NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION

Iowa State University
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Team Introduction

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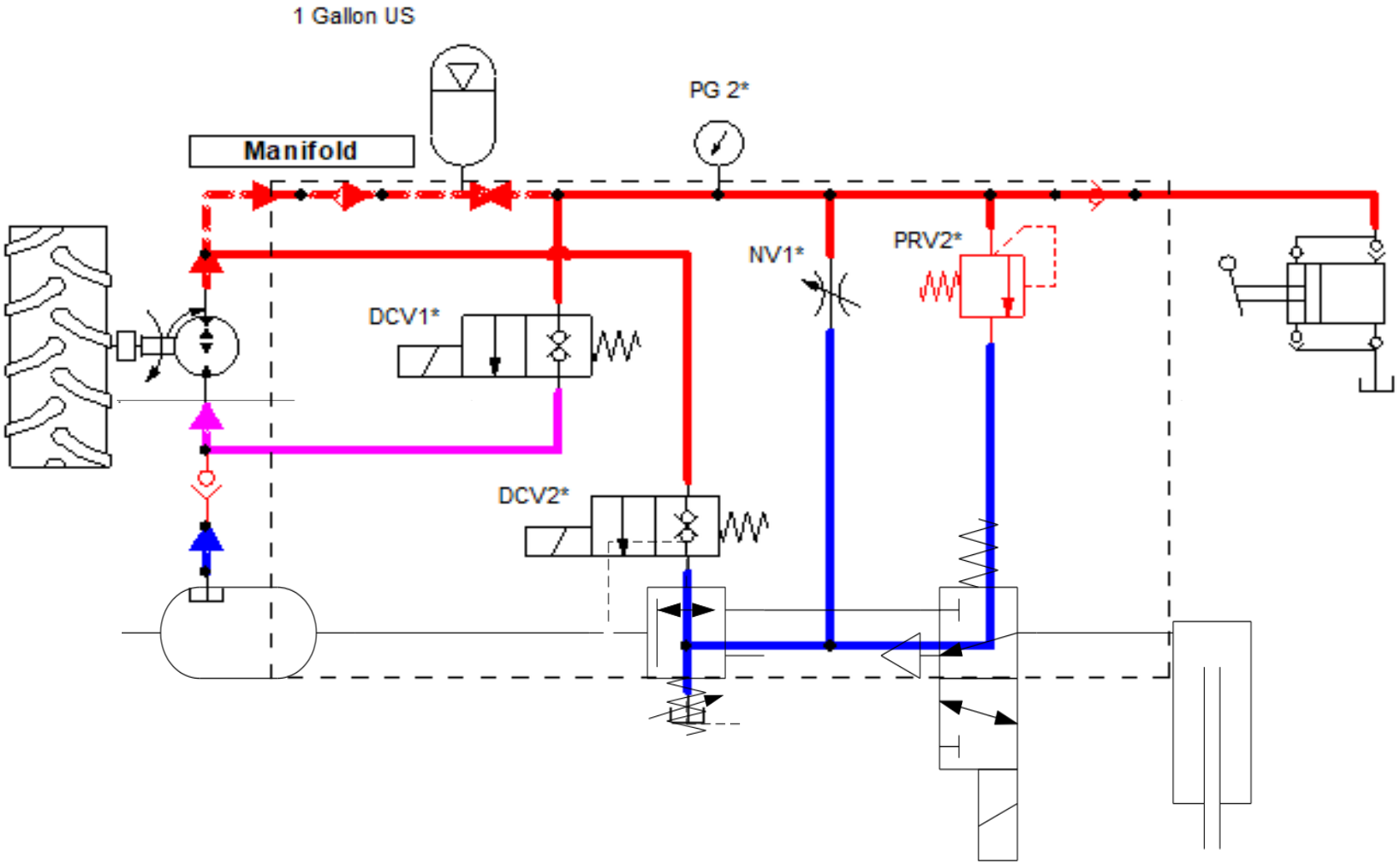
Problem Statement

- Our team sought to design a human powered vehicle that effectively uses fluid power for power transmission and energy storage as a competitive entry in the fluid power vehicle challenge
- We want the design to be capable of:
  - Incorporating Electronics and Pneumatics
  - Traveling 2 miles in 20 minutes
  - Maximizing efficiency

Midway Presentation Summary



Midway Presentation Summary

- Hardware Selection
  - Human powered circuit
    - Pump: Micro-axial piston pump (0.018 CID)
    - Motor: Gear Pump (2.1 cc/rev)
  - Accumulator powered circuit
    - Motor: Bent-axis piston motor (5 cc/rev)
- Electronics
  - Implemented an Arduino UNO to control the logic of the bike
    - Push buttons engage the clutch to the rear drive and then opens the poppet valves
    - Allows for change of circuits to accumulator power and allows for regenerative braking

Mode	DCV1	DCV2	PSV
Direct Drive	0	0	0
Regen Brake	0	0	1
Accumulator Power	1	1	1*
Accumulator Charge	0	0	0

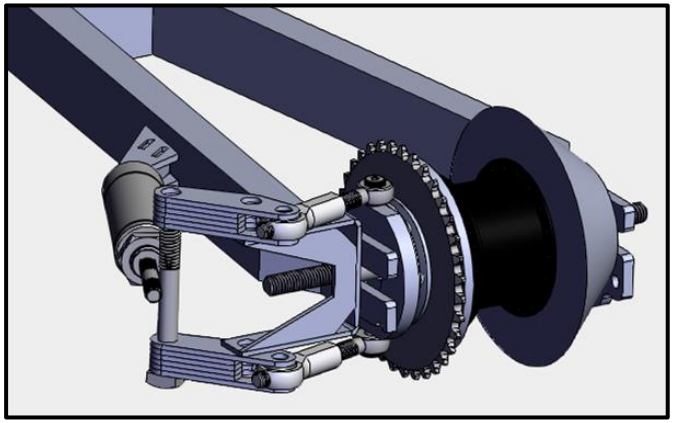
*Need to engage momentarily before engaging DCV1 and DCV2

0 - Solenoid not energized

1 - Solenoid energized

Bike Construction

- The bike was operational by the proof of working bike deadline
- We used the same bike frame from the previous year
- Most parts were designed and fabricated by the team
  - The clutch kit was designed and fabricated by the team
  - The motor and pump mounts were welded on campus by team members
  - The accumulator mount was designed and 3D printed by the team
  - The front sprocket was designed by the team and cut out at the campus waterjet lab
  - Bike logic and harnessing was developed by the team

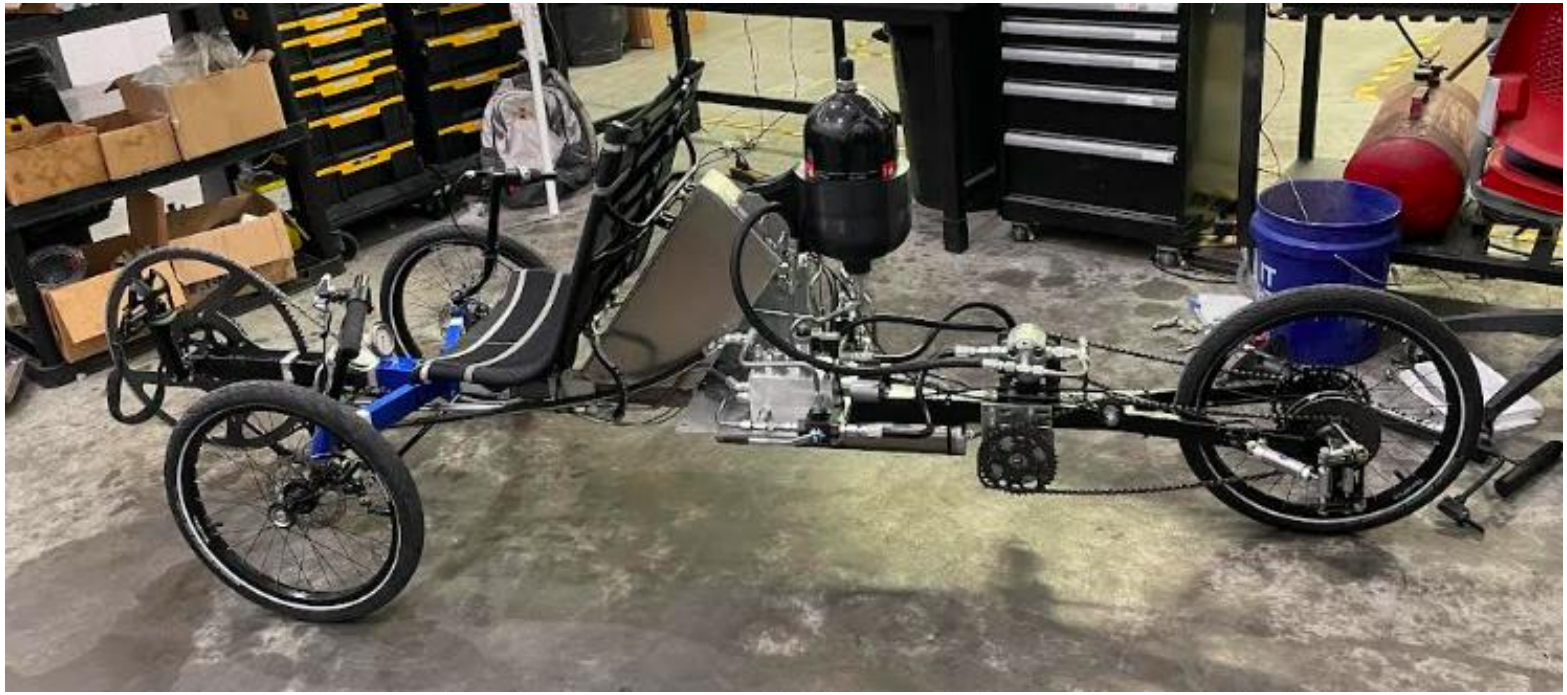


Testing

- We have been testing throughout the building process
  - testing different pump speeds to test flow rates
  - Applying resistive loads to the motor to determine torque needed
- Further testing was conducted upon finishing the bike
  - Problems were realized that we couldn't test prior to finishing the bike
  - Our chain alignment was off slightly and there was too much slack
  - We weren't spinning the pump fast enough to have enough flow rate to efficiently operate the rear motor
  - The initial motor for the accumulator side of the circuit was not large enough
- Fine tuning
  - The chain is aligned and tensioned correctly
  - We added a double reduction to the front to spin the pump faster
  - We have switched out the motor for the accumulator circuit

Final Vehicle

- The bike is functional and easy to operate
  - Electrical wiring is covered
  - Hydraulic Lines have been organized
  - Hardware has been adjusted



Lessons Learned

- Hydraulic Theory
  - Pump speed greatly impacts flow rate
  - Flow Impacts circuit efficiency
- Mechanical Components
  - Not all designs work as expected
  - If you're willing to learn you can still make things work
  - Fabricating parts is extremely difficult and time consuming
- Lead Time
  - Ordering and outsourcing parts can take much longer than expected
- Teamwork
  - Splitting responsibilities helps accomplish things more quickly
- Networking and Professionalism
  - Adhering to advice of industry professionals is important to success
  - Networking with students and professionals with similar interests is valuable to career development

Thank You

From the Iowa State Fluid Power Club and FPVC Team