NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION

Loyola Marymount University (LMU)

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April 28, 2022

Introductions

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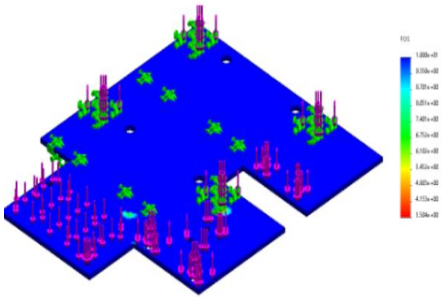
Problem Statement & Objectives

- The main focus of this project revolves around the various topics related to hydraulic powered components. This resulted in the team's understanding and utilization of fluid powered circuits, hydraulic hosing, solenoid valve control, accumulator pressurization, and regenerative braking in the final design.
- The team's primary goal was to be LMU's first team that qualified for the NFPA Fluid Powered Vehicle Challenge
- This meant designing a vehicle that would qualify for all three events: the sprint race, the endurance race, and the efficiency challenge

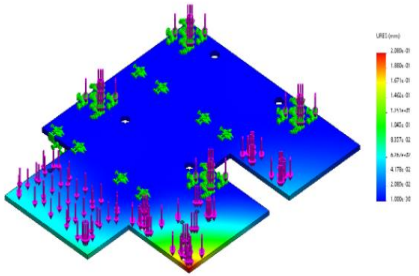
Midway Design Review Summary 1

- Qualification for all three competition events
  - Efficiency challenge
  - Sprint race
  - Endurance race
- Vehicle Design Goals
  - Vehicle stability
  - Easy mounting/removal of parts
  - Rider comfort/access to electronic controls
- SolidWorks Finite Element Analysis (FEA) program on mounting plates
  - Check for plate deflection with all parts
  - Factor of Safety and deflection values

Current Design: Min. FOS = 3.5



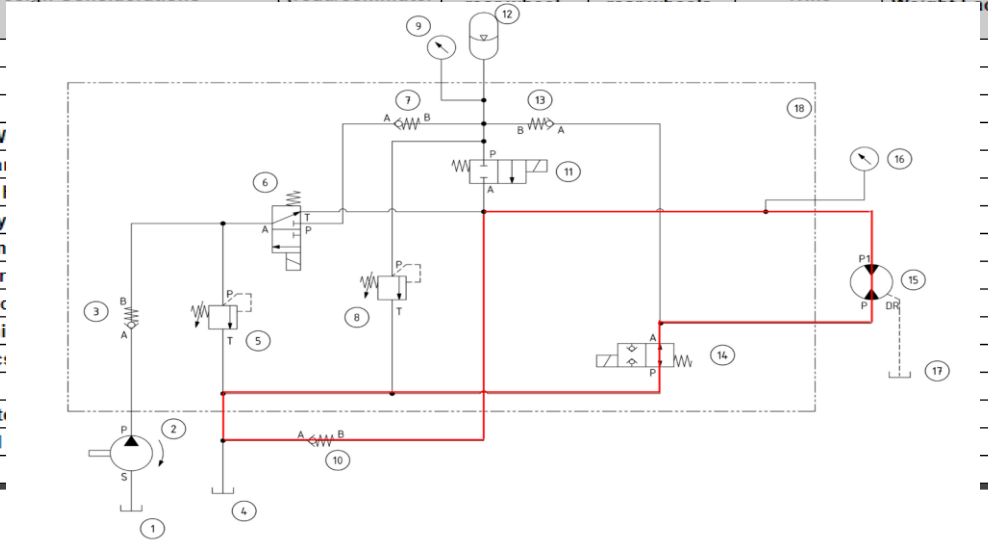
Current Design: Max. Deflection = 0.209 mm



Midway Design Review Summary 2

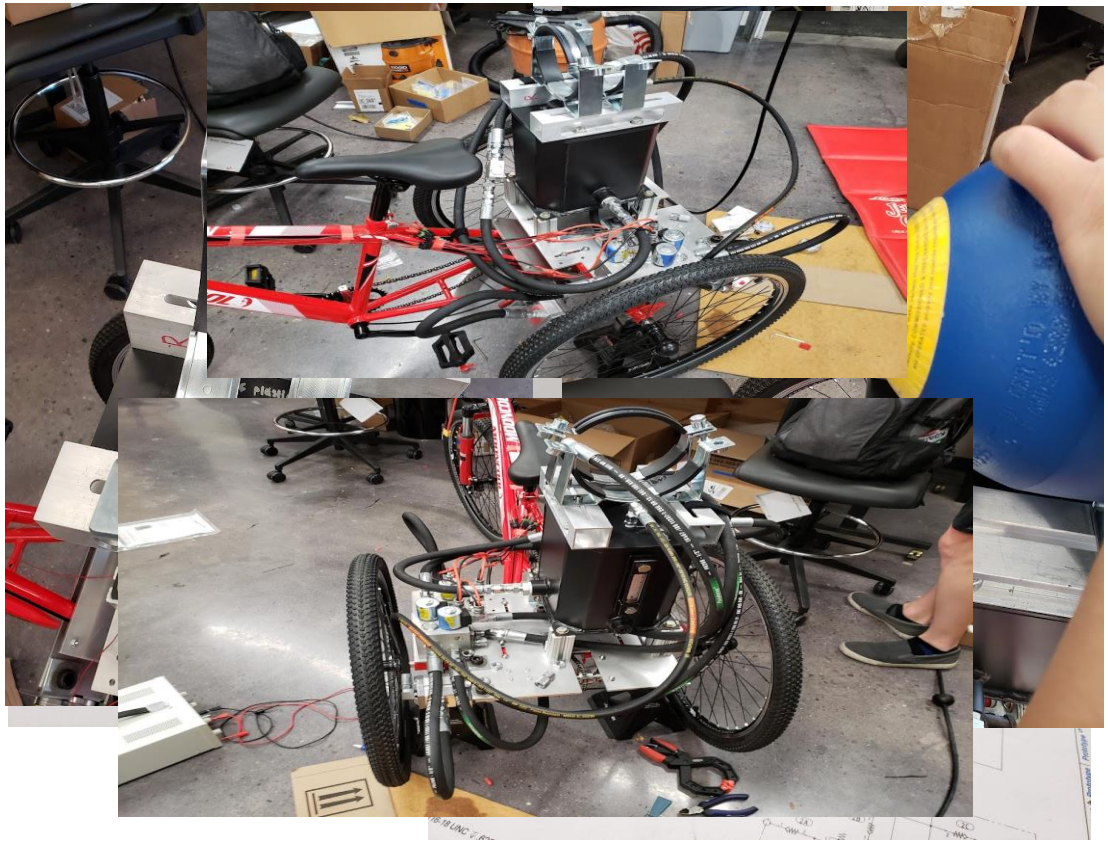
- Components decision through design matrix
  - Frame, gear/pump assembly, brake types
- Hydraulic Circuit Modes
  - Direct Drive
  - Charge
  - Discharge/Boost
  - Regenerative Braking
  - Coasting

Design Considerations	Regular Bicycle (road/commuter	Recumbent Bicycle (one	Recumbent Bicycle (two	Trike	Consideration
Safety					
Cost					
Stability					
Vehicle W					
Load Bea					
Space to I					
Reliability					
Ease of m					
Maneuver					
Human-pc					
Ergonomi					
Aesthetic					
Unweight					
Weighted					

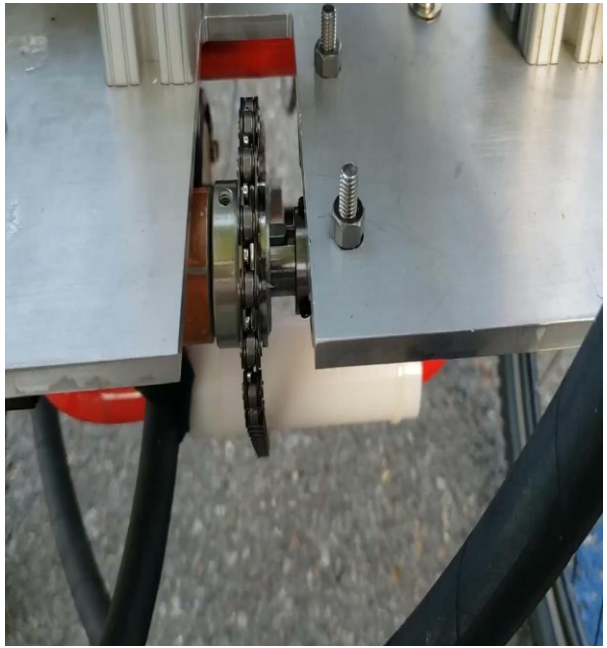


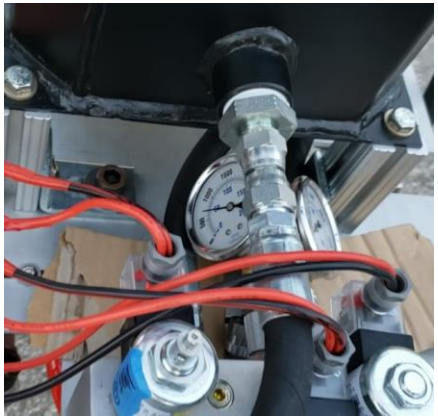
Construction and Assembly

1. Put trike together
2. Machine and attach mounting plate onto trike rear
3. Machine and mount reservoir extension slots
4. Attach hose fittings, test points, pressure gauges, and solenoids to custom designed manifold
5. Machine and attach pump and motor drivetrain to system
6. Electronic box construction and LED, solenoid, kill switch wiring
7. Pre-charge the accumulator and mount on top of reservoir
8. Hydraulic hose connection



Vehicle Testing



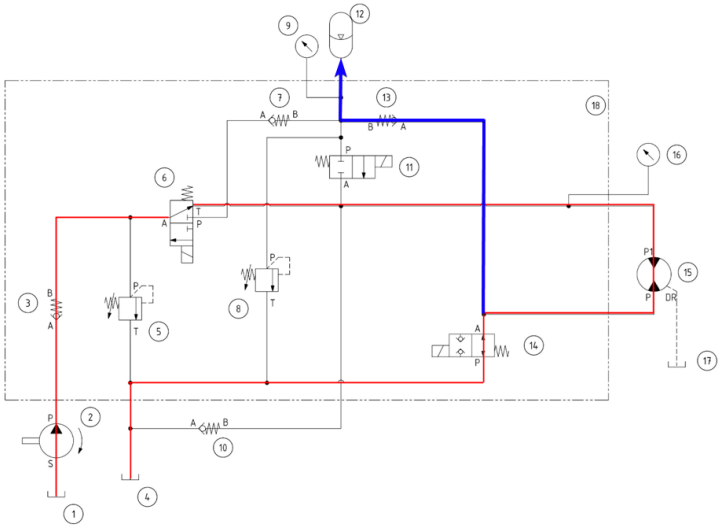


Test Results

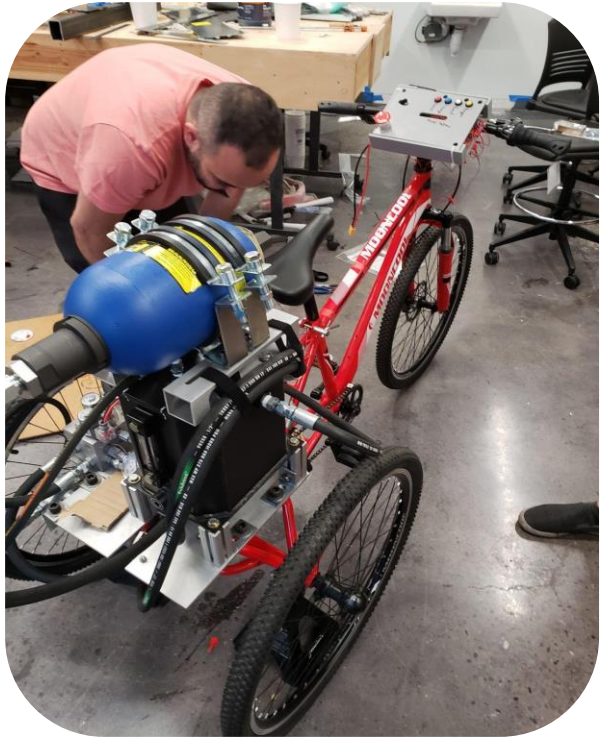
- Buttons properly switch between each mode
- Kill switch properly cuts off power from 14 volt battery
- No leaks found at hoses
- Relief valves properly vent pressure if exceed 1000 PSI

Unresolved Issues

- Rider has easier time pedaling if only done constantly
- Direct drive has side effect of charging accumulator



Final Vehicle



- Mode Testing
  - Direct Drive Mode: Yes
  - Charge Mode: Yes
  - Discharge/Boost Mode: Yes
  - Regenerative Braking: Yes
  - Coasting: Yes

Lessons Learned

- **Order parts as early as possible**
  - Lead times can be long, and suppliers frequently are unable to fulfill orders
- **Integration and testing should be given a large portion of a project's schedule**
  - Assembling systems take a great deal of time and working through integration issues is highly time consuming.
- **Spending more time in the ideation phase as a team is a wise investment**.
  - Re-designing systems that don't work is significantly more work and time consuming than taking a smarter approach from the beginning
- **Be weary of trusting CAD models**
  - Numerous CAD files from manufacturers had inconsistencies with actual products
  - The bike itself had highly complex geometry that was difficult to accurately model
- **Engineering is a highly iterative process**
  - Many design issues only come about once components are available and systems have been integrated
- **Contact Industry Members on Uncertainties**
  - Contacting industry members on design uncertainties is needed to ensure vehicle qualifications
  - The team was originally going to ignore the case drain on the gear motor and would have been disqualified
  - Beginner team for the competition, might have been better for team to interact with industry members more experienced with hydraulic circuits