NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION
TEAM or INSTITUTION NAME
TEAM ADVISOR
DATE

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Problem Statement

To design a hydraulic bike that is solely human powered and can capture energy to store inside an accumulator.

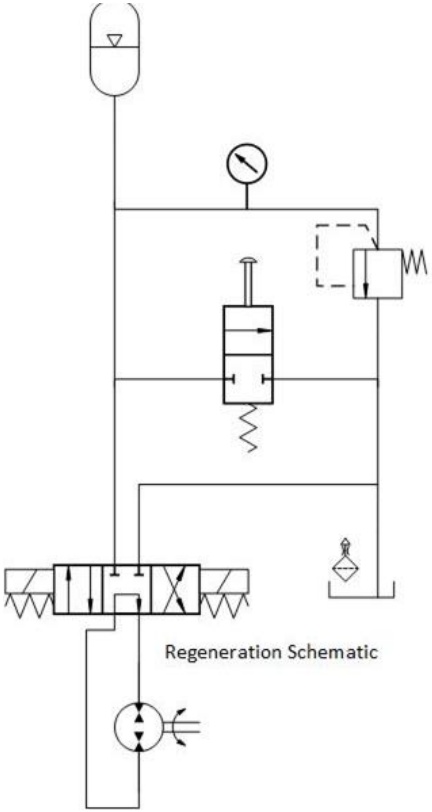
Design Goals

- Design a more efficient power input system
- Maximize the efficiency of our 1 gallon accumulator
- Reduce weight without losing structural strength

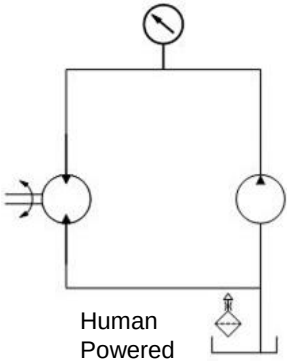
Midway Vehicle Design

- Power Input/Output Changes
- Planetary Gear System
- Bladder Reservoir
- Pneumatic Derailleur

Midway Schematic



Regeneration Schematic



Human Powered Circuit

Old Bike Frame

- Used for Prototyping
  - Hydraulic Circuit
  - Power Input System
  - Location Mounts on Frame for Hydraulic Equipment
- Disadvantages of the old Bike Frame
  - Steel frame makes it heavy
  - Power input system is not ideal
  - Not good mounting locations for hydraulic equipment

New Bike Frame

- Final Prototyping
  - Human Powered circuit testing
  - Power Input system
  - Steering System

- Advantages of new frame
  - Weighs much less than the old frame
  - New power input system without u-joints
  - Easily to mount hydraulic components with new mounting points

Vehicle Construction

- Built from 80/20 aluminium extrusion
  - Modular system
  - Customizable
  - Strong and Light Material
  - Ability to create build-at-home project kit

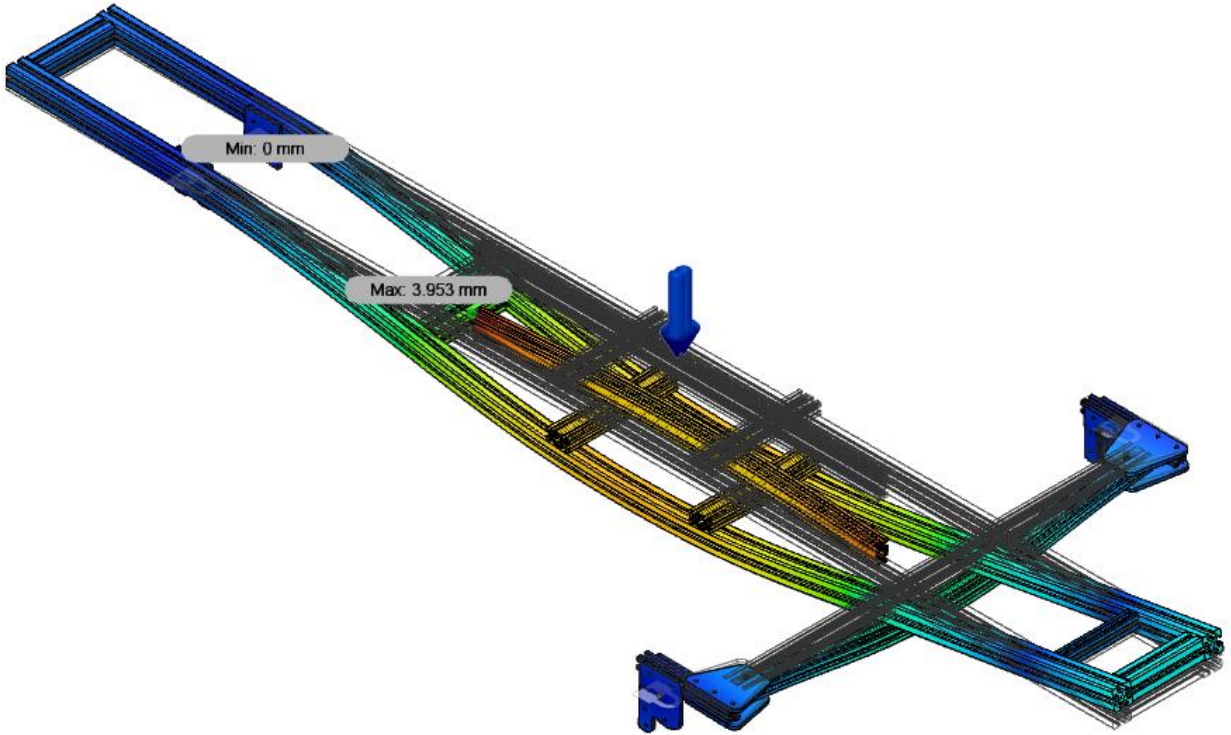
FEA Testing of bike frame

- 4mm deflection at

  400 lb force

- Well above factor

  of safety of 2.5

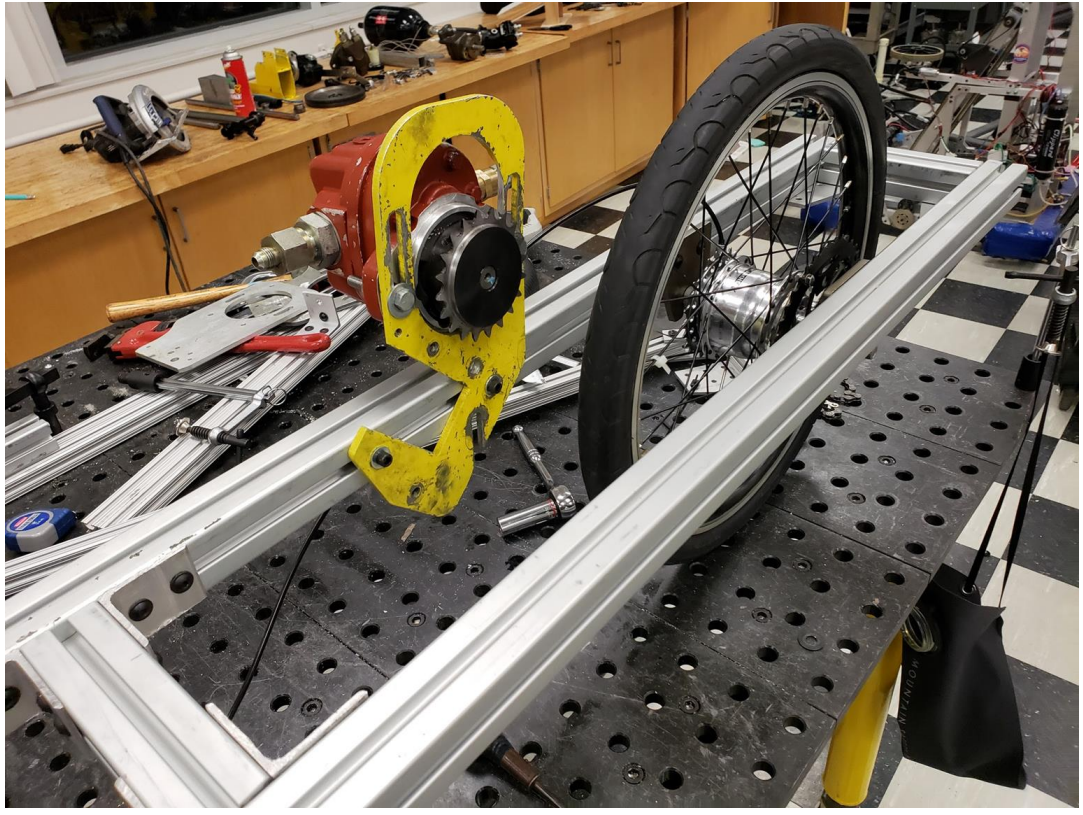


Bike Design

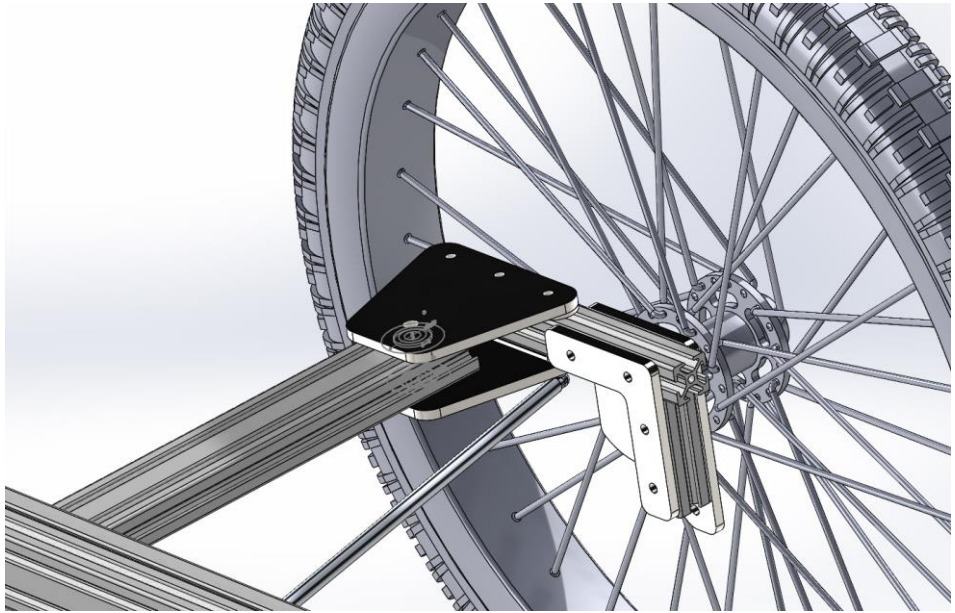
First Bike Design was completed in SolidWorks

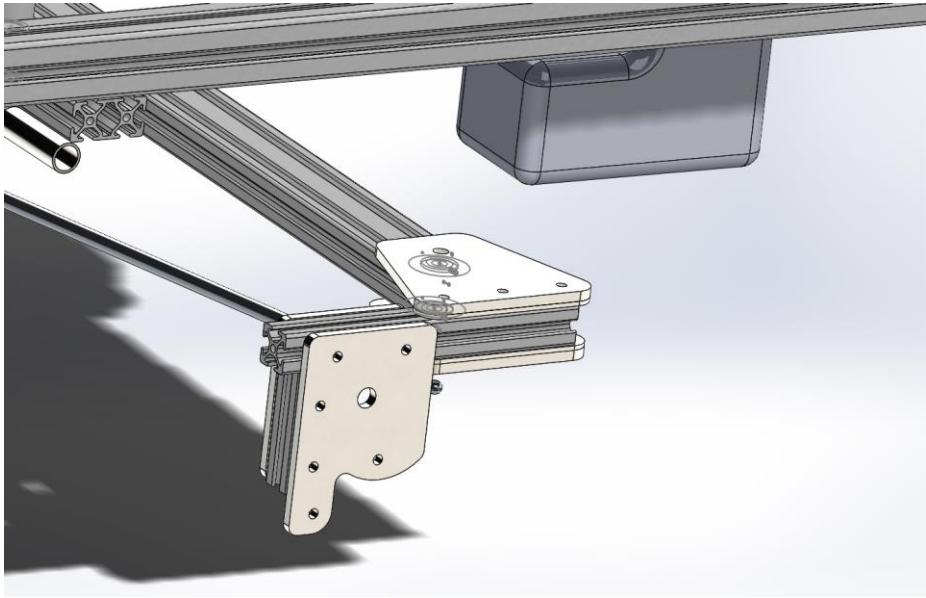
Vehicle Construction

Vehicle Construction

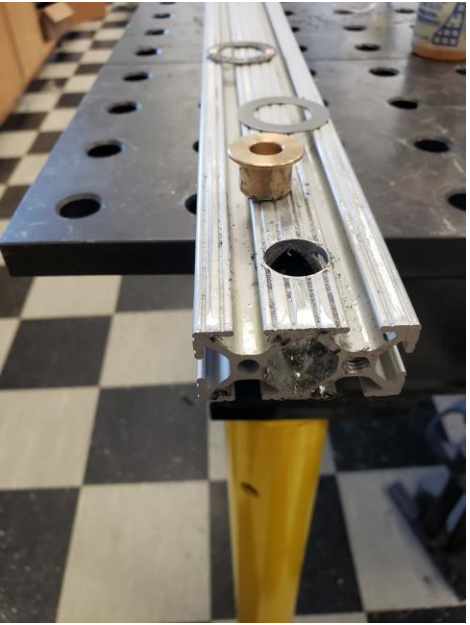


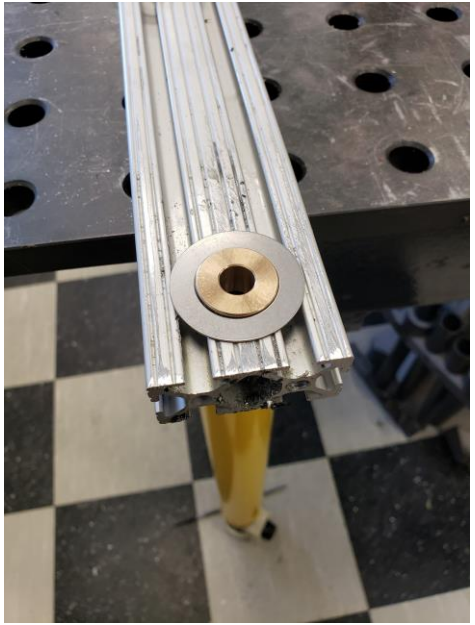
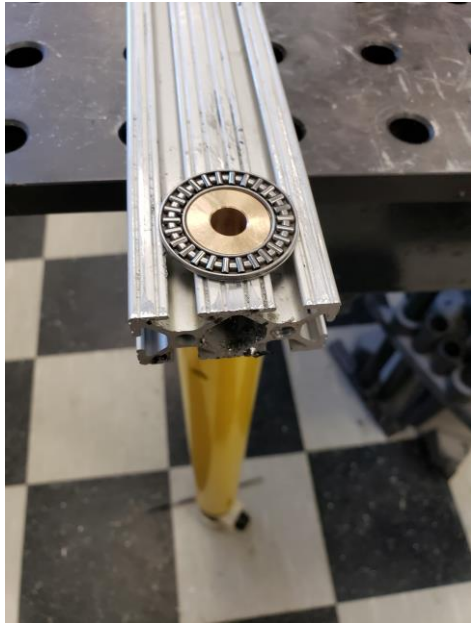
Wheel Mount and Steering





Steering System Building



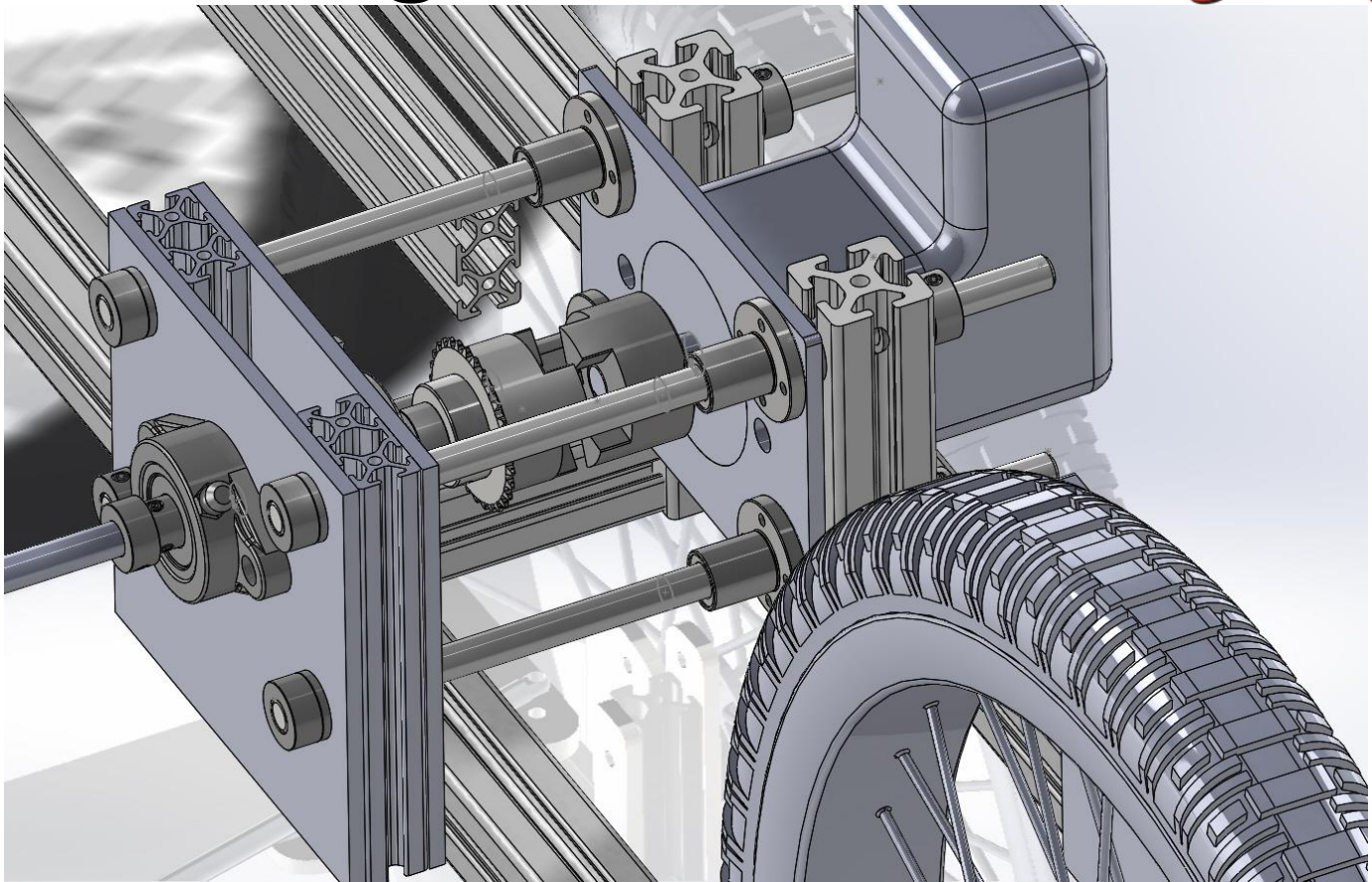
Bike ready for testing

First Bike Ride

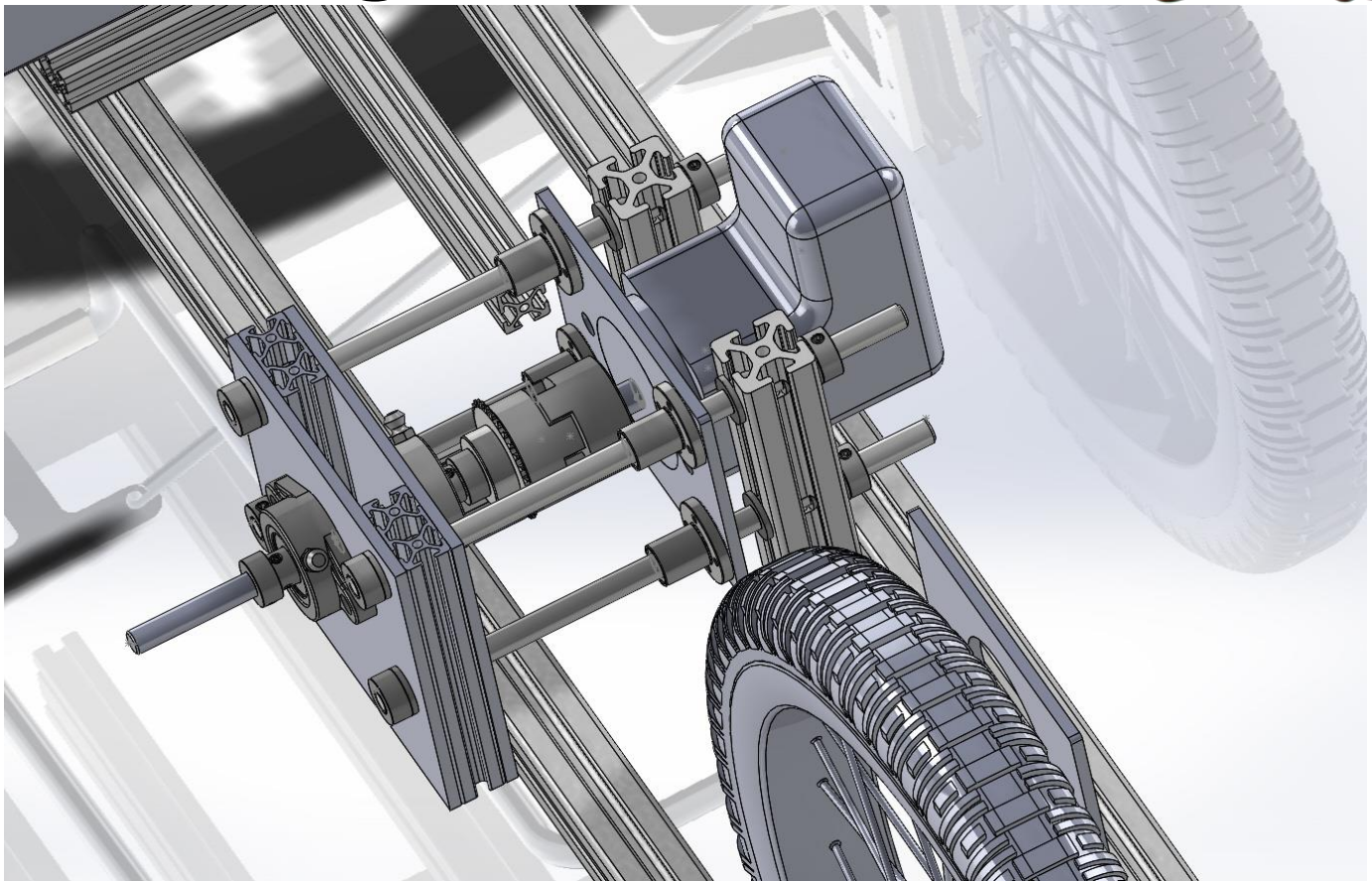
Pneumatic Clutch

- The clutch is for the accumulator/regeneration circuit
- This is to make the system more efficient
- Pneumatic actuator will engage/disengage chain drive

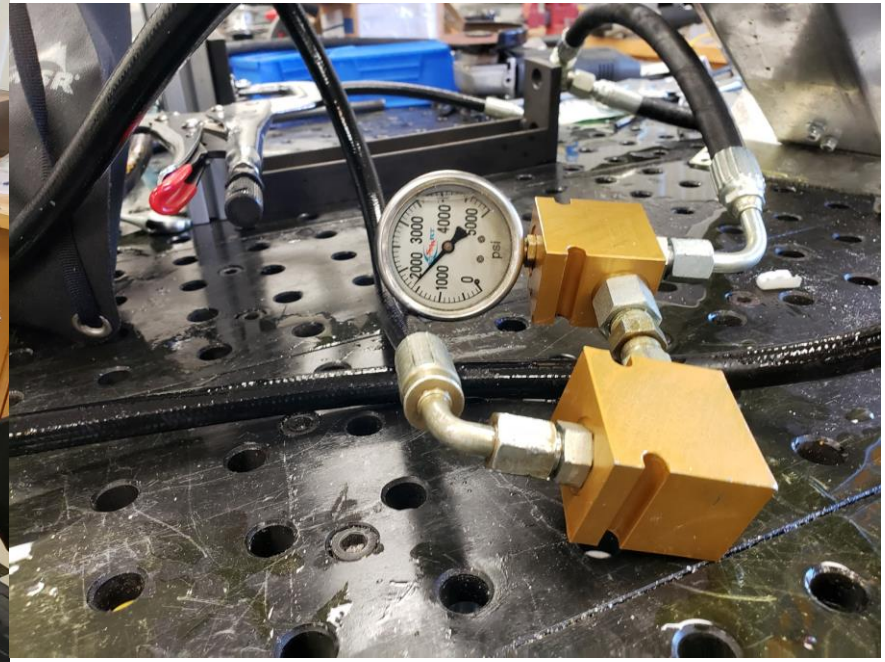
Clutch Design



Clutch Design

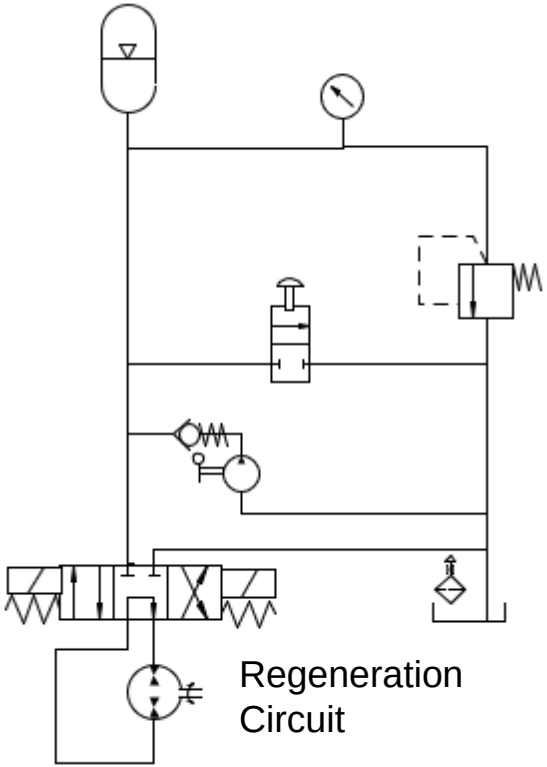


Accumulator Testing

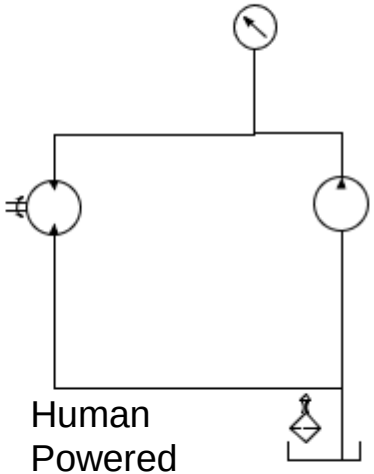


Accumulator Testing

Hydraulic Schematic



Regeneration Circuit



Human Powered Circuit

Bike Specifications

Weight of frame alone: 50 lbs
Approximate weight of assembled vehicle: 136 lbs
Length:8’
Width:4’

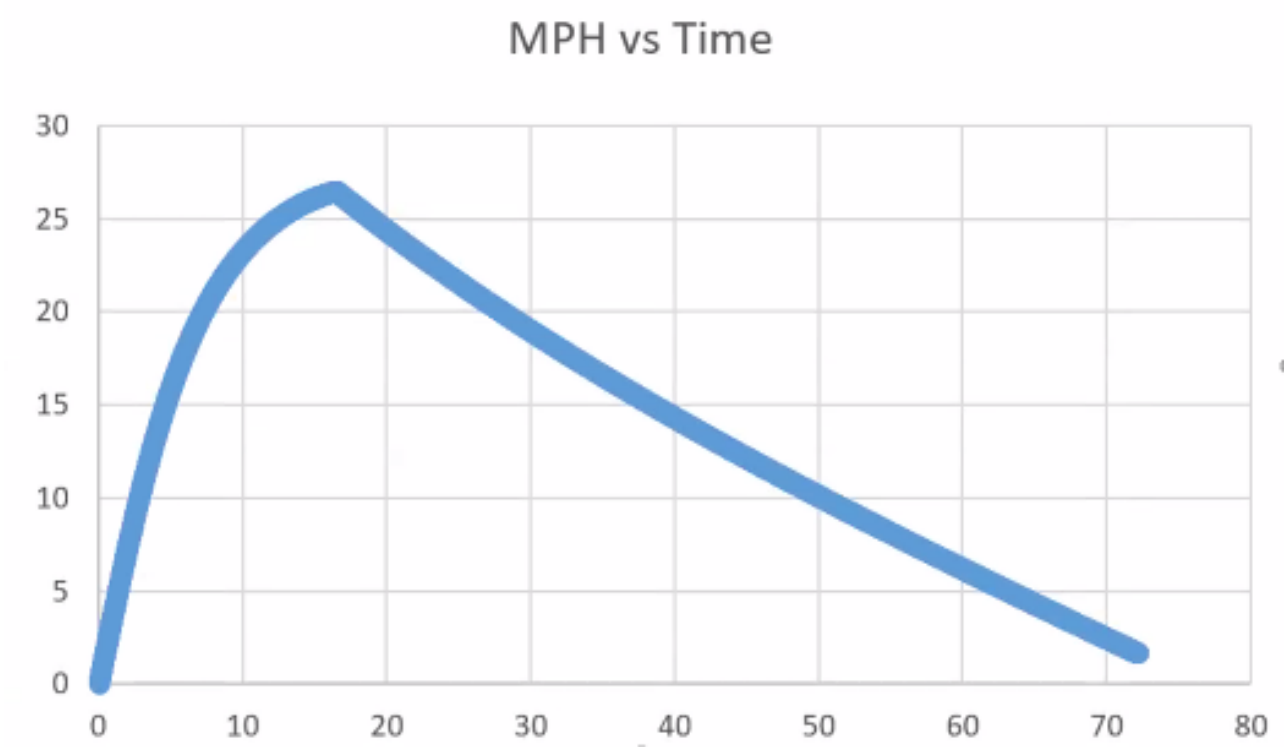
With Accumulator

Force on back Wheel at max pressure: 57.10845 lbf
Theoretical Top Speed using Accumulator: 27 MPH

Without Accumulator

Force on back Wheel without accumulator: 6.722 lbf
Max tested Speed in hydrostatic: 12 - 13 MPH

Theoretical Data



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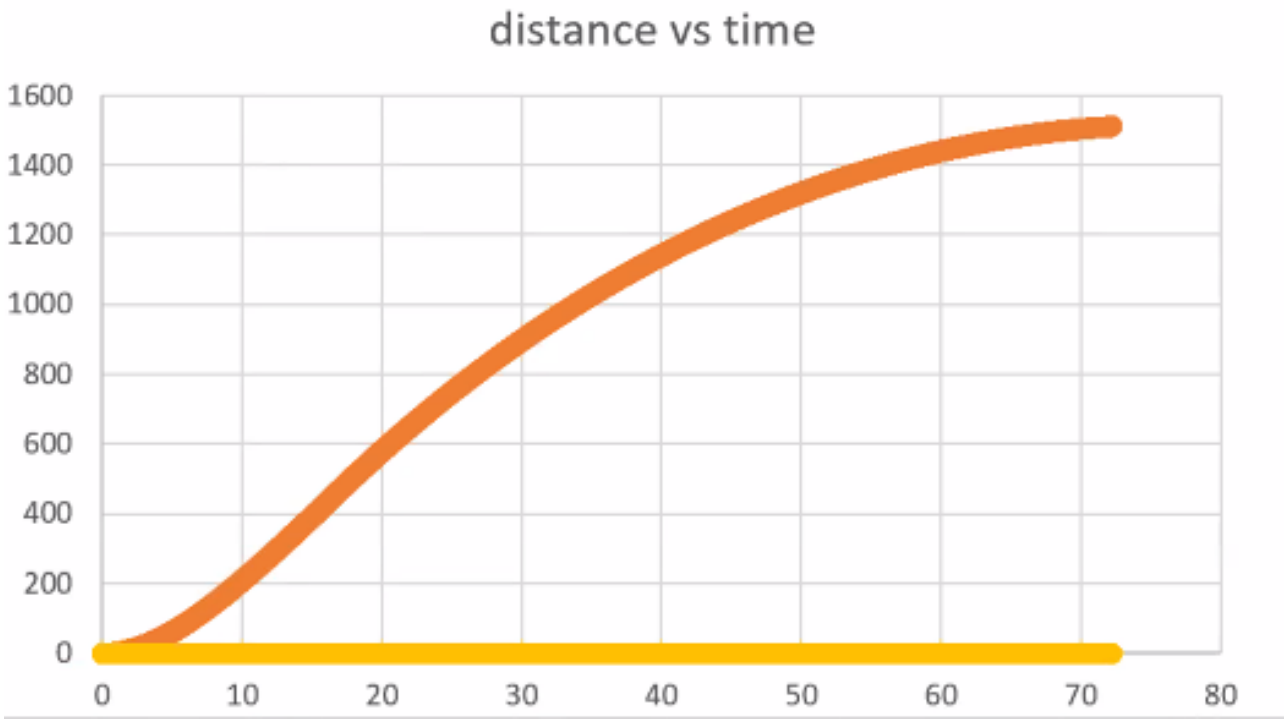
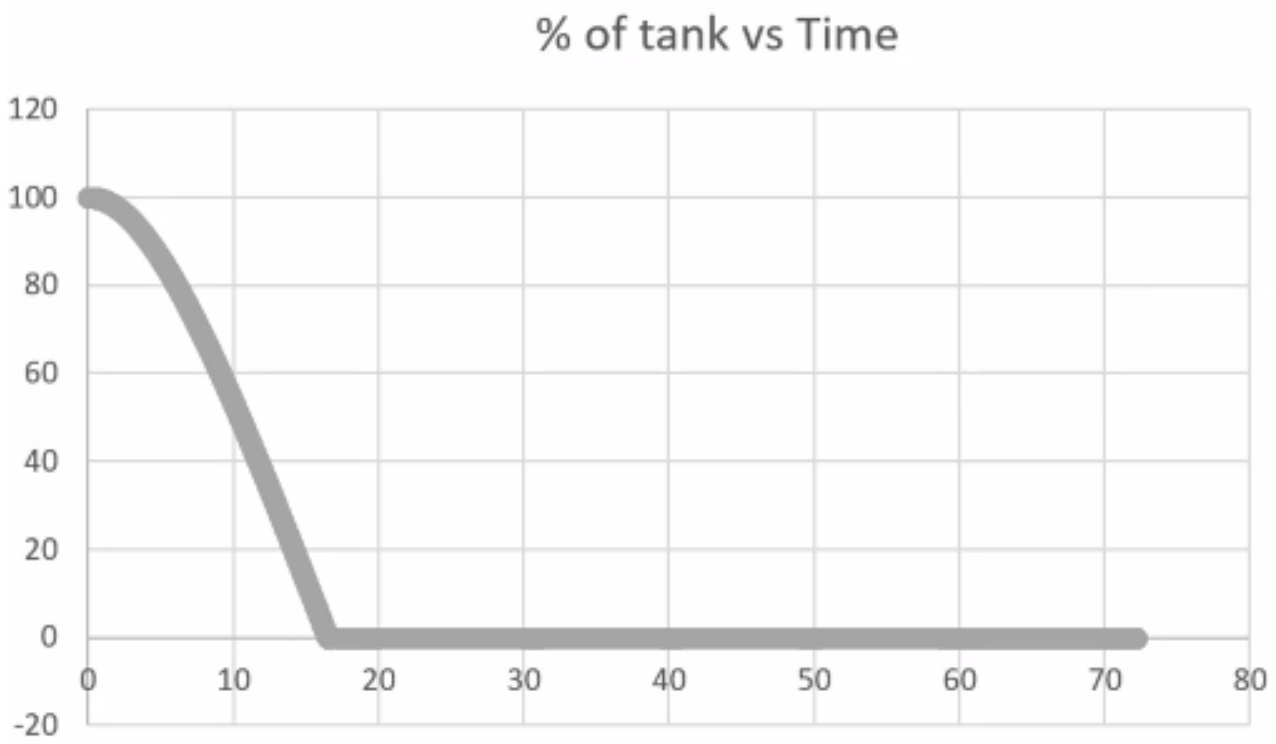


Theoretical Data



What We Learned

- Operating a WAZER (Water Jet Cutting Machine)
- Operation of a CNC machine
- Mount Fabrication and Design
- How to perform FEA simulations
- How to work well as a team
- Prototyping parts quickly using additive manufacturing
- How to prioritize and delegate tasks effectively

Possible Future Improvements

- Build and test clutch system
- Perform more efficiency testing
- Longer handlebars for easier steering
- Mount accumulator to bike building, any necessary mounts
- Shorten overall hydraulic hose lengths to reduce line losses
- Build and mount enclosure to bike to reduce wind resistance
- More ergonomic seating