NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

Final Presentation

Loyola Marymount University

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4/13/23

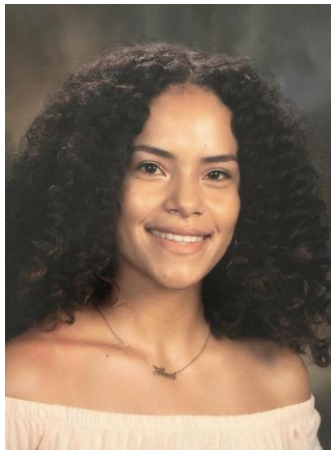
Loyola Marymount University

Team Introduction

- All senior capstone students
- All new to FPCV
- Excited to be participating!

Ambuj Bhatnagar

Brent Rouiller



Cole Daniel

Brendan Smith

Alexis Mendez

Objectives

Design Objectives

- Qualify for all four events
- Maximize performance in sprint race

Hydraulic Circuit Objectives

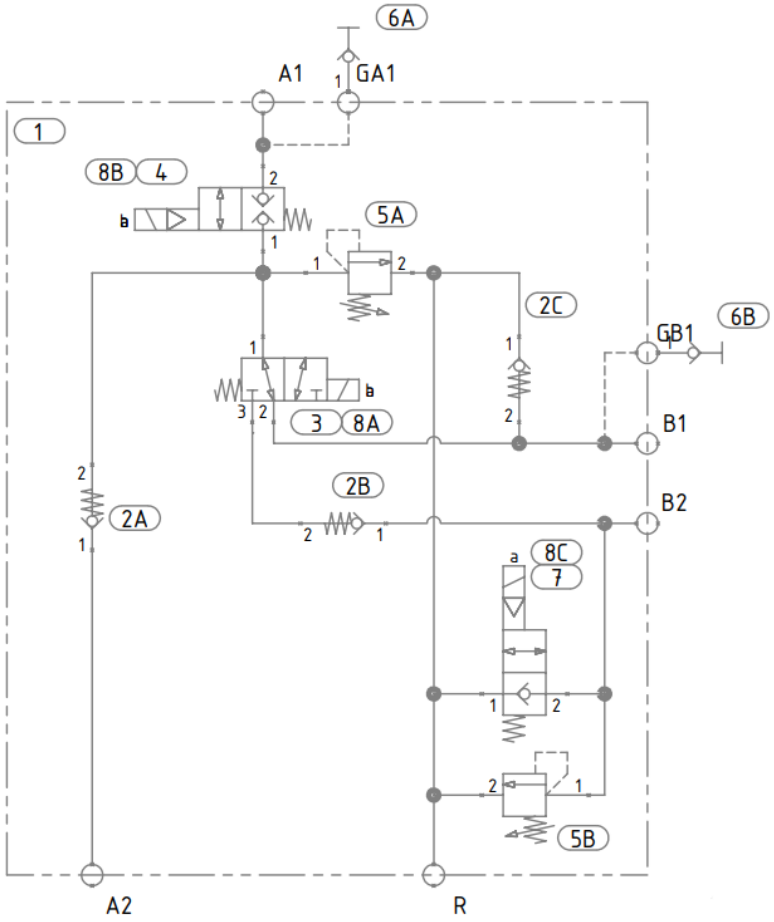
- Five operating modes
- Design the circuit around the pump and motor

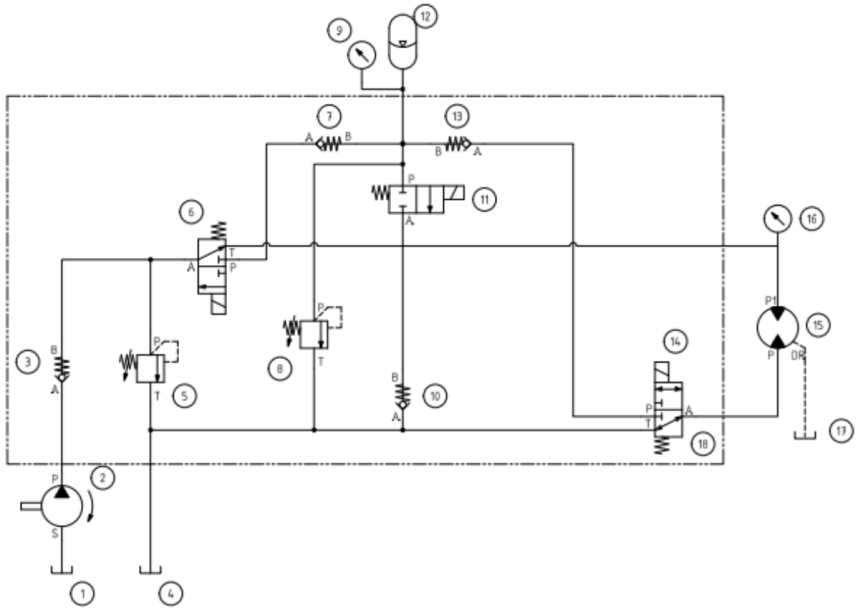
Vehicle Design Features

- Light-weight design (107 lbs w/ fluid):
  - Honeycomb composite sandwich material used for top and bottom deck
  - Additional weight savings: 1.5lb reservoir, 12lb accumulator
- 20” wheels for decreased rotational moment of inertia
- Gear shifting on front drivetrain for easy accumulator pressurization

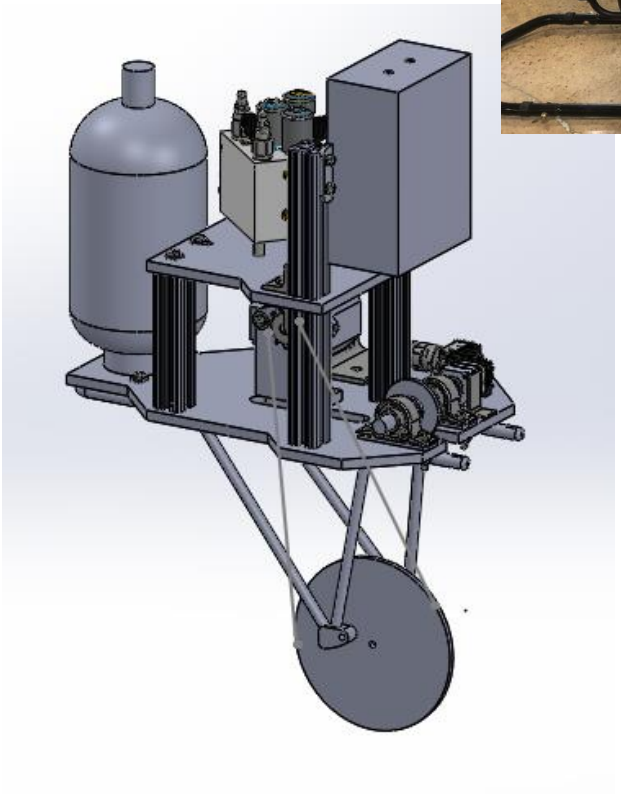
Hydraulic Circuit

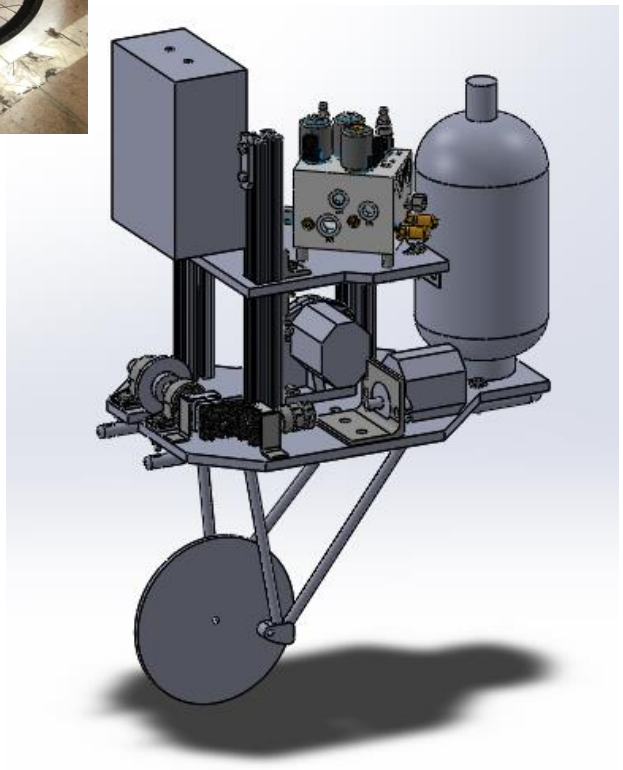
Last year's design implemented a 'coast mode', whereas this year we are implementing this 'boosted drive mode'





Vehicle Construction





Vehicle Construction

- Aluminum Honeycomb Core, Fiberglass Face composite sandwich used for mounting panels (high strength and low weight)
  - Oversized clearance holes used to give provide room for adjustment and perfect alignment during assembly
  - Oversized washers used to position components in oversized holes AND distribute load without deforming plate

- Vertical accumulator mounting for optimal discharge

Double-deck design with composite mounting panels

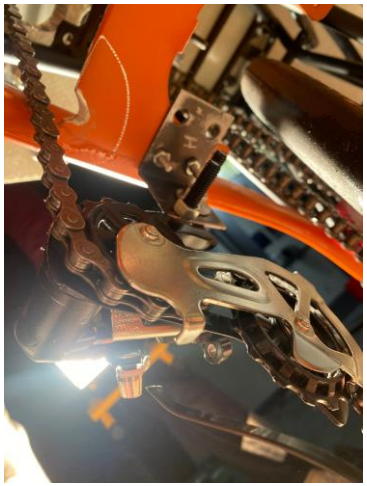
Vehicle Construction

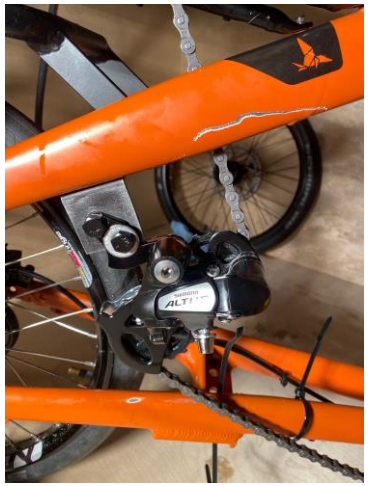
- 3-Speed chainring for multiple gear ratios
  - Front derailleur to switch between gears while pedalling

Front chain tensioner

- Mount designed and manufactured for Shimano rear chain tensioner which came with the bike frame

- Front chain tensioner used to keep chain in correct orientation when going into the derailleur
  - Difficult to maintain correct position when full load on it so additional options were tested





Rear chain tensioner

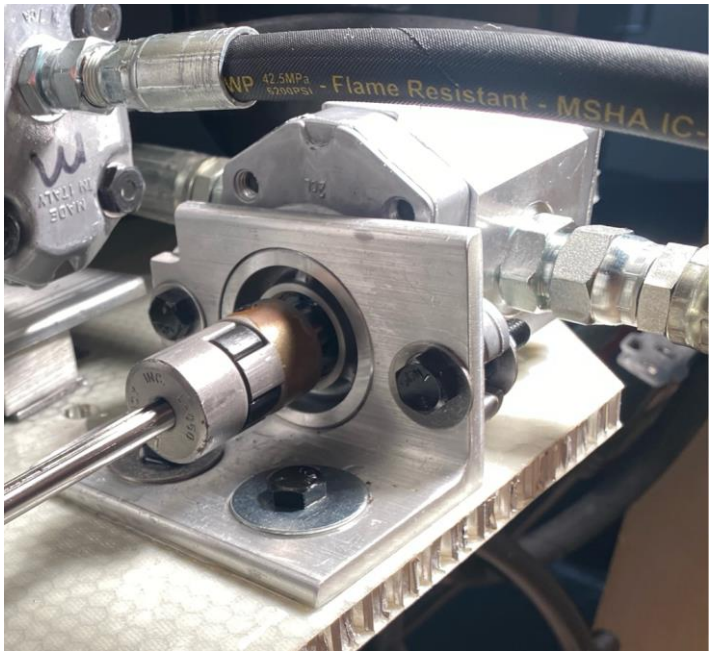
Vehicle Construction

- 90 degree gearbox with built in 3:1 speed increaser to keep the design compact
- Freewheel sprocket allows rider to coast without pedaling
- Mounting for drivetrain components use spacers to maintain a consistent shaft height

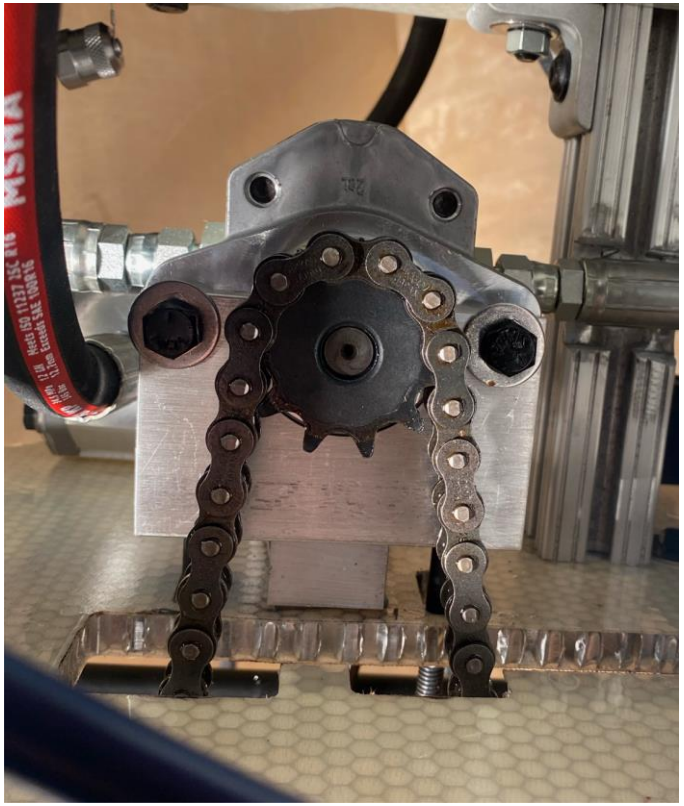
90° gearbox and freewheel sprocket

Vehicle Construction

- Fabricated custom pump and motor mounts when supplier couldn't fulfill order
  - Our machinist was already running behind schedule, so this further delayed assembly was rushed



Pump mount



Motor mount

Testing

- Hydraulic circuit testing
  - Listened to audio cues of manifold valves to test each mode.
  - No leaks found among all hose connections.
  - After testing on the rack, circuit in direct drive was deemed successful.
  - Live test performed with Brent as rider was successful.
  - Accumulator charge/discharge tested.
- Pump drivetrain testing
  - Implemented several front chain tensioners after first iteration failed.
  - First used clamping hub coupling on a keyway shaft. The shaft slid inside coupling, eliminating any power transmission. Resolved by replacing the clamping hub coupling with a set screw coupling.
- Motor drivetrain testing
  - Initial misalignment between motor sprocket and wheel sprocket. Shifted motor mount and cut new slots in honeycomb for chain travel.

Lessons Learned

- Integration and testing should be given a large portion of a project's schedule
  - Assembly take a great deal of time and working through integration issues is highly time consuming
- Engineering is a highly iterative process
  - Many design issues only come about once components are available and systems have been integrated
- Order parts as early as possible
  - Lead times can be long, and suppliers are sometimes unable to fulfill orders