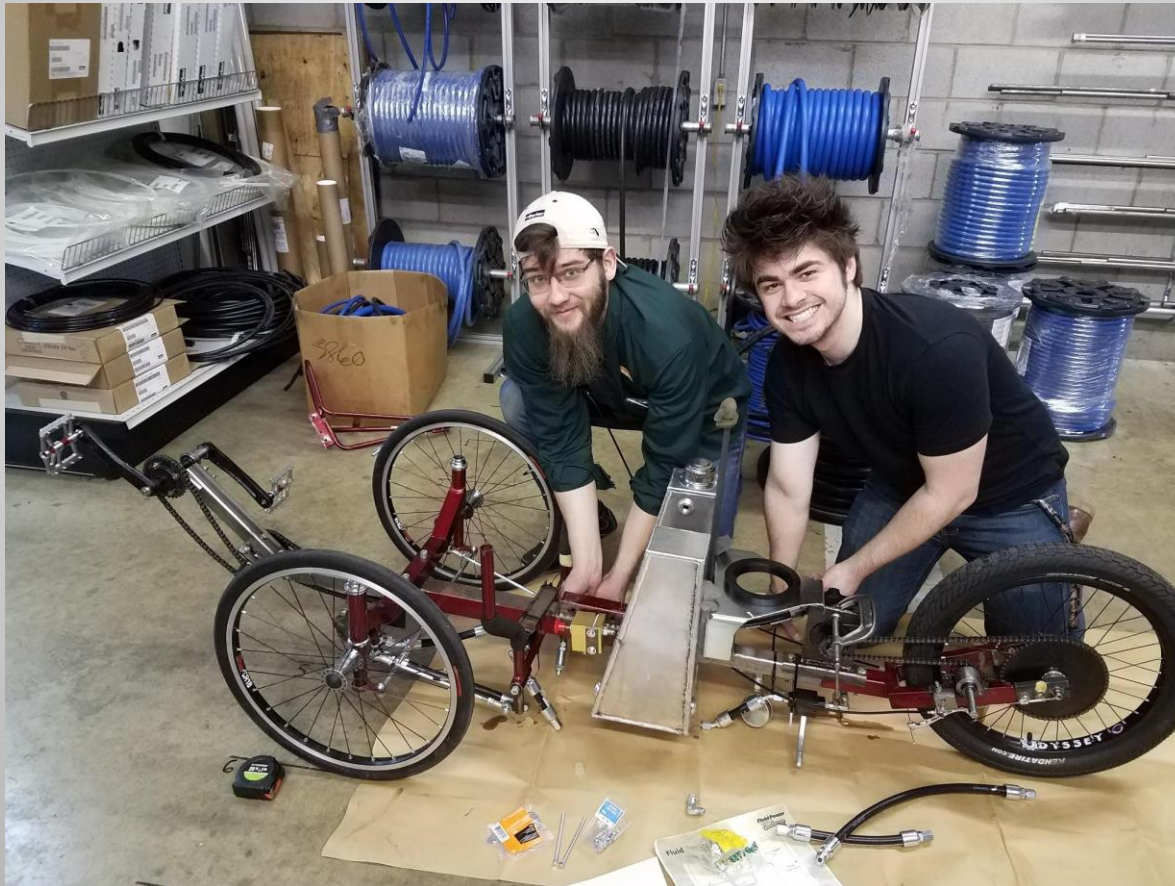
Vehicle Construction

🚲 Charging the accumulator

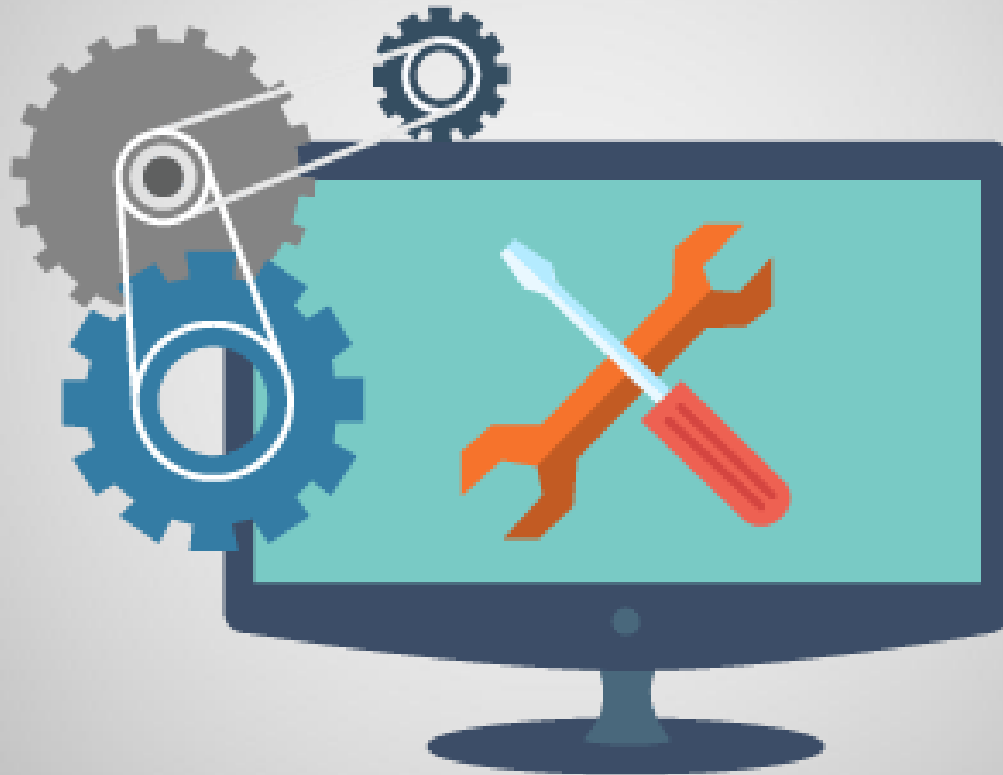


Vehicle Construction

Reduction of Fittings



Vehicle Testing/ Improvements



Testing Overview



Sprint

- 2.5 Gallon Accumulator



Efficiency

- 2.5 Gallon Accumulator
- ½ Gallon Accumulator



Endurance

- 2.5 Gallon Accumulator



Sprint Testing




2.5 Gallon Accumulator

Sprint/ Without Quick Disconnects

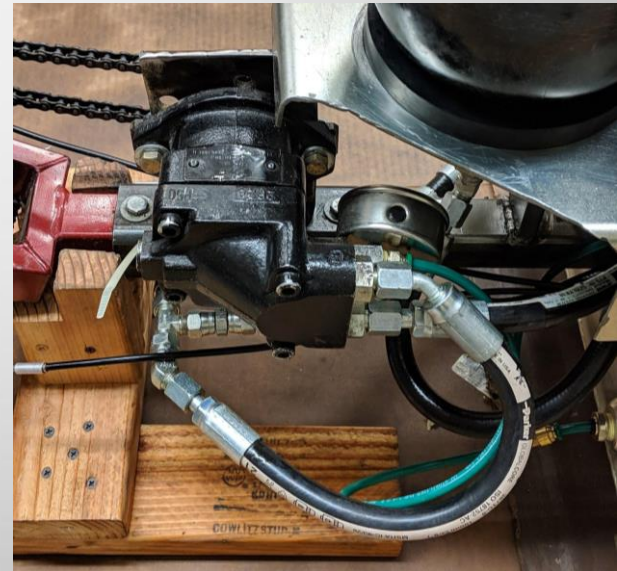
Pre-Charge	Trial 1 (s)	Trial 2 (s)	Trial 3 (s)	Trial 4 (s)
600				19.63
800			18.85	18.5
1000	~29.326	20.46	17.53	17.26

Sprint/ With Quick Disconnects

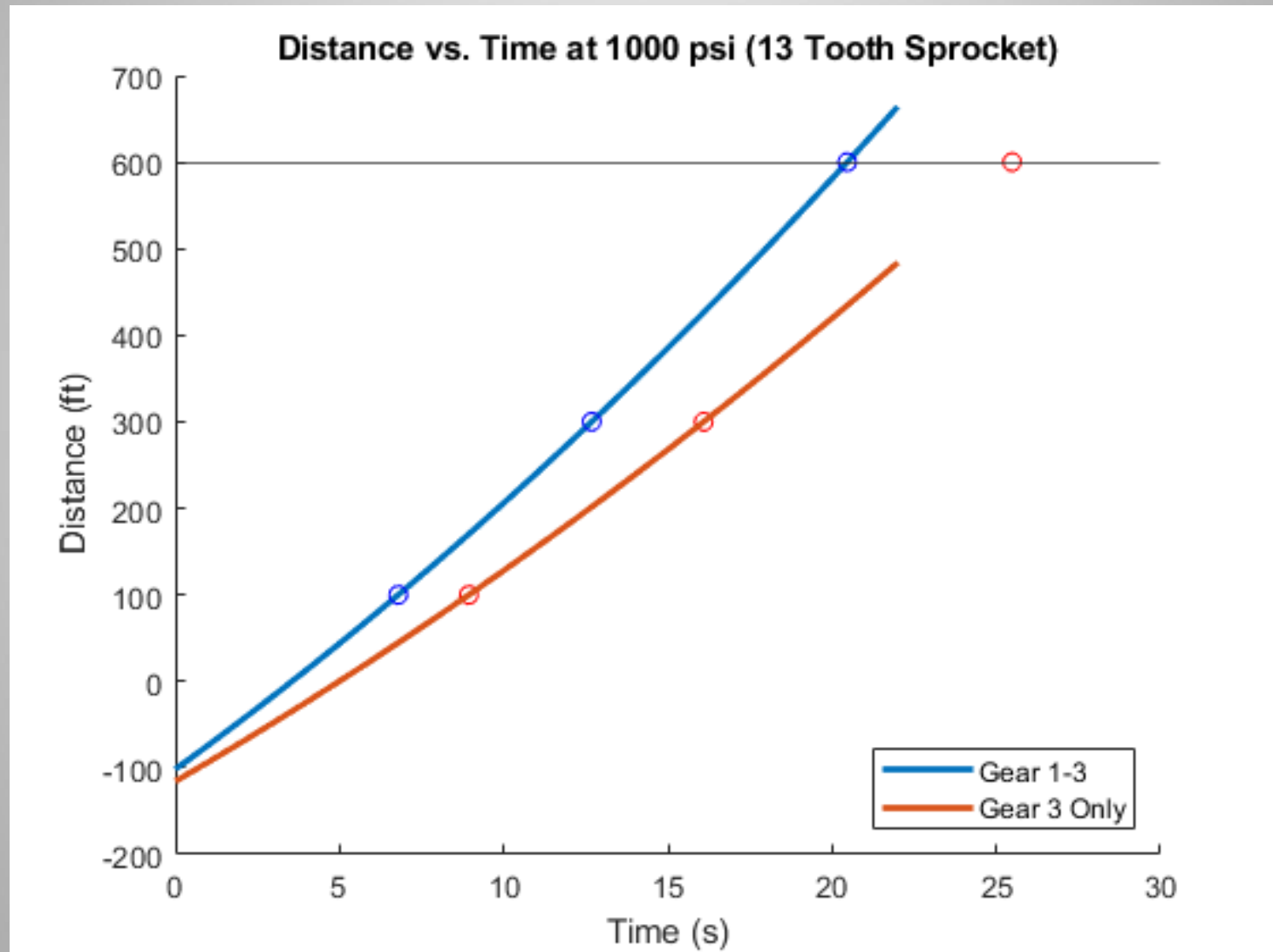
Pre-Charge	Trial 1 (s)			
1200	19.24			
1400	19.74			

Bike Improvements

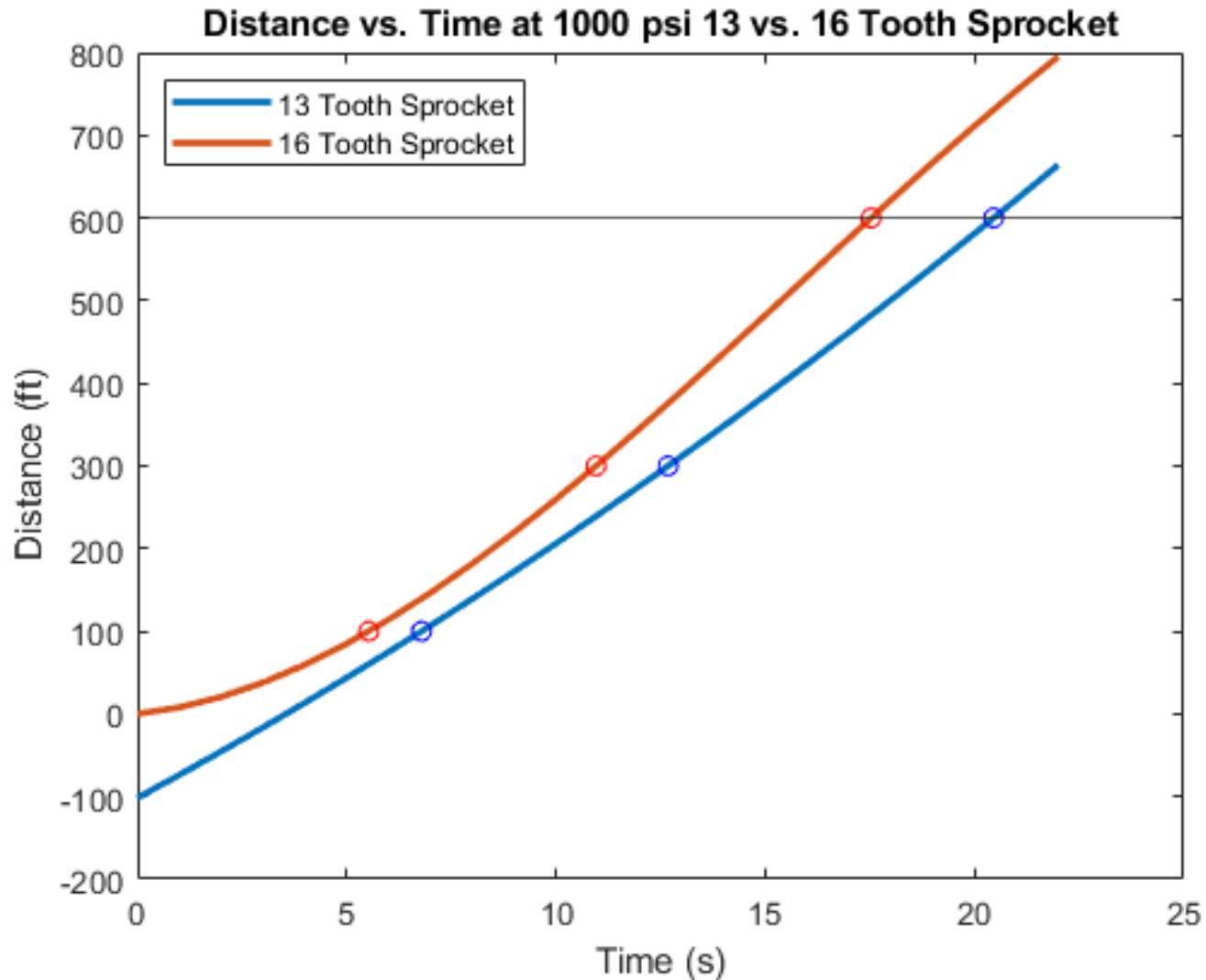
- 🚲 Increased back end gear ratio
- 🚲 Motor orientation
- 🚲 Fixed back end fork
- 🚲 Moved idler
- 🚲 Moved bearing housings



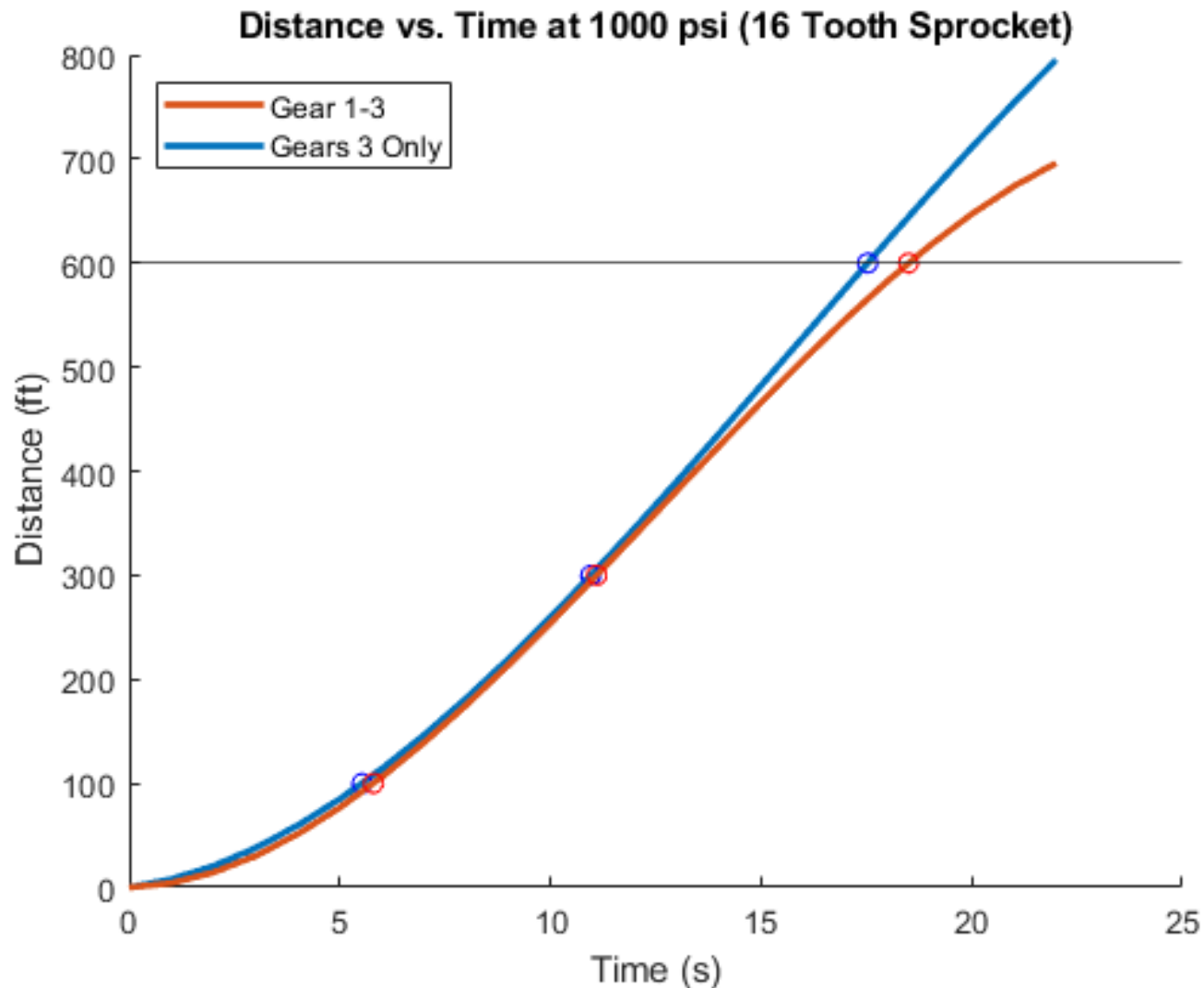
Improved Results



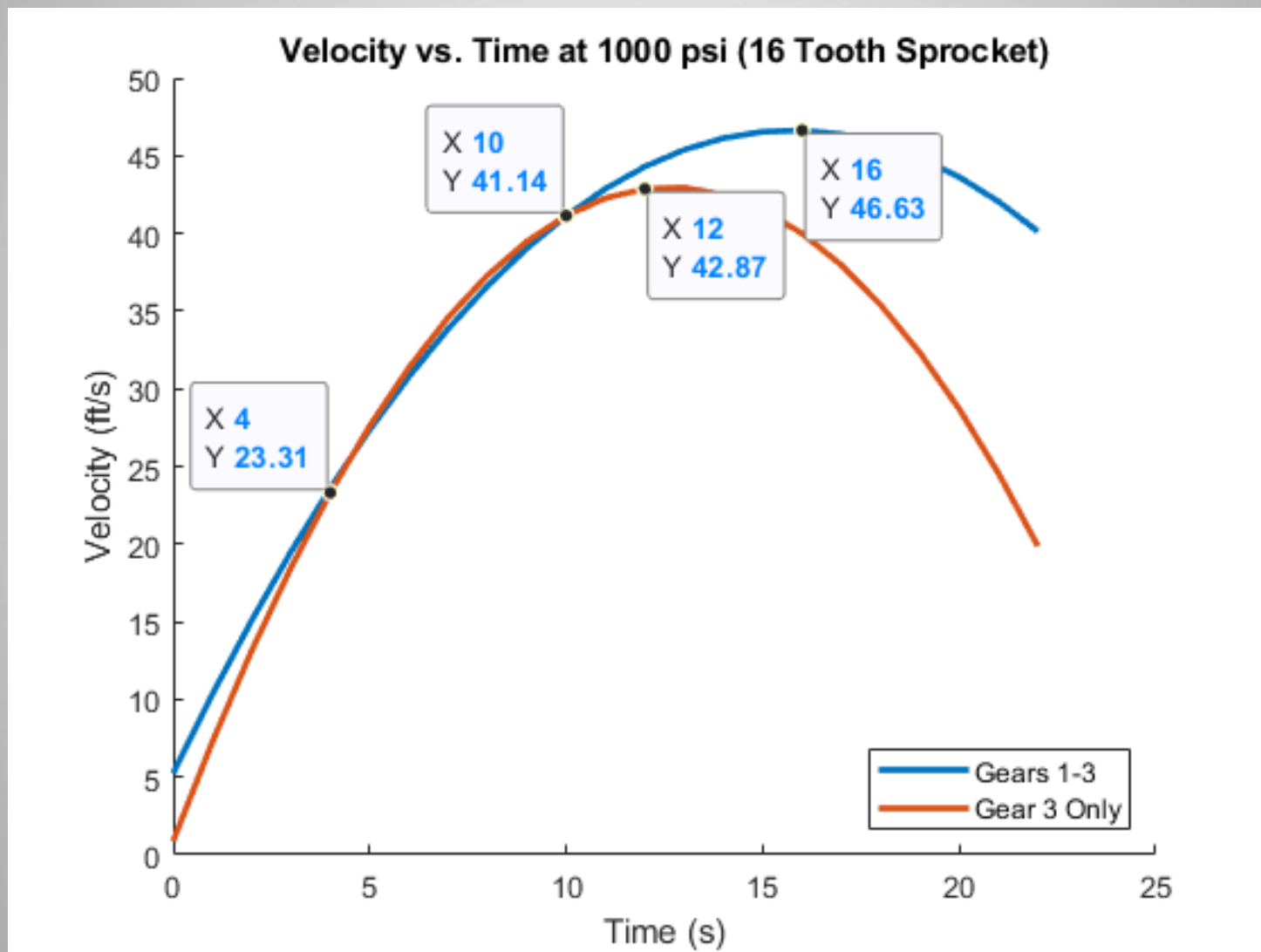
Improved Results



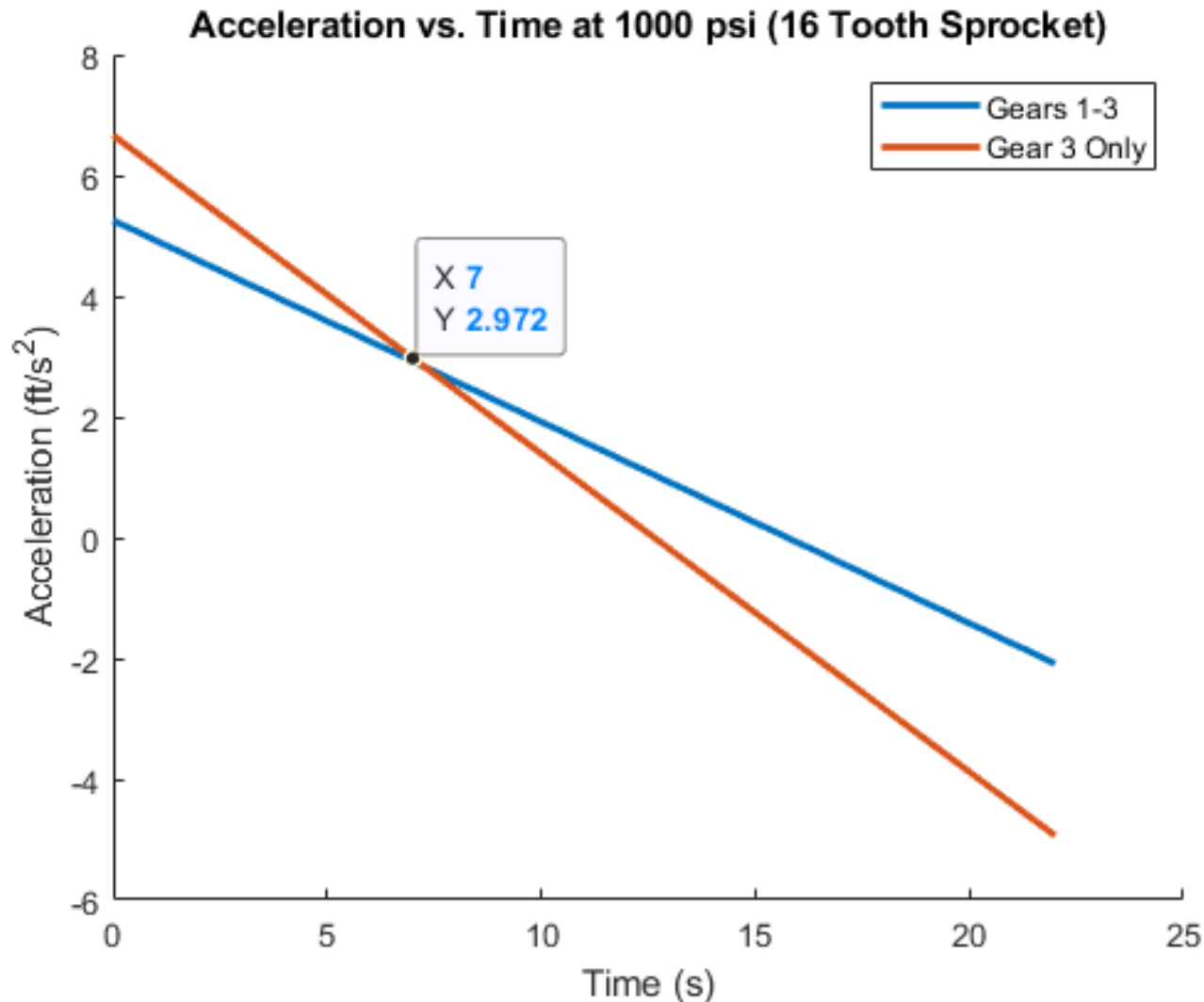
Improved Results



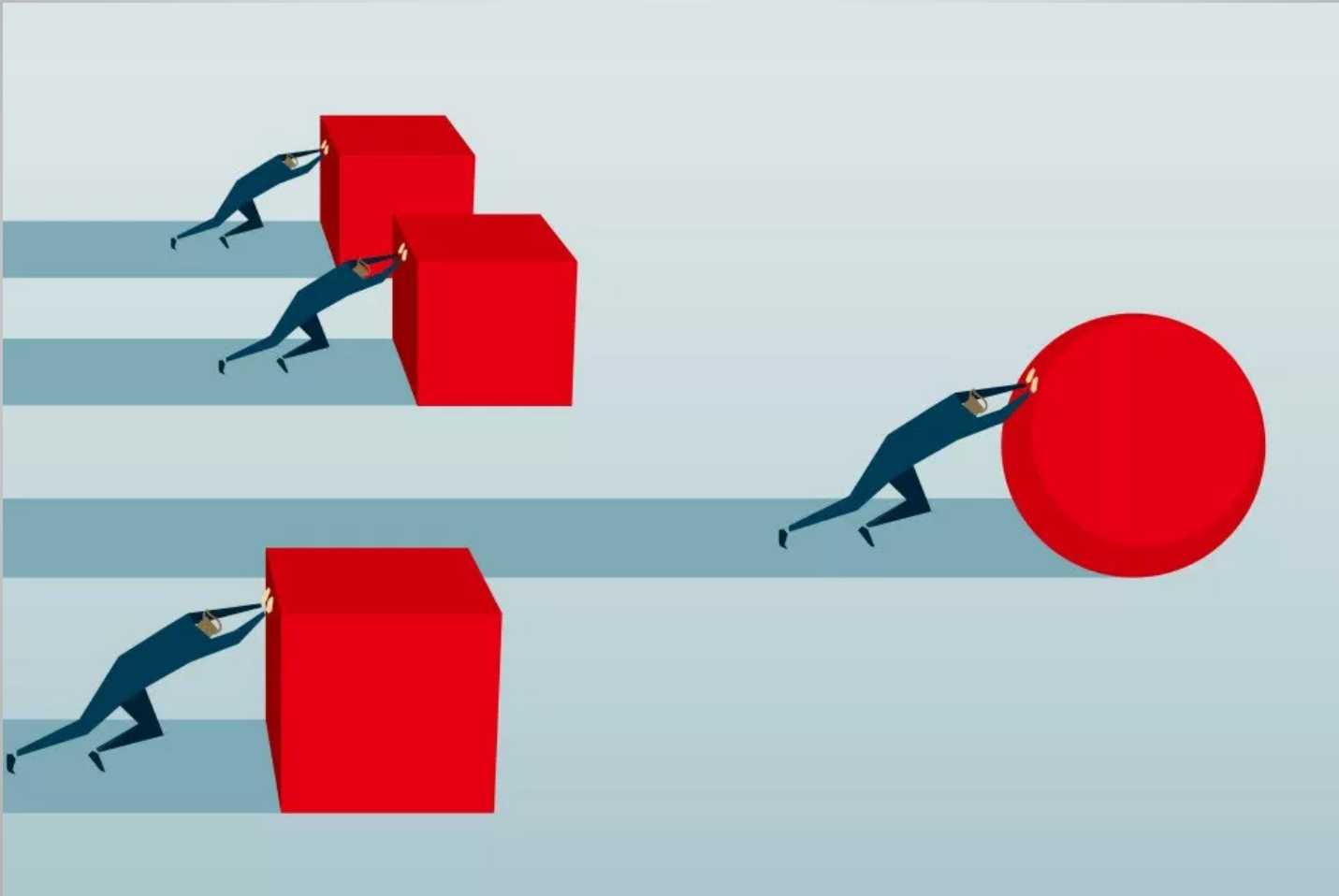
Improved Results



Improved Results



Efficiency Testing



2.5 Gallon Accumulator



Precharge	Distance	Score
1000	4974.4	3.3
800	4995.8	4.16
600	4988.8	6.65



½ Gallon Accumulator

Precharge	Distance	Score
1000	1599.2	5.3
800	1452.2	6
600	1271.2	7.06
350	1031.2	9.82
150	915.2	20.34



Endurance



Lessons Learned



Lessons Learned Outline

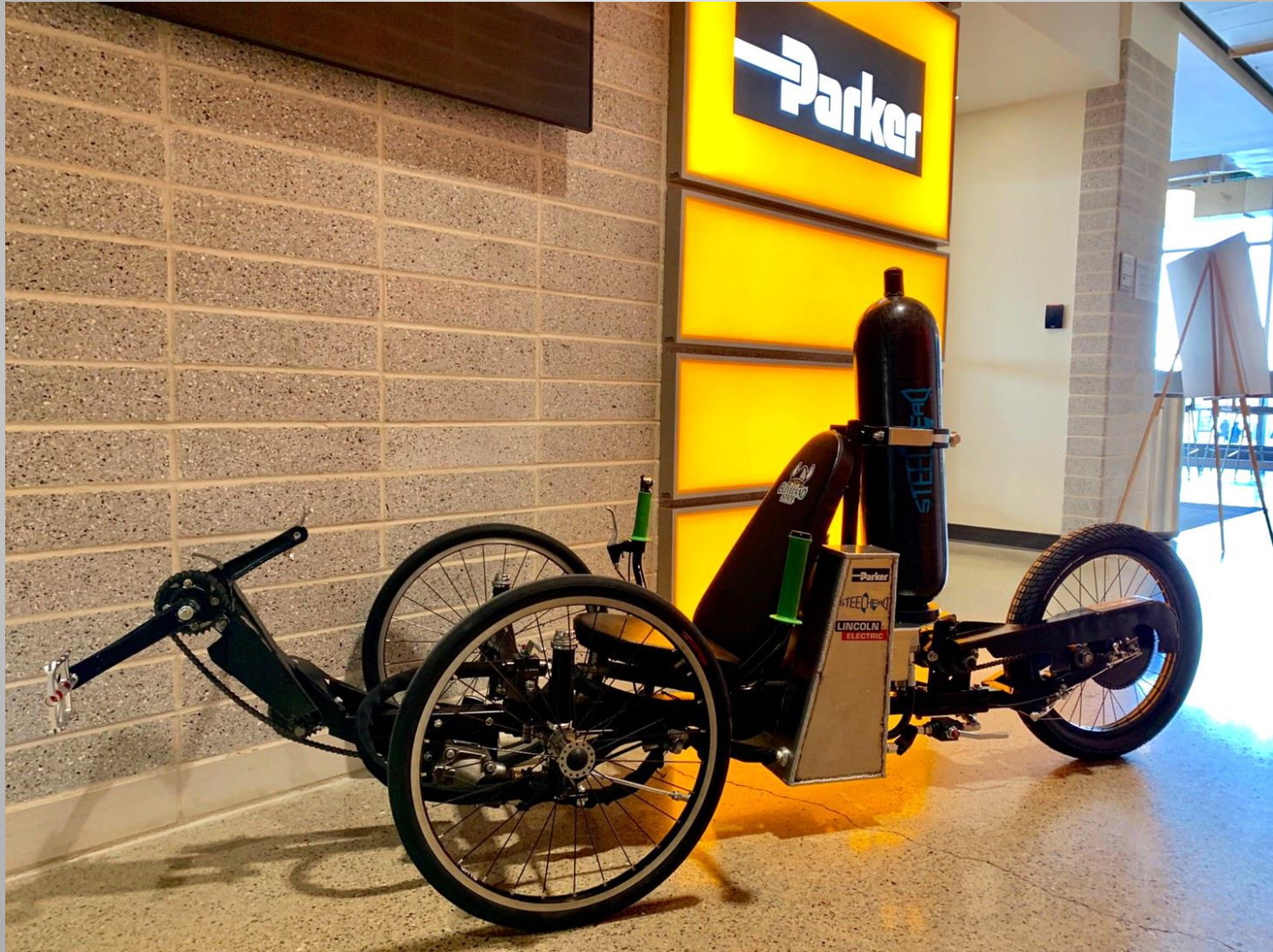


- 🚲 Fluid Power Circuit
 - Friction Loss in Fittings
 - Pull Valve
- 🚲 Mechanical
 - Alignment
 - Gear Ratio



Final Vehicle

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Questions

