NFPA Fluid Power Vehicle Challenge

NFPA
Education and
Technology
Foundation

FINAL PRESENTATION &
DESIGN REVIEW
Cleveland State University
Bogdan Kozul
4/21/2025

Team Introduction

Liquid Fury

Chloe Amoroso, Jeremy Krul, Jerry Donovan, Antonio Perez, Agim Merlika, Joseph Lyons

Team Introduction

Faculty Advisor / Industry Mentors

- Bogdan Kozul
- Neil Baker
- Charlie Houser

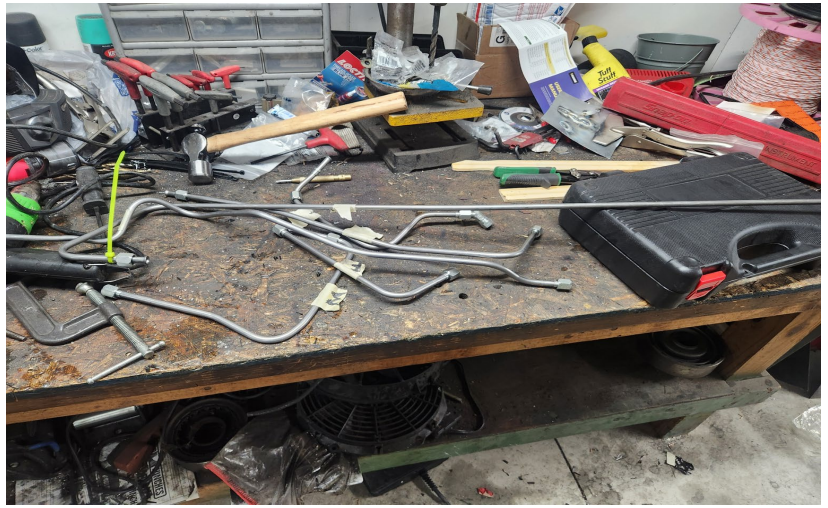
An APPLIED Fluid Power® company

Completion Overview

Fall Semester	Spring Semester
• Finalized Bike Idea • Started Bike Assembly • 60% of parts ordered • Introduced electronic controls • Met with mentors virtually	• 100% of parts ordered • Completed Hardline Tubing • Completed/Implemented Electronic Controls • Prototype Completed • Testing Completed for adjustments • Fully Assembled Bike per safety regulations • In-person meet up with mentors • Built Shipping Container for Bike • Shipped Bike Successfully for Competition! • Win Competition!

Overcoming Obstacles

- Making adjustments for Hardline Tubing
- Preventing Leaks
- Shipping Container
- Minimizing Weight
- Familiarization with CODESYS
- Gear Ratio Adjustments
- Pressure Adjustments
- Expanding User Accessibility
- Considered all Safety Precautions

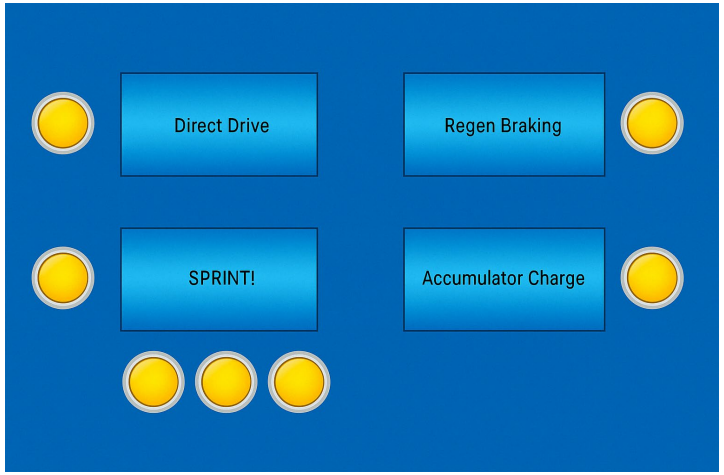


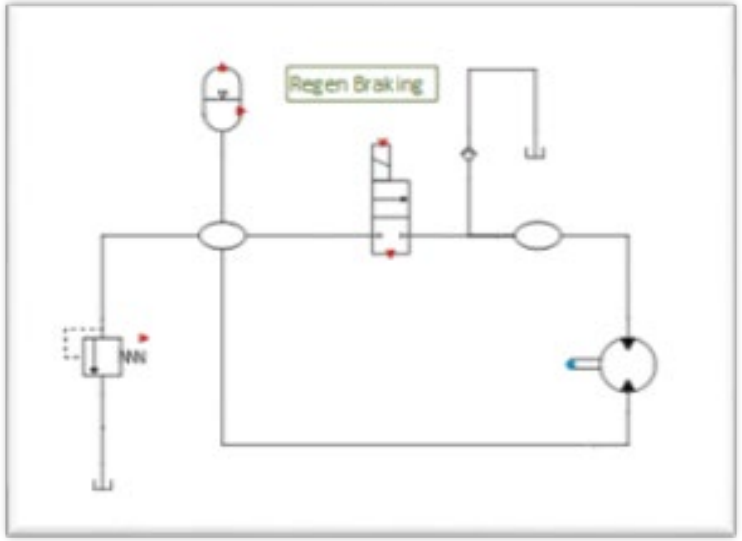
Prototype Testing

- Safety Precautions
- Pressure Adjustments
- Seat Modifications
- Speed Readings
- Adjusting Gear Ratios
- Testing Drive Functions per Competition (sprint, endurance, regenerative braking, efficiency)
- Testing different tires

Regenerative Braking

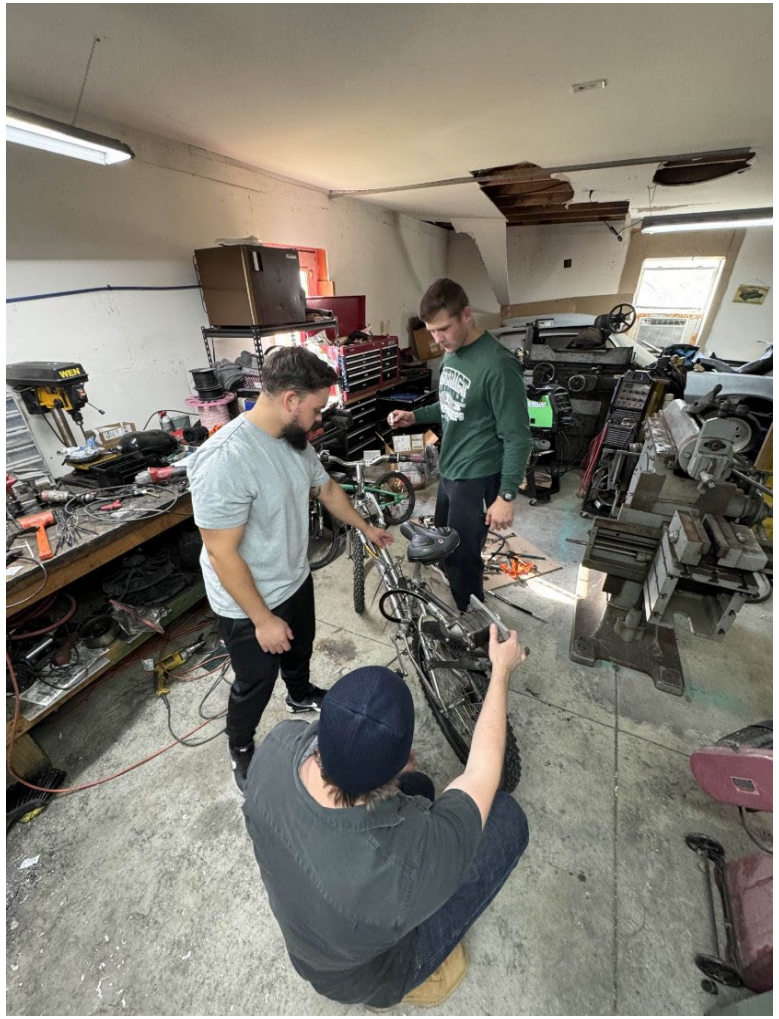
- Assured functionality during prototype phase
- Accessible through electronic controls
- Redirects motor to pump, pulling fluid out of tank, sending to accumulator
- Safely decreases bike speed





Lessons Learned

- Tubing cutting, bending, and flaring to minimize leakage
- Gear Ratio Adjustments for better take off
- Troubleshooting/Fuse Checks
- Chain tension is important to the performance, having it too loose or too tight can result in unsafe operation
- Wheel truing for more efficient riding

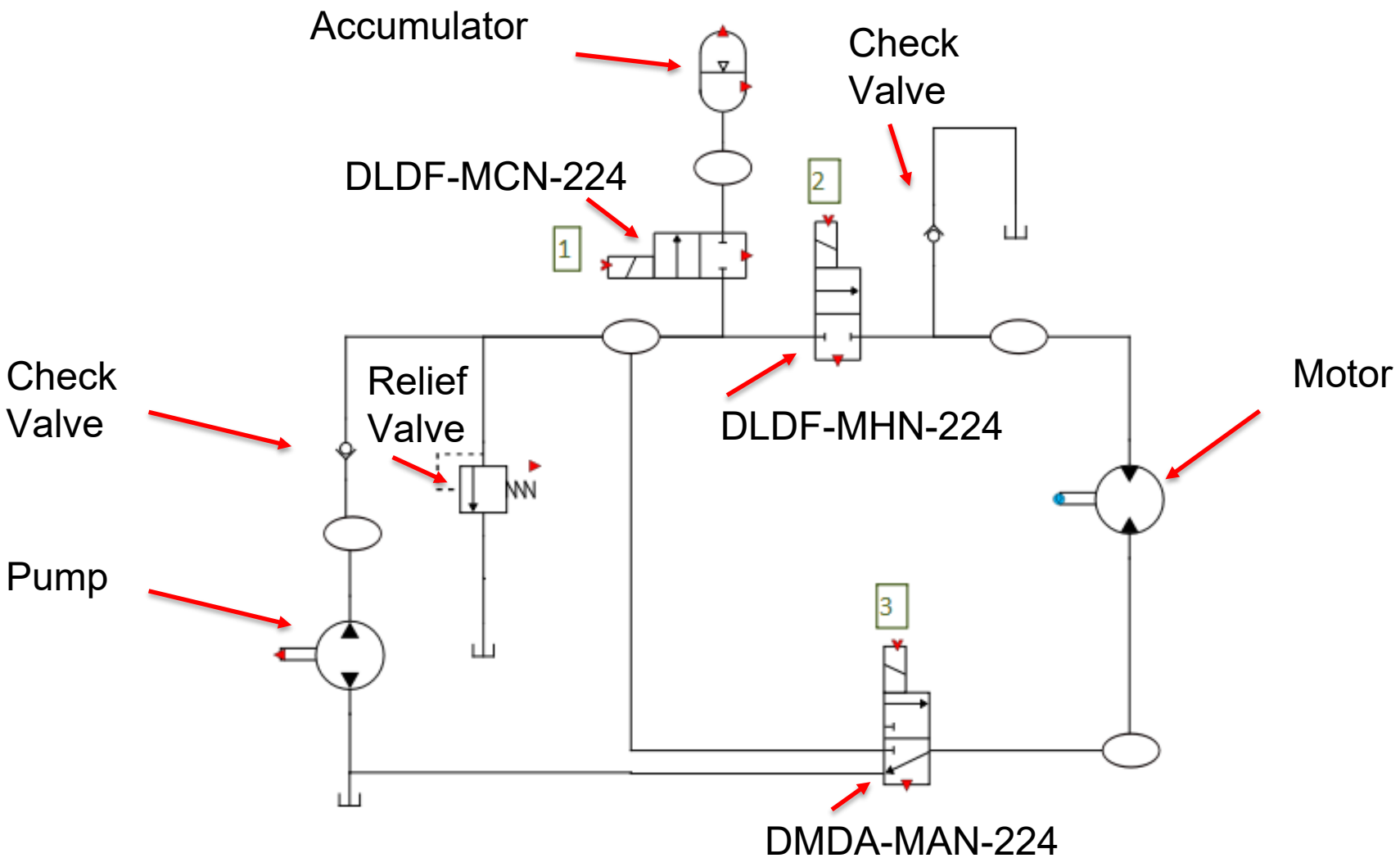


Lessons Learned cont.

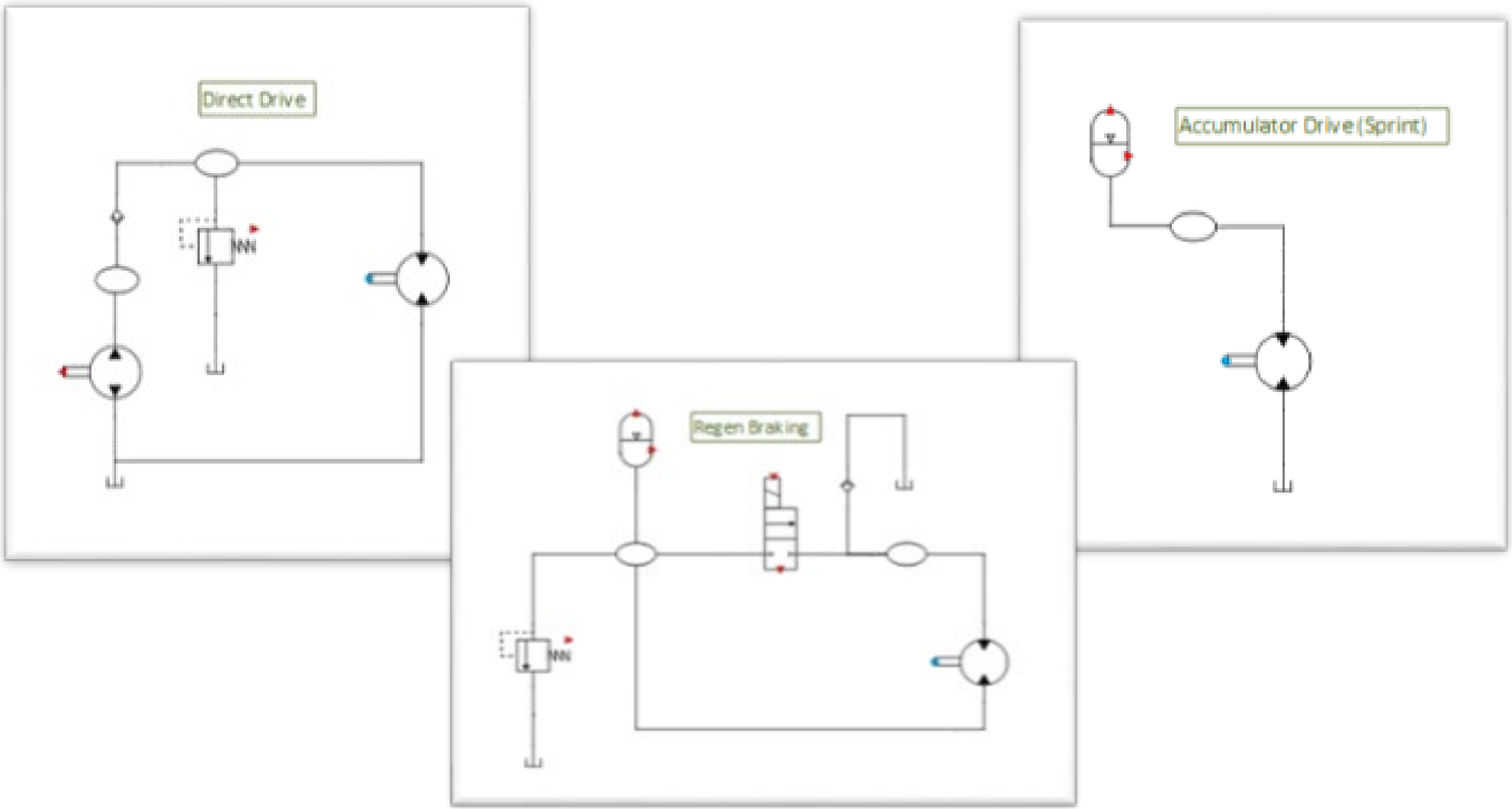
- Engineering Industry Introduction
- Researching Hydraulic Valves and Solenoids
- Implementing Electronic Controls
- Hydraulic System Assembly
- Fabrication Tooling used in Manufacturing Environment

Final Schematic

- 3/8" Line SAE 8 Fittings
- 3/8" Line SAE 8 Fittings



Individual Schematic Functions

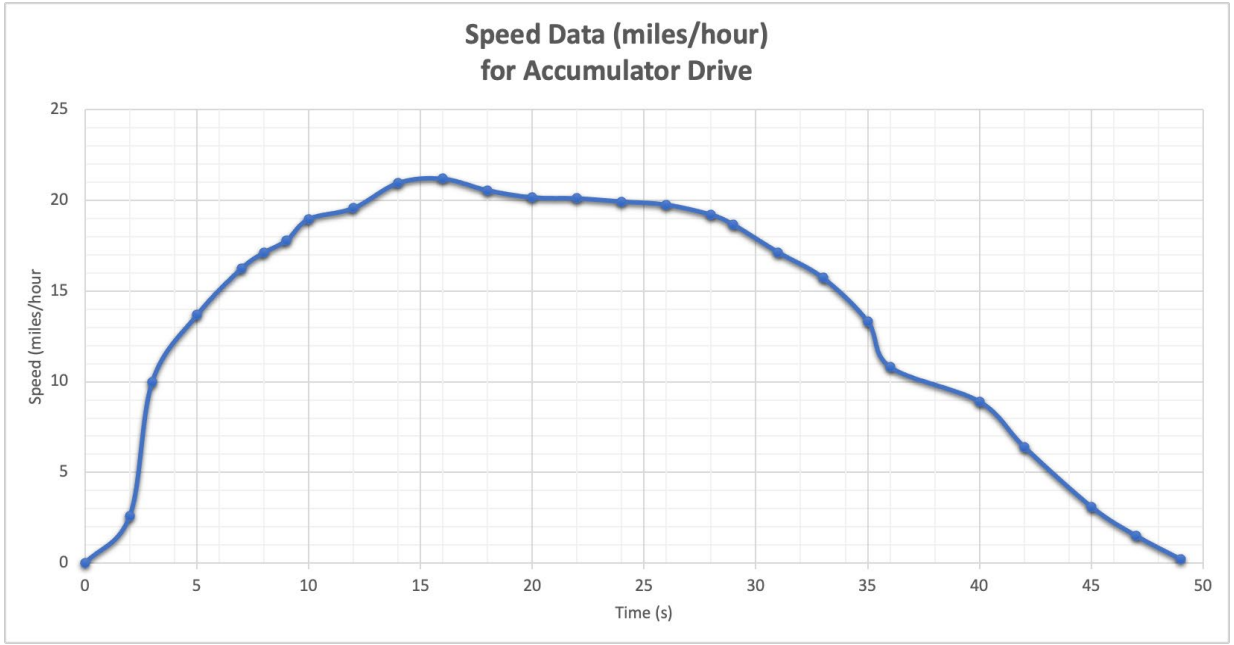


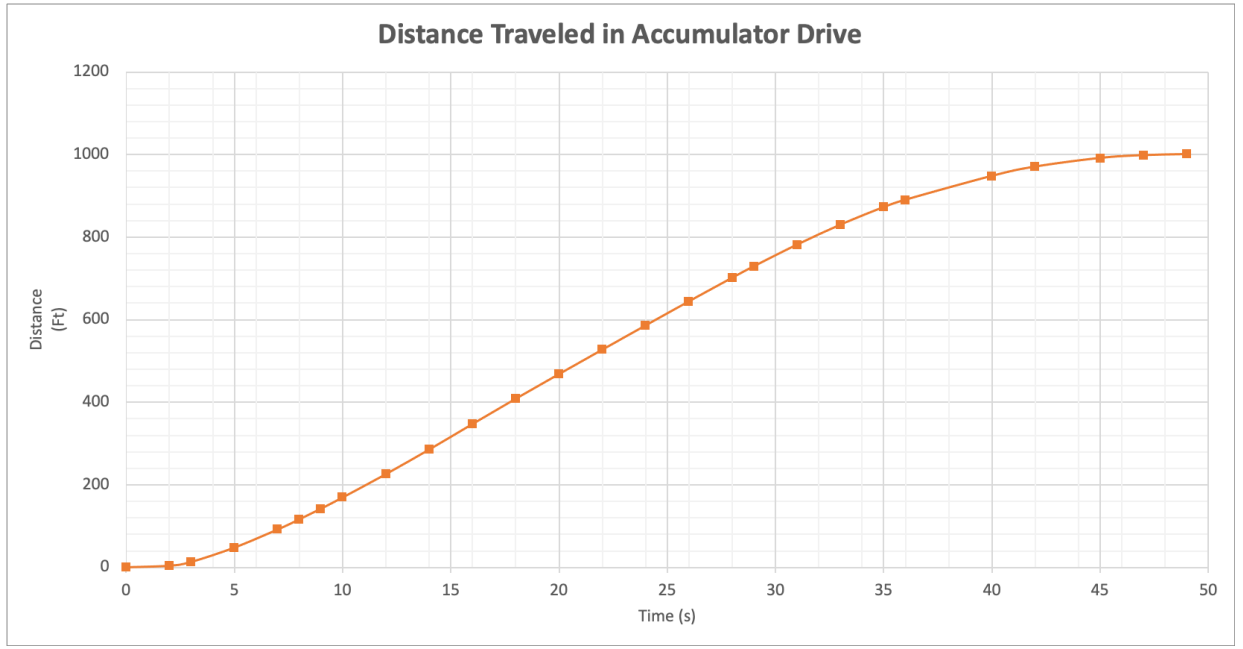
Vehicle Data/Calculations

- Constants
  - Pump Gear Ratio: 4.5 : 1
  - Motor Gear Ratio: 3 : 1
- Calculated Data (@ 800 Psi Nitrogen Pre-charge)
  - 1316 ft Travel Distance for Sprint Race
  - Max Wheel Torque: 416 in-lbs
  - Average Wheel Torque: 200 in-lbs
  - Max Pulling Force: 32 lbs

Vehicle Testing

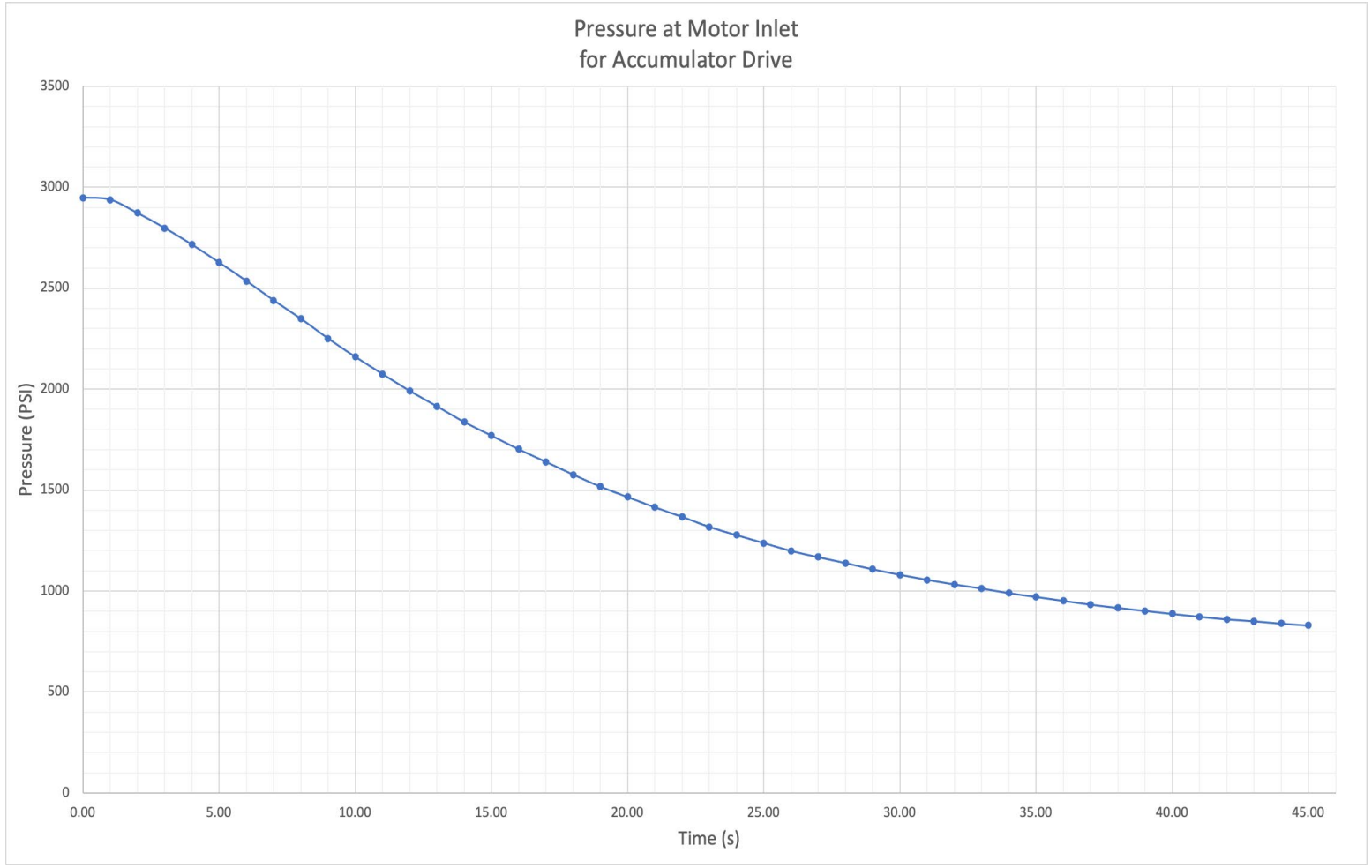
- Accumulator Drive (@ 800 PSI Pre-charge)
  - Max Speed: 22 MPH
  - 1000 ft Travel Distance
  - Total Time to reach empty: 49s





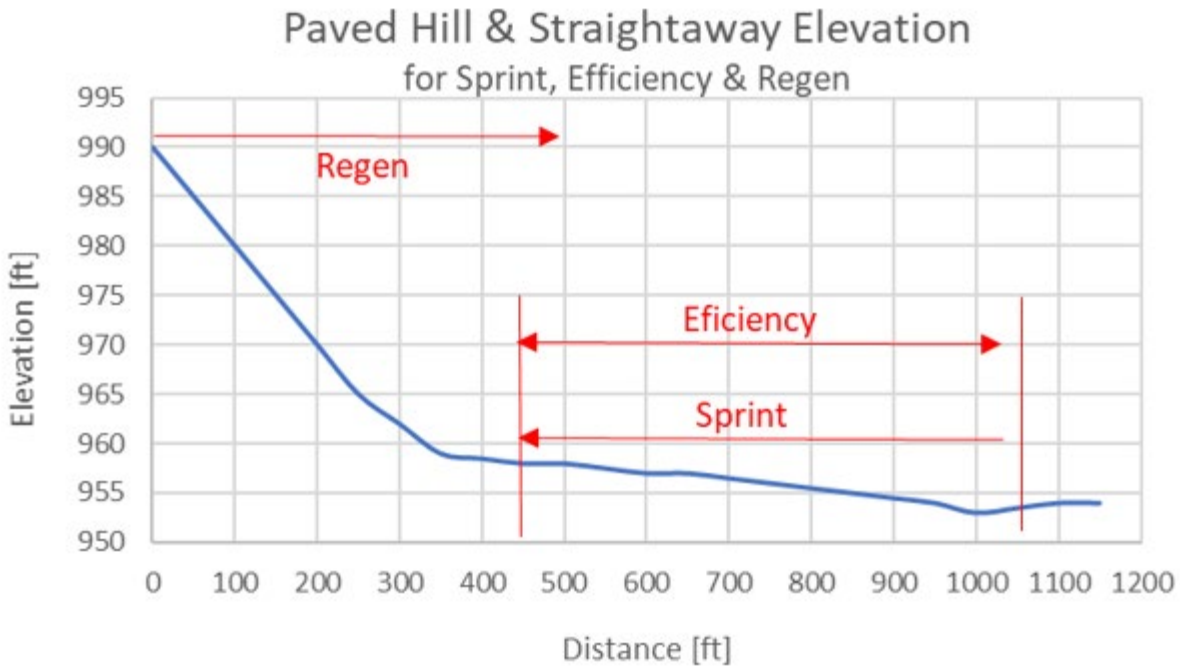
Vehicle Testing

- Accumulator Drive (@ 800 PSI Pre-charge)



Vehicle Projections

- Knowns:
  - Sprint Race Distance: 600 Ft
- Changes
  - Increase the pre-charge to 1000 psi
    - Reduces our depletion time
    - Increases time to peak speed
    - Reduces our total traveled distance to around 800 Ft



Final Fabrication

- Hardline tubing
- Manifold Mount
- Chain Guards
- Rear Gear Ratio Adjustment
- Customizable Bike Seat
- Pressure Adjustment
- Crate Build for Bike

Bike Features

- Regenerative Braking, Direct Drive, Acceleration, Charge
- Chain Guards (safety)
- Safety Solenoid Kill Switch
- Upright Mount/Stand
- Electronic Controls
- Weight / 115 Lb

Where We Started

Final Product

Improvements to make

- Larger Pedal to Pump Gear Ratio for better Direct Drive Operation
- Better Weight Reduction
- Implement more testing devices for better data
- Utilize more of the control pack
  - Data Management
  - Real Time Data