NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION

Michigan Technological University
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Michigan Tech

Team Introduction

Mentors: Courtney Castelic & Cedrick Barber
Team Advisor: David Wanless
Team Members: Jay Kintner
Will Norton
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Eric Pederson

Design Objectives

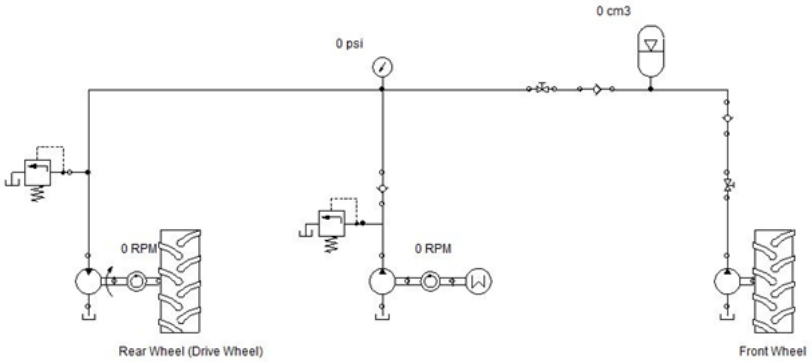
- Create a quick, efficient, and reliable vehicle with fluid power.
  - Speed
    - Target: 7Mph
  - Efficiency
    - 35%
  - Reliability
    - No Leaks
    - No Breakdowns
    - Of Obvious Quality

Midway Summary

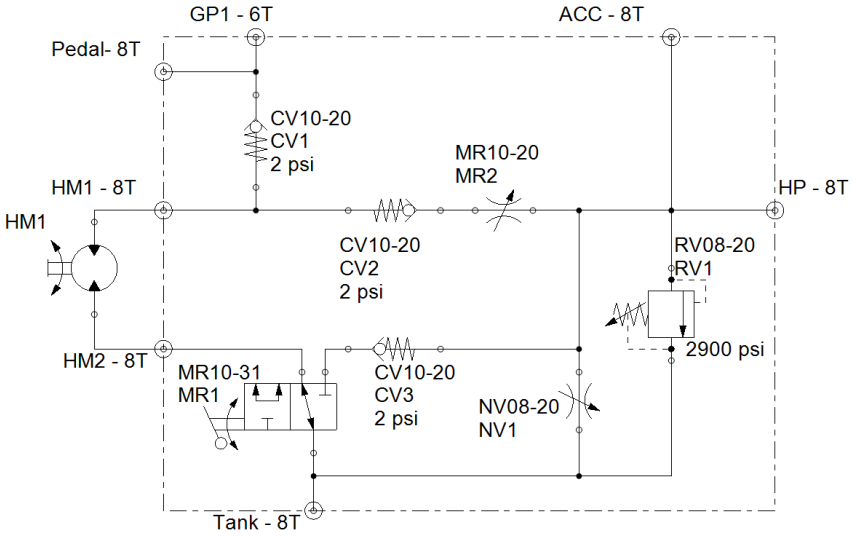
- Initial Bike Design
  - Lacking valves and brackets
  - Unconfirmed component geometry
  - Presentation of general idea

Midway Summary cont.

- Initial circuit
  - Front wheel regeneration
  - Lack of valves



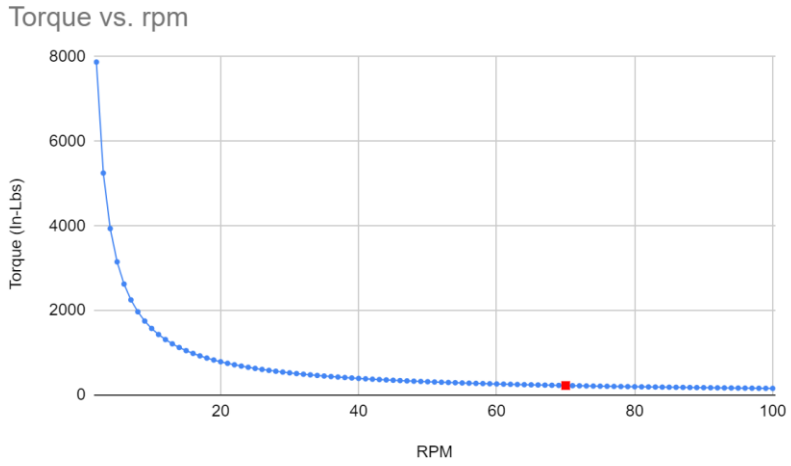
- Final circuit
  - Use of valves
  - Front wheel ignored
  - Use of manifold

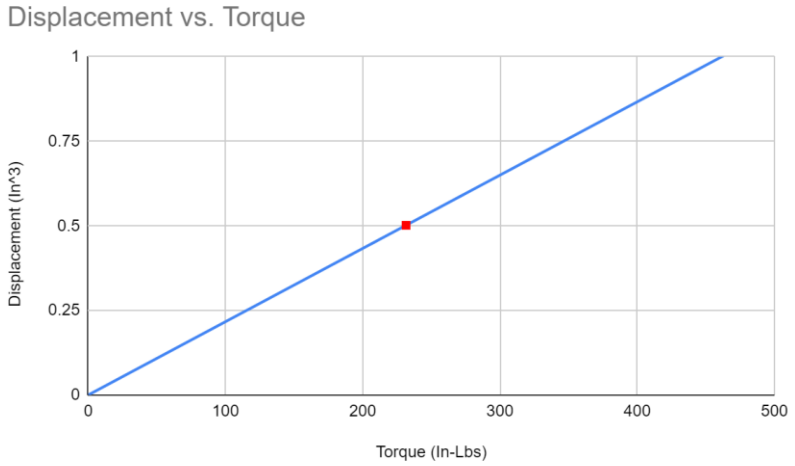


Midway Summary cont.

Results of Analysis

$Torque = \frac{Hp * 5252}{RPM}$	$Torque = \frac{0.25 * 5252}{70} = 18.76 Ft * Lbs.$ $= 225\ In * Lbs.$
$MPH = \frac{Wheel\ Diameter\ * RPM}{336}$	$MPH = \frac{27 * 70}{336} = 5.625\ MPH$
$Displacement = \frac{Torque * 2\pi}{Pressure(psi)}$	$Displacement = \frac{225 * 2\pi}{2900} = 0.48\ In^3$
$GPM = \frac{RPM * Displacement}{231}$	$GPM = \frac{70 * 0.48}{231} = 0.145\ GPM$





Midway Summary cont.

Selection of hardware

- Once we found our displacement and flow rate requirements, we were able to start picking parts.
- We designed our bike with the Parker P1 series piston pump that fit near our design requirements
- We ended up choosing a gear motor and a gear pump from the order form that fit our design specifications.
- Hoses are to all be of 3/8” size with -6 JIC male ends.
- Additional hardware was ordered separately.

Vehicle Construction

- Started with an existing frame
- Rapid prototyping
  - using models of the pump, motor and accumulator to model mounting brackets
  - 3D printed the manifold to help with laying out the frame
- Began machining parts

Driving the Pump

- Chain and sprockets to drive the pump
  - 2:1 sprocket ratio
  - Keyed and threaded sleeve on pump shaft

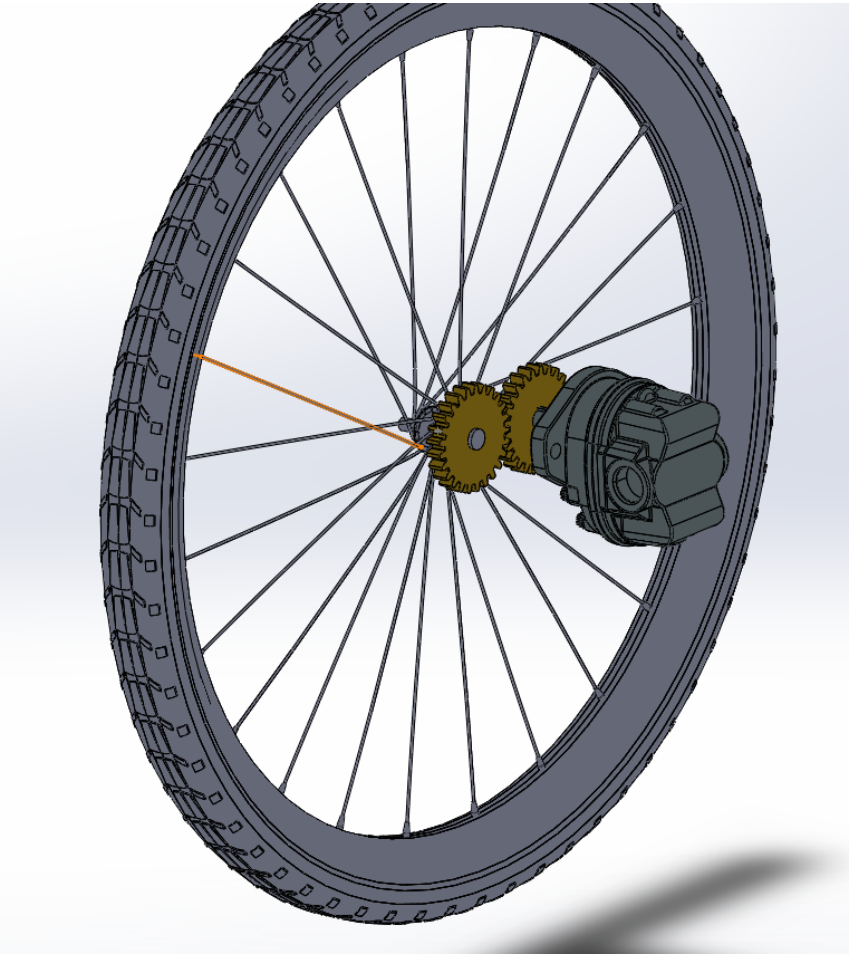
Driving the Pump Cont'd

- Freewheel clutch bearing on the pump
  - Driven one way and allows for coasting
    - Freewheels when shaft moves faster than sprocket
  - Still regenerates from motor to accumulator

https://www.ebay.com/itm/Shimano-MX30-BMX-Single-Speed-Freewheel-Sprocket-18-T-/310896342091

Driving the Rear Axle

- Spur gears to drive the rear axle
  - 3 inch, 72-tooth spur gears
  - 1:1 gear ratio
  - Internally threaded sleeve on axle to attach gear



Lessons Learned

- First year participating in the competition gave the team a steep learning curve to overcome.
- When we came to certain hydraulic fundamentals, we had to research and teach ourselves some of the theory
- Utilizing 3D printers to effectively prototype mounting brackets and other parts
- Using Automation Studio to model and improve our circuit design

Problems Overcame

- Our accumulator size and weight was larger than expected and we had to account for this
- Not having an in-depth background in hydraulics
- Not building a custom bike frame and having to find a bike that fit our needs

Questions?