NFPA Fluid Power VEHICLE Challenge

NFPA
Education and Technology Foundation

Final Presentation
University of Louisiana at Lafayette
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UNIVERSITY of LOUISIANA LAFAYETTE

Team Introductions

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Team Introductions

Michael Tonore

Team Introductions

Austin Sun Chee Fore

Team Introductions

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Lessons From Previous Years

2021-2022 Competition Vehicle

Lessons From Previous Years

The University of Louisiana at Lafayette has competed with the NFPA in the 2021-2022 event. Referencing the previous vehicle proved beneficial for the planning and development of this year's team.

- Old model is a traditional tricycle with high center of gravity
- Due to its dual axle construction and significant reinforcement the vehicle is heavy and over-engineered structurally
- The hosing used throughout the vehicle is unnecessarily long and has multiple tight bends causing turbulent flow
- The vehicle was optimized for the efficiency challenge which led to differing design objectives from this year's sprint-oriented design

Vehicle Design

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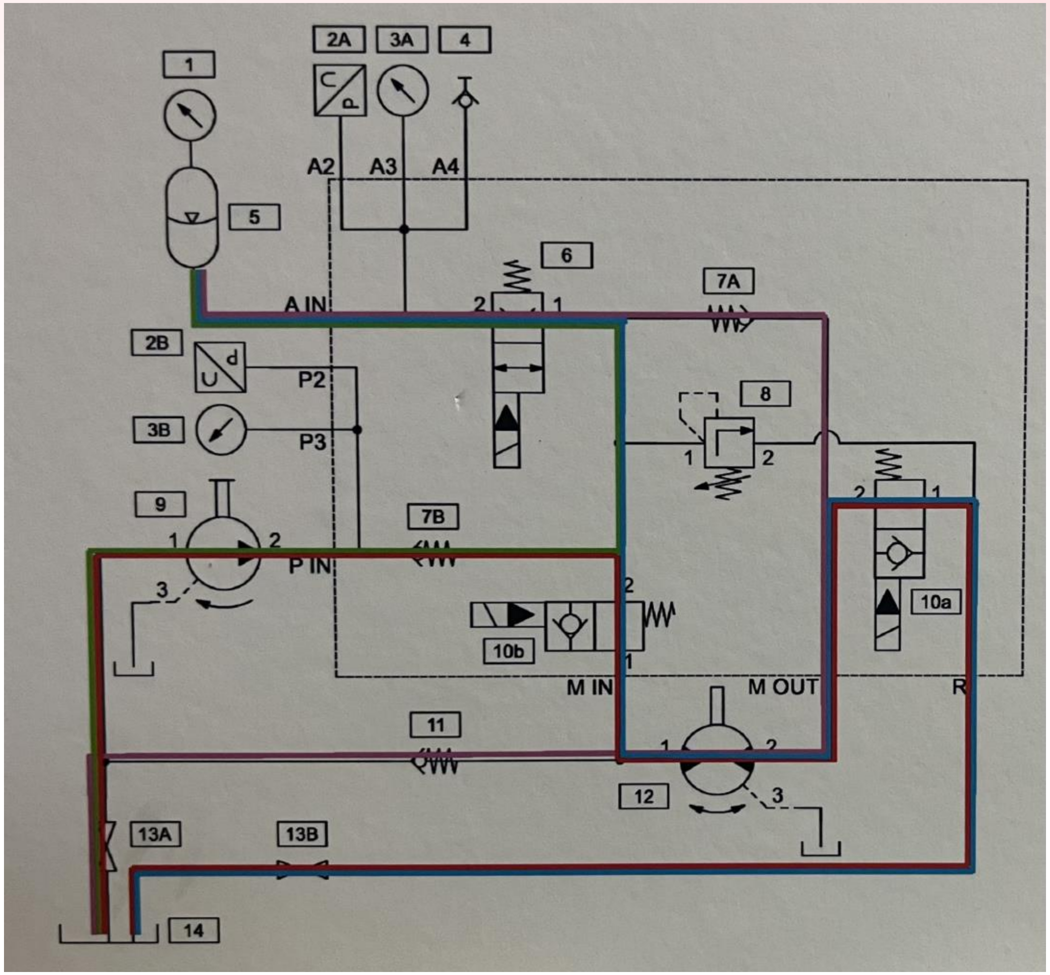
Vehicle Design

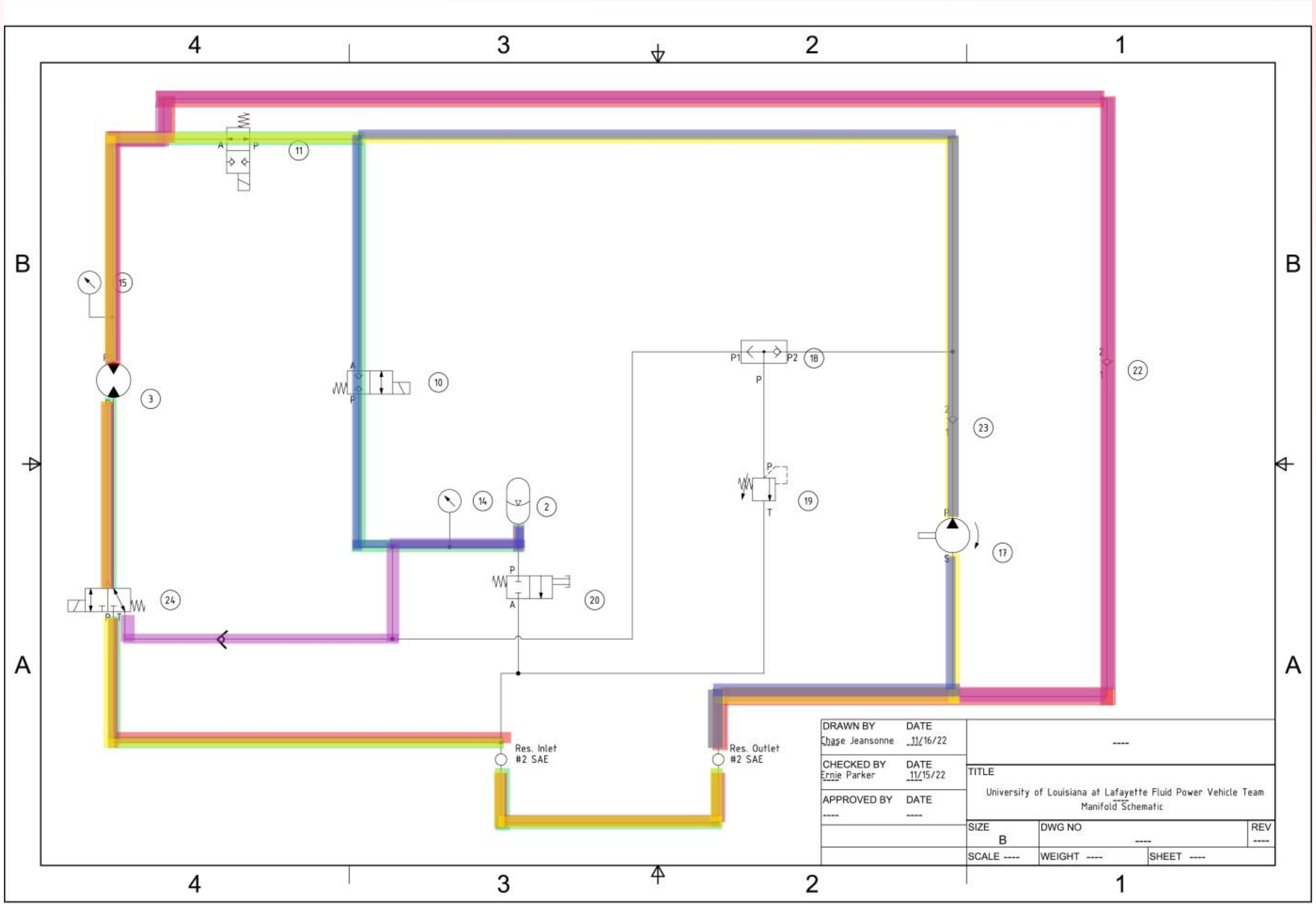
The team elected to build and modify a recumbent style tricycle with specific design concerns in mind;

- Modifying a commercial steel frame offers a high strength to weight ratio with minimal over-engineering
- A recumbent design's lower center of gravity provides stability at higher top speeds
- The single rear drive wheel simplifies power transmission from the gear motor to drive wheel.
- Lower overall weight (178 lbs.) when compared to previous year's (206 lbs.)
- Ideal centralized component mounting positions behind and under rider

Previous Year's Hydraulic Schematic



Current Year's Hydraulic Schematic



- Accumulator Charge
- Accumulator Drive
- Regenerative Braking
- Coasting
- Direct Drive

Vehicle Construction

Frame Modifications

- Main frame was extended 7 inches

Frame Modifications

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- Vehicle's seat was welded into a permanent position

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Frame Modifications

- Rear wheel was replaced and connected to the vehicle using pillow block bearings and a ½ inch all thread

Frame Modifications

- Custom-made chain tensioner with idler sprocket was utilized at rear wheel to reduce the number of necessary chains

Frame Modifications

- Pedal gear was modified to accept custom-made gears

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Vehicle Mountings

- Major Hydraulic Components

Reservoir

Motor

Accumulator

Pump

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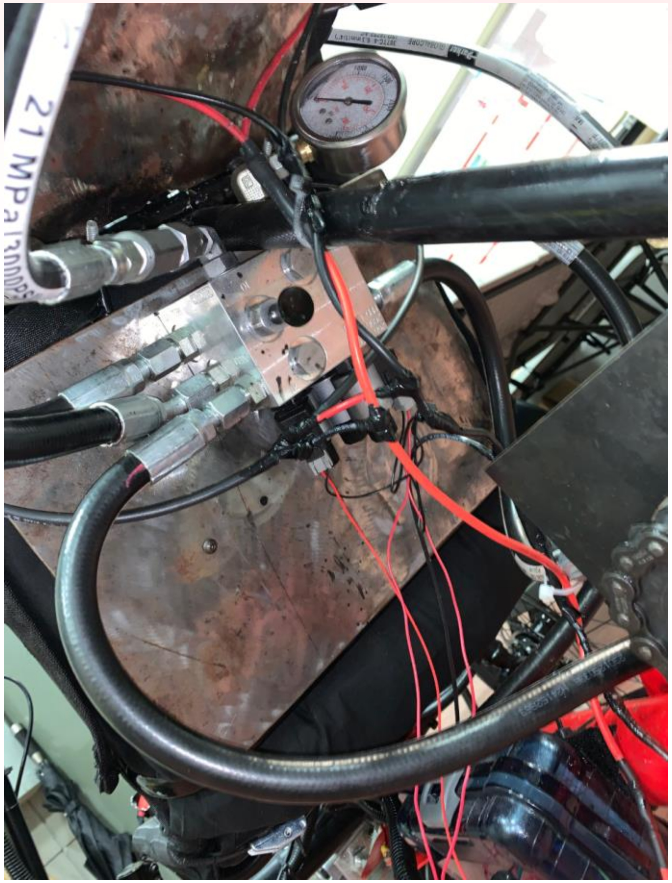
Vehicle Mountings

- Major Hydraulic Components



Vehicle Mountings

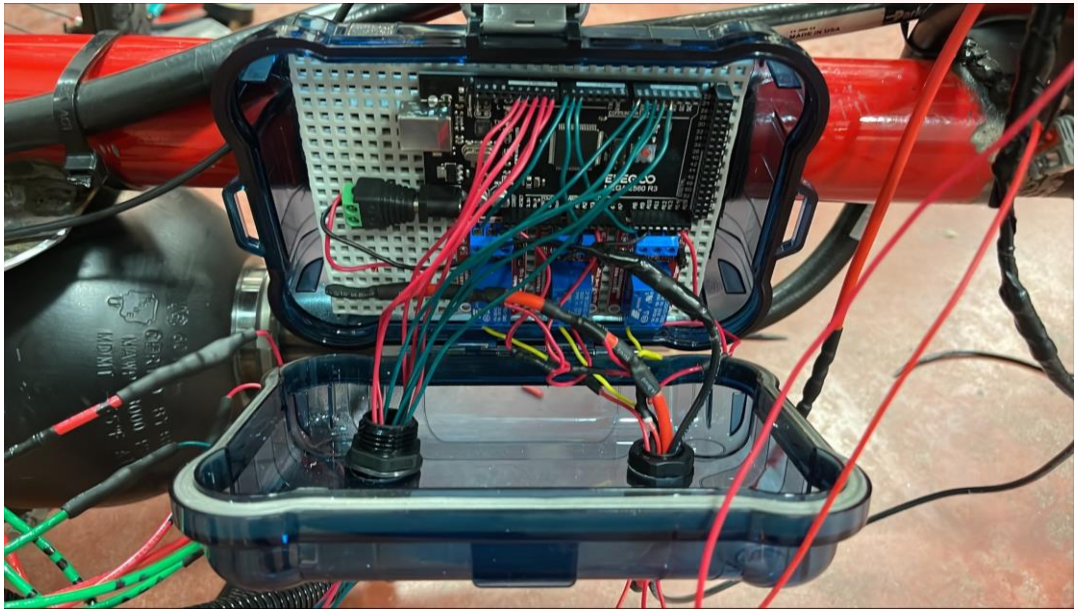
- Chain guard was added to protect the rider's leg from the pump to pedal chain

Vehicle Mountings

- A cushion was added as extra padding for the rider's back behind the seat along with a storage bag for extra components

Vehicle Mountings

- Electrical box was mounted on the main frame behind the vehicle's seat



Hydraulic Systems

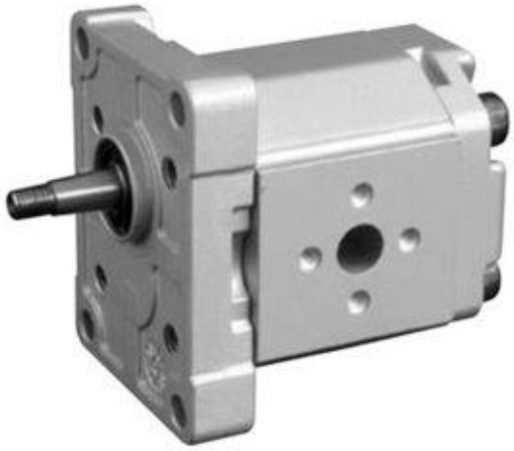
Hosing

- Parker 5/8 inch OD hose with 3/8 inch ID and 1/8 inch wall thickness
- Rated working pressure is 3,000 PSI
- Light weight, low cost, easy fastening
- Precise measurements by Connector Specialists Incorporated
- Pressure tested to ensure 3,000 PSI working pressure

Hydraulic Systems

Motor

A 1.025 CID Bidirectional Danfoss Hydraulic Gear Motor was chosen in comparison to the previous year's 0.73 CID Bent Axis Piston Motor to enable higher sprint speeds.



Hydraulic Systems

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Pump

A Danfoss 0.659 CID hydraulic gear pump was chosen in comparison to the previous year's 0.31 CID bent axis piston motor, to fulfill the mid-range flow requirements of the motor under accumulator drive.

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Electrical Systems

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Electronic Components Overview

- Controls solenoid valves
- Displays accumulator pressure
- Displays vehicle speed
- Utilizes two Arduino Mega boards

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Electrical Systems

Arduino Mega Boards Functions

- First Arduino Mega
  - Controls LCD screen
  - Displays accumulator pressure
  - Interprets pressure transducer voltage
- Second Arduino Mega
  - Controls solenoid valves
  - Connected to light-up switches in 3D printed housing
  - Sends signals to relays for valve control

Electrical Systems

Speedometer and Power Supply

- Wireless speedometer
  - Uses GPS signal for speed and distance tracking
  - Odometer feature
- Power supply
  - Two 12V drill batteries wired in parallel
  - Doubles power storage capacity, maintains constant voltage

Budget

- $5835.33 of the total budget of $7000 was spent during the selection and construction process of the vehicle

- $2871.64 was spent from the NFPA's $3000 component allotment

- $2963.69 was spent from ULL's $4000 budget allotment

- Team was **$1164.67 Under Budget**

Vehicle Testing

- Vehicle testing began shortly after the installation of the electrical systems, and enabled the validation of several design choices.

- During testing the pedal to pump sprocket gear ratio, rear wheel to motor sprocket gear ratio, and nitrogen pre-charge were varied.

Sprint Testing

11 tests conducted

Optimal settings

- Nitrogen pre-charge: 1400 PSI
- Accumulator charge: 3000 PSI
- Back wheel to motor gear ratio: 1.8:1

Results

- Top speed: 28 MPH
- Time elapsed: 18.04 seconds

Endurance Testing

5 tests conducted

Optimal settings

- Rider swap per lap
- Pump to pedals gear ratio: 5:1
- Back wheel to motor gear ratio: 1.35:1
- Nitrogen pre-charge: 1100 PSI

Results

- Distance traveled: 11,000 feet

Efficiency Testing

8 tests conducted

Optimal settings

- Nitrogen pre-charge: 1300 PSI
- Accumulator charge: 1400 PSI
- Back wheel to motor gear ratio: 1.8:1

Results

- Distance traveled: 328 feet
- Efficiency score: 35%

Regenerative Testing

6 tests conducted

Optimal settings

- Nitrogen pre-charge: 850 PSI
- Back wheel to motor gear ratio: 1.8:1

Results

- Maximum distance traveled: 896 feet

Our NFPA Hydraulic Vehicle Journey

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Our NFPA Hydraulic Vehicle Journey

Lessons Learned 2023

Knowledge Gained & Skills Developed

- In-depth understanding of hydraulic systems and their practical applications
- Hands-on experience in designing, building, and testing hydraulic bike components
- Improved teamwork, communication, and problem-solving skills
- Exposure to industry-leading experts and resources through the NFPA

Lessons Learned 2023

Expressing Our Gratitude

- Immense appreciation for the invaluable guidance, mentorship, and support provided by the NFPA, Danfoss, Hydac, IFP Motion Solutions, Sunsource, and Connector Specialists Incorporated
- Thankful for the opportunity to contribute to the future of sustainable transportation
- Looking forward to further collaboration and continued learning experiences

Questions?