# NFPA Fluid Power VEHICLE Challenge

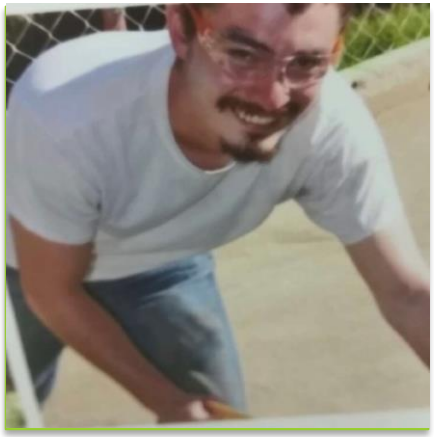
NFPA Education and Technology Foundation

**Final Presentation**
**Pump My Ride**
**Cal Poly, San Luis Obispo**
**Dr. James Widmann**
**April 16, 2020**

# Team Introduction

**Jacob Torrey**
Testing, 3D Design

**Bryson Chan**
Controls, Hydraulic Circuits



**Aaron Trujillo**
Manufacturing

**Kayla Londono**
Project Planner, Modelling

# Agenda

1. Summary of Midway Review
2. Manufacturing
3. Final Vehicle Design
4. Design Verification Testing
5. Lessons Learned

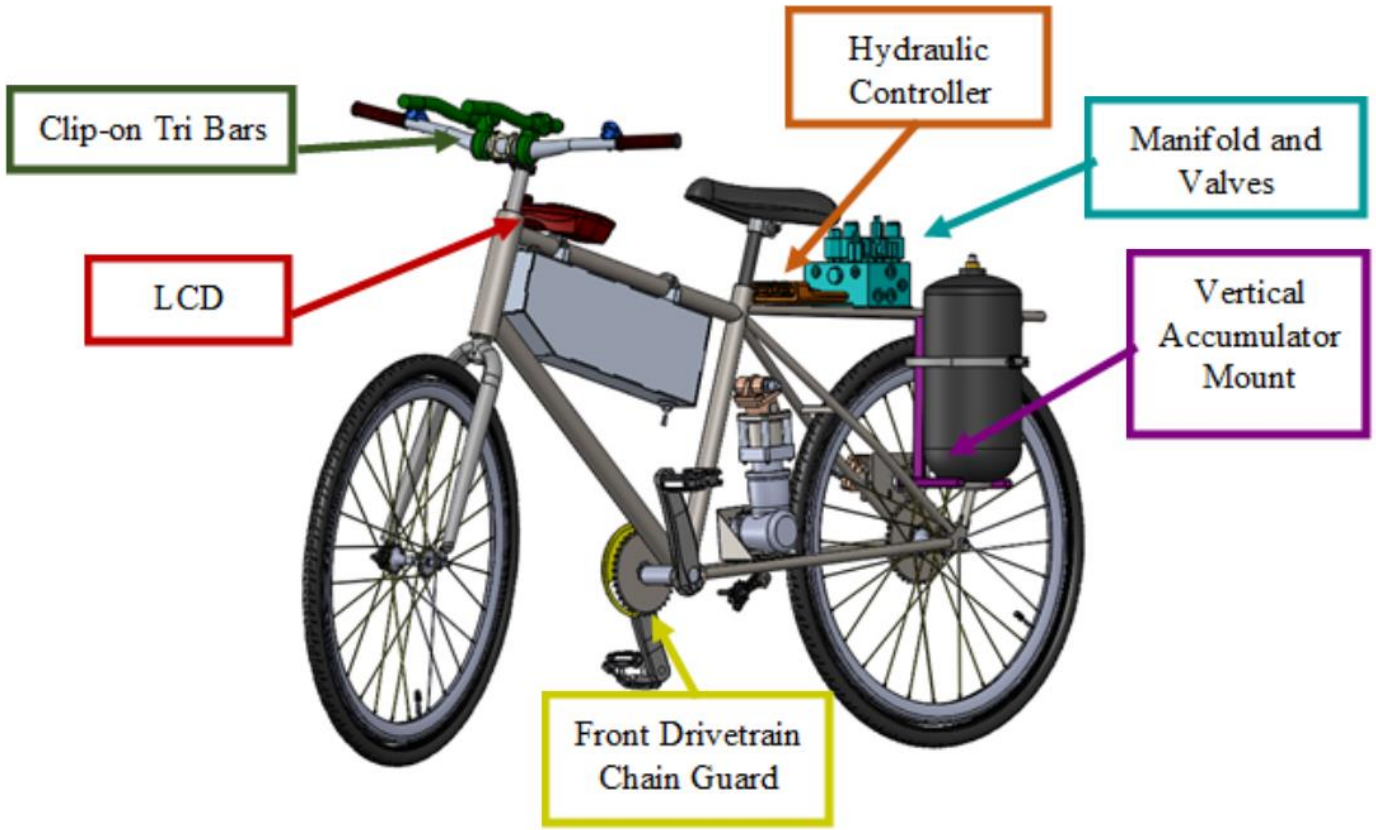
# Midway Summary

# Midway Vehicle Design

FOCUS ON HYDRAULIC EFFICIENCY

IMPROVE POWER TRANSFER

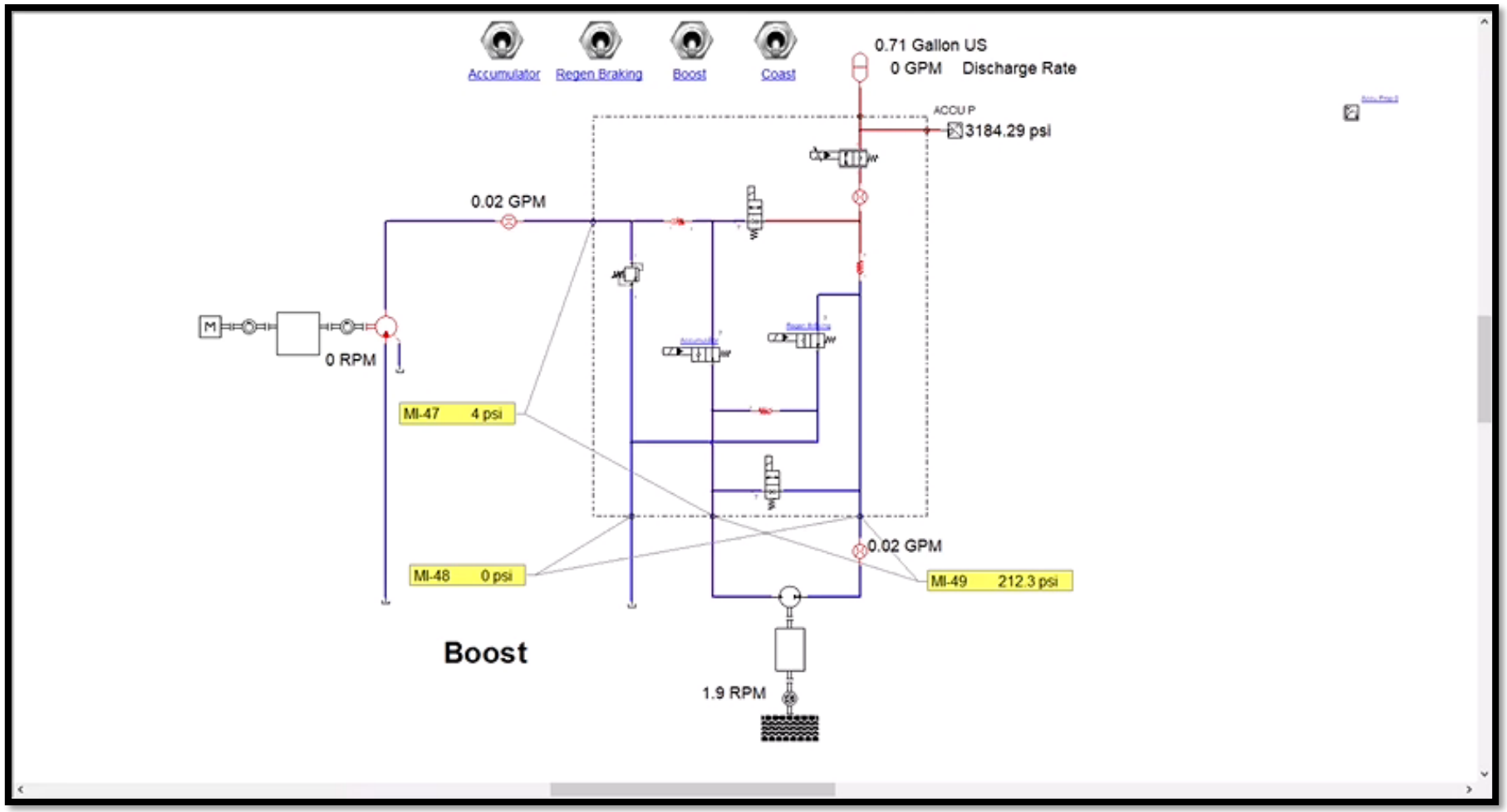
MODELLING, ANALYSIS & TESTING



# Key Hardware Selections

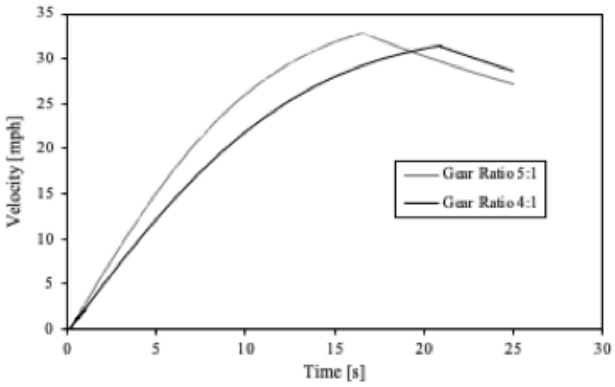
- Steelhead Composites 3.78L bladder accumulator
- New Coast Solenoid Valve
- Hydraforce manifold
- Hydraforce ECDR electric controller unit
- New tires (Continental GP 5000)
- Bontrager Aerolite clip-on tri bars
- Hardlines

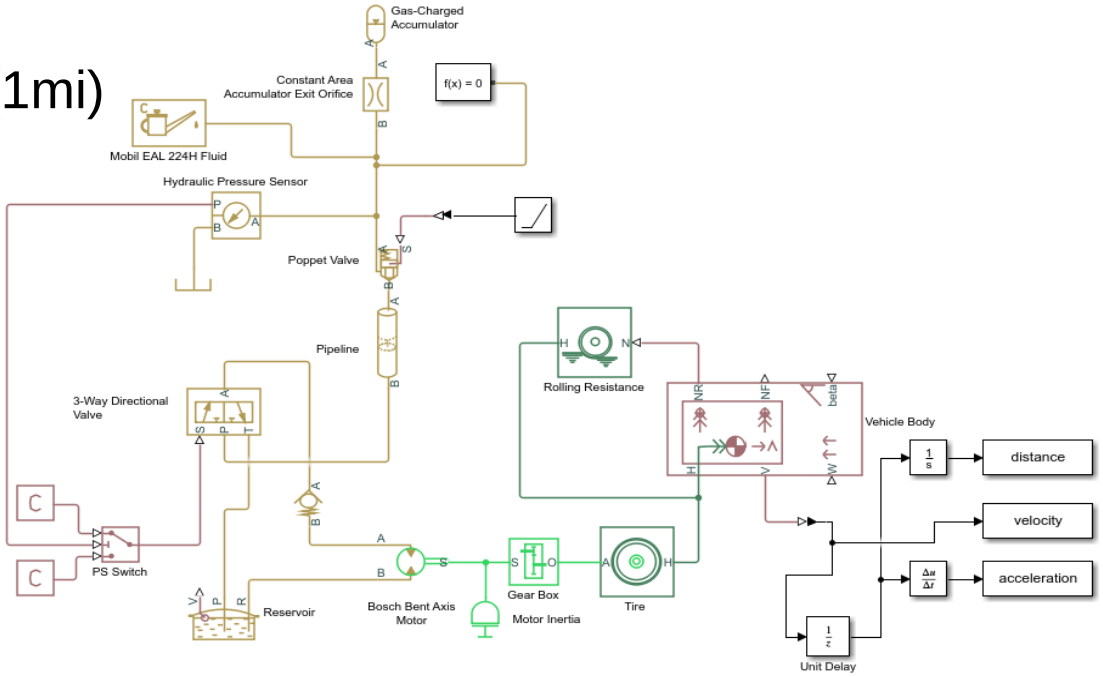
# Hydraulic Circuit Design



# Analysis

- Simscape Predicted Vehicle Performance
  - Gear Ratios, Air Drag, System Flowrate, Accumulator Sizing
- Patterson Model
- Braking Calculation 1.79 FoS
- Baseline tests
  - Endurance: 5min 23s (1mi)
  - Sprint: 19.5s (500 ft)



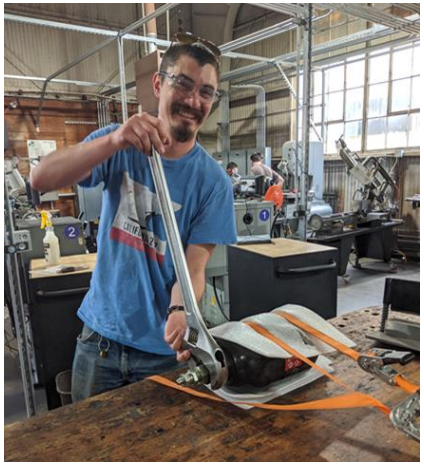



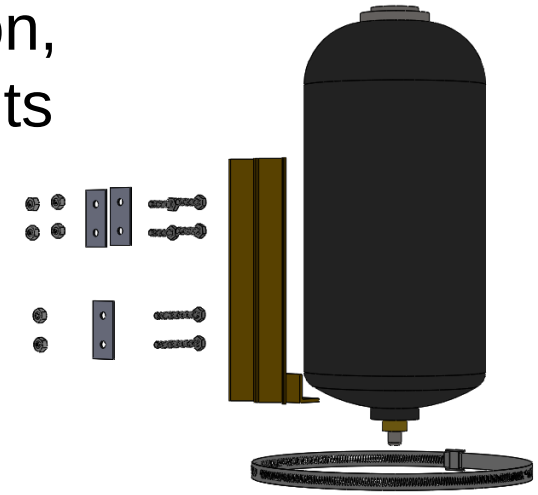
# Manufacturing

# Accumulator

## Manufacturing

- Rebuild
  - Observed system pressure equal to pre-charge pressure some time after system was discharged
- Vertical Mount
  - Acquired angle iron, hose clamp, U-bolts
  - Welded steel

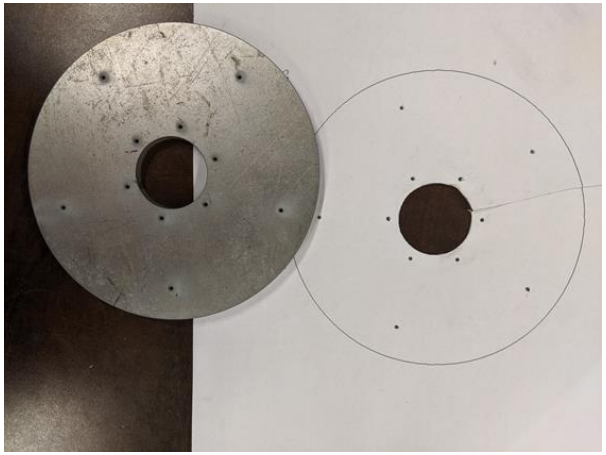




# Rear Drivetrain

## Manufacturing

- Replaced rear wheel w/front disk brake wheel
- Added driven sprocket
- Waterjet adapter plate



# Rear Drivetrain

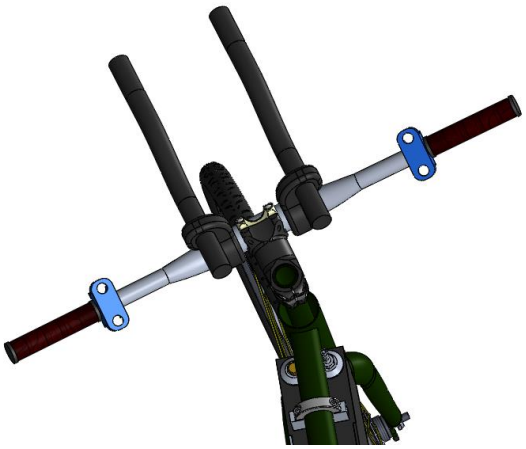
## Manufacturing

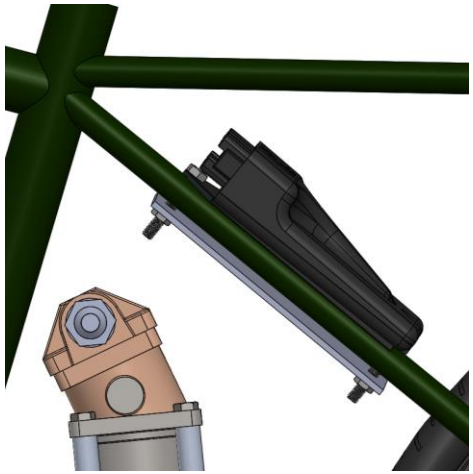
- Motor repositioning
  - Correct direction, sprocket alignment, chain tension.
- Waterjet mount

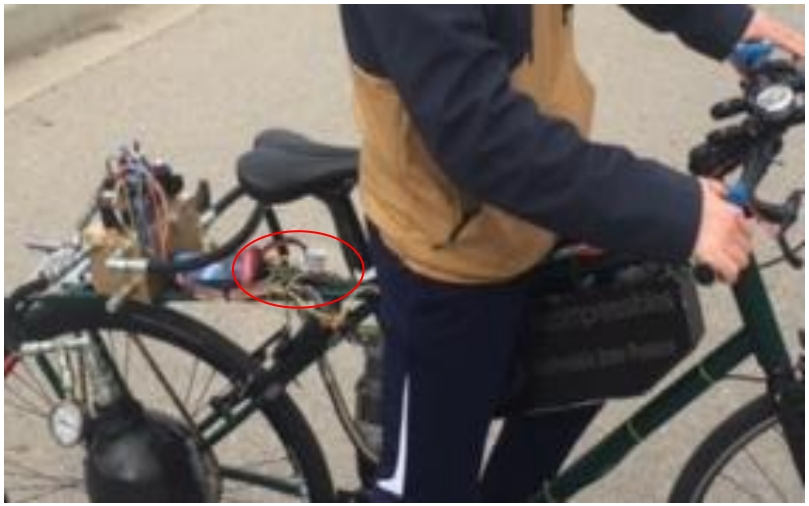
# Mechatronics

## Manufacturing

- ECDR Controller
- Push Buttons
- Wiring Management

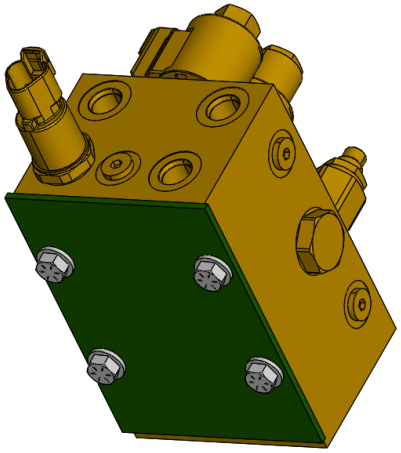


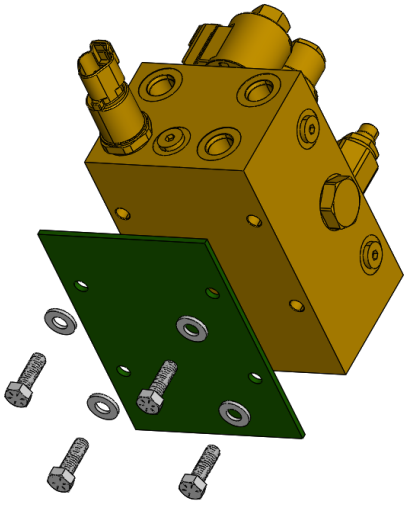




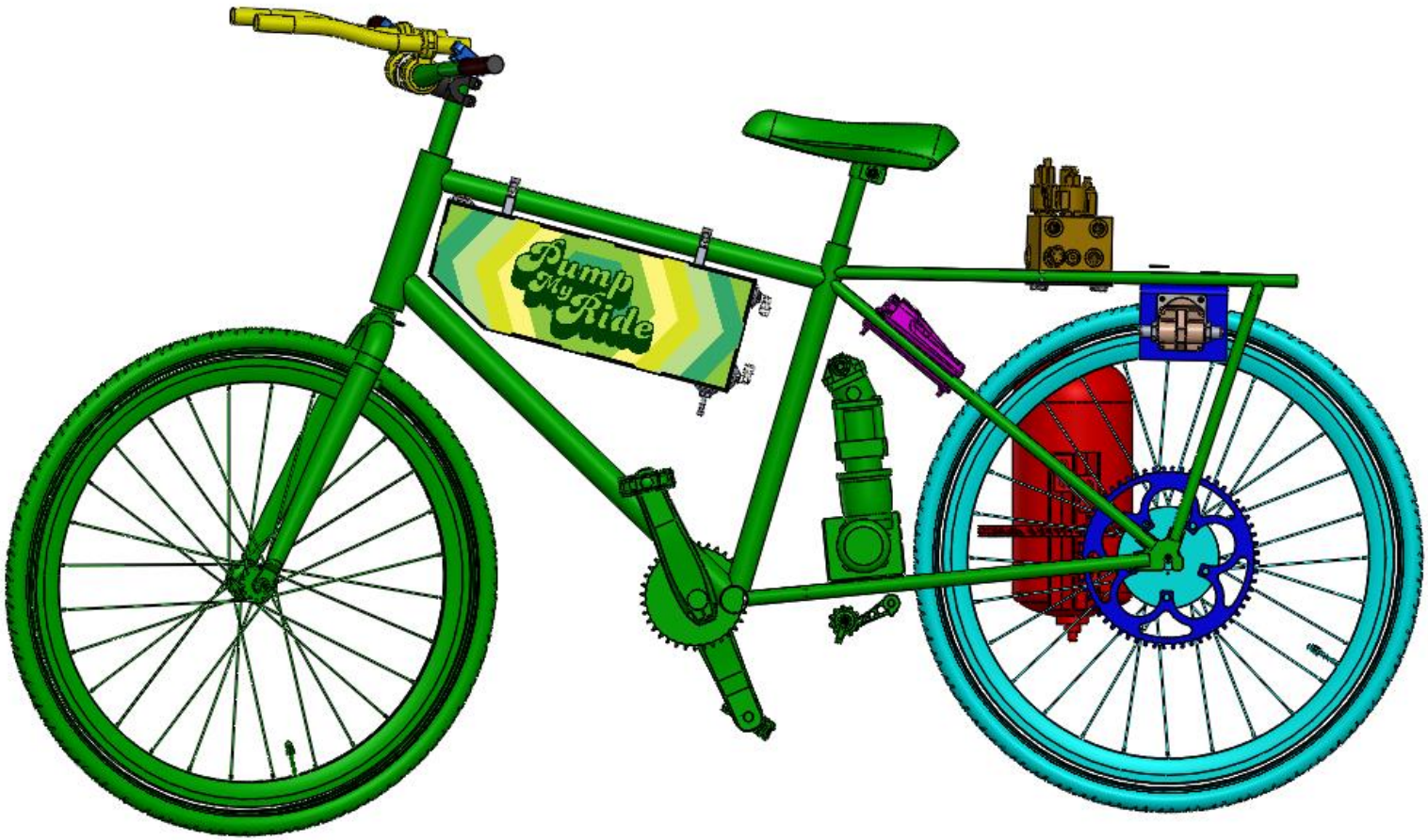
# Manufacturing

- Manifold – Produced and Sponsored by Hydra Force





# FINAL VEHICLE DESIGN



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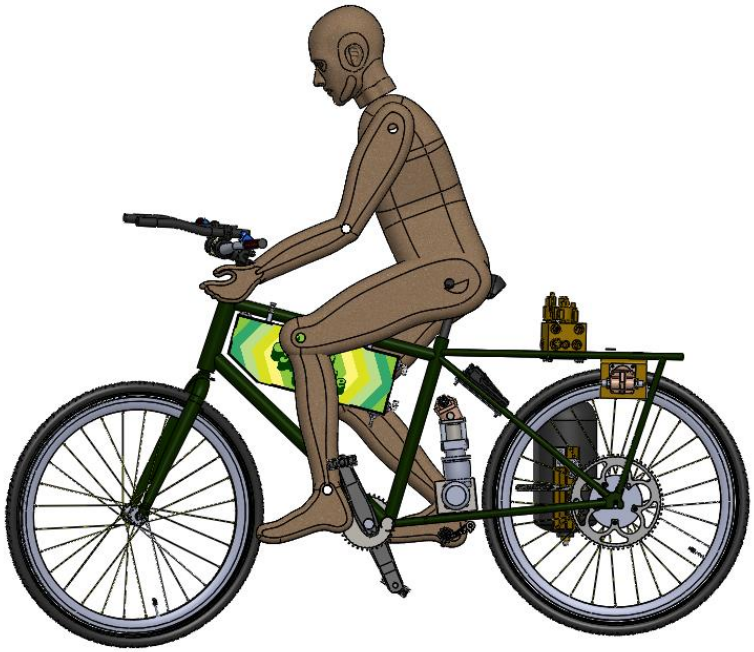


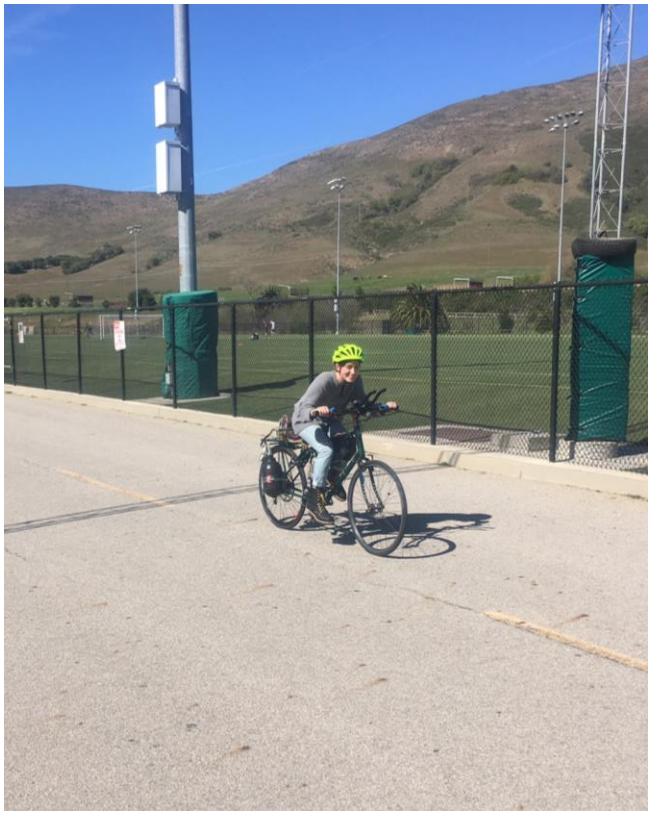
# Design Verification

# Design Verification

- Pre-charge determination
  - Predicted sprint, endurance, and efficiency scores with variable pre-charge between 500 psi and 100 psi.
  - Most important for efficiency and sprint score

# Design Verification

- Sprint
  - 600 ft track.
  - Goal: 18 s
  - Highest pre-charge and system charge, 500 psi and 3000 psi, respectively.
  - Result: 21.96 s



# Design Verification

- Endurance
  - Mile course
  - Zero accumulator charge pressure
  - Goal: 4 min 30 s
  - Result: 5 min 40 s

# Design Verification

- Efficiency
  - Goal: 18%
  - Tested simultaneously with sprint.
  - Measured revolutions, converted to distance.

| Final efficiency score results. | | | | | | |
|---|---|---|---|---|---|---|
| March 13, 2020 | | | | | | |
| Pre-charge (psi) | Charge (psi) | Accumulator Volume ($in^3$) | Weight (lbs) | Revolutions | Total Distance (ft) | Efficiency (%) |
| 500 | 3000 | 231 | 266 | 165¼ | 1800 | 12.17 |

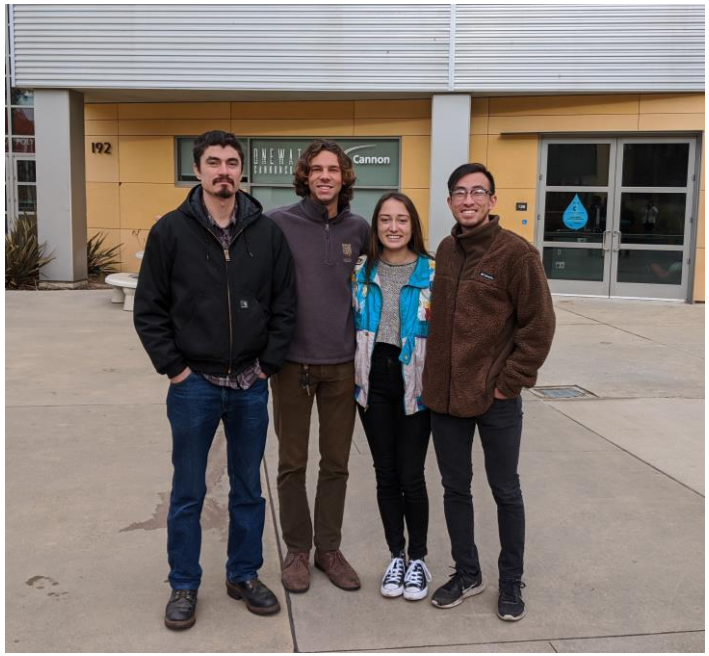
# Lessons Learned

# Lessons Learned

- Importance of bleeding air in the system
- Inspect independent components frequently
- Extensive testing required
- Riding technique is just as important as vehicle construction
- Hydraulic component lead times can be problematic

# Recommendations

- Employ hardlines
- Test different final drive ratios (was not possible w/previous design
- Improve control interface
- Better component selection
- Test, Test, Test




# Thank You

Questions?