# NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

**FINAL PRESENTATION**
**UNIVERSITY OF CINCINNATI**
**HYDRAULIC BIKE TEAM**
**MUTHAR AL-UBAIDI**
**4/15/2020**

# Agenda

1. Team Introductions
2. Problem Statement & Objectives
3. Midway Presentation Summary
4. Vehicle Construction & Progress Made
5. Lessons Learned
6. Questions

# Team Introductions

# Muthar Al-Ubaidi, PhD

- **Professor and Director Mechanical Engineering Technology Program**
- **Education**
  - B.S. Mechanical Engineering, University of Baghdad
  - Masters Nuclear Engineering, University of London
  - PhD Nuclear Engineering, University of Cincinnati
- **Project Team**
  - Faculty Advisor

# Frame Team

**William Mason**

**Andrew Brueneman**

**Ethan Salisbury**

**Jacob Epperson**

# Circuit Team

**Taylor McConnell**

**Nolan Schwaeble**

**Andrew Irwin**

**Nick Gusching (Team Lead)**

# Problem Statement & Objectives

# Problem Statement & Objectives


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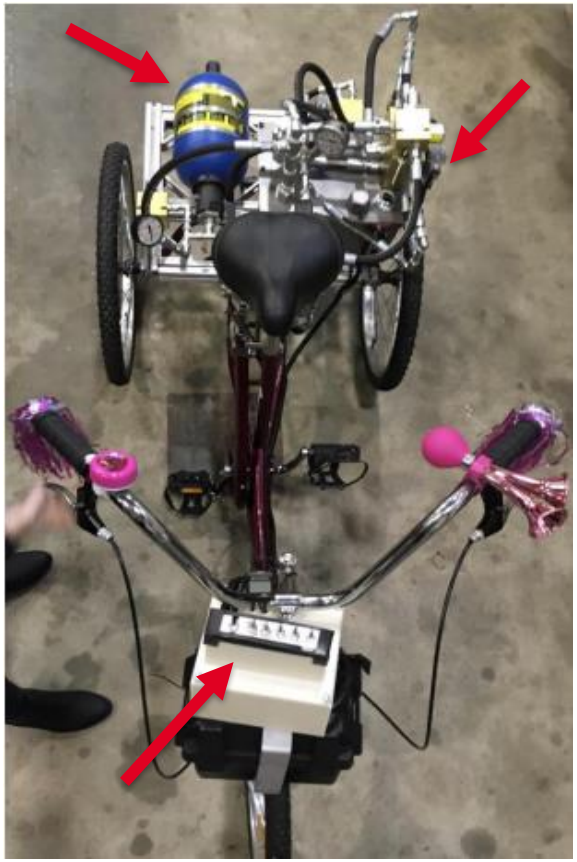
# Midway Presentation Summary

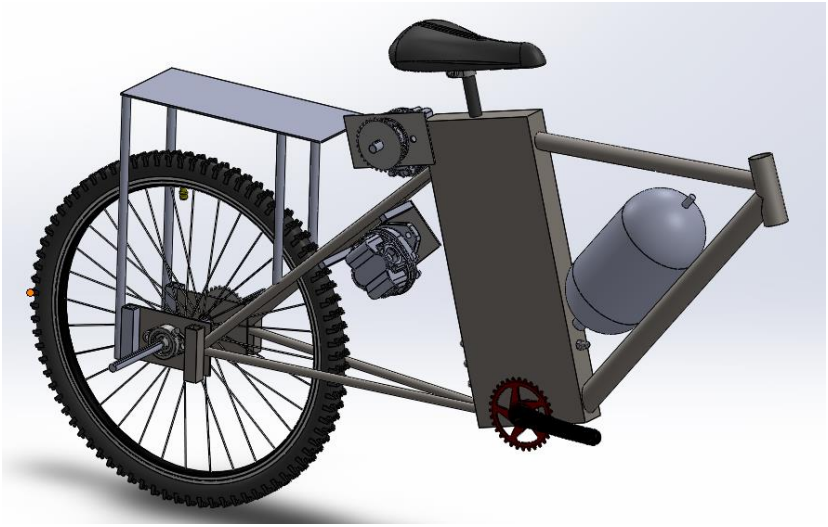
# Past Projects & Design Objectives

2018 Bicycle



2019 Tricycle

# Vehicle Design



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# Fluid Power Circuit Design

| Drive Functions | |
|---|---|
| | Regenerative |
| | Acc. Drive |
| | Acc. Charge |
| | Direct Drive |




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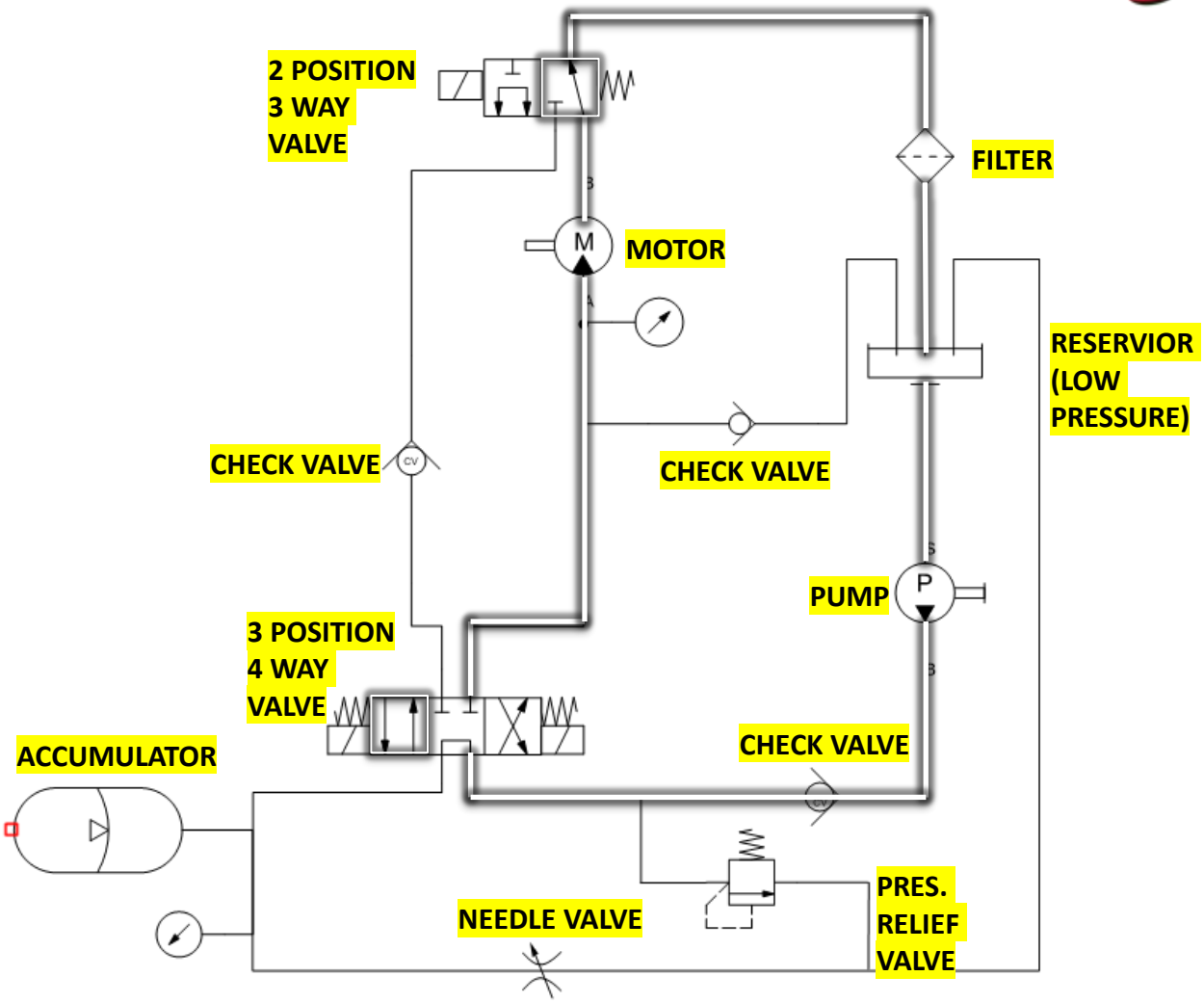
# Direct Drive

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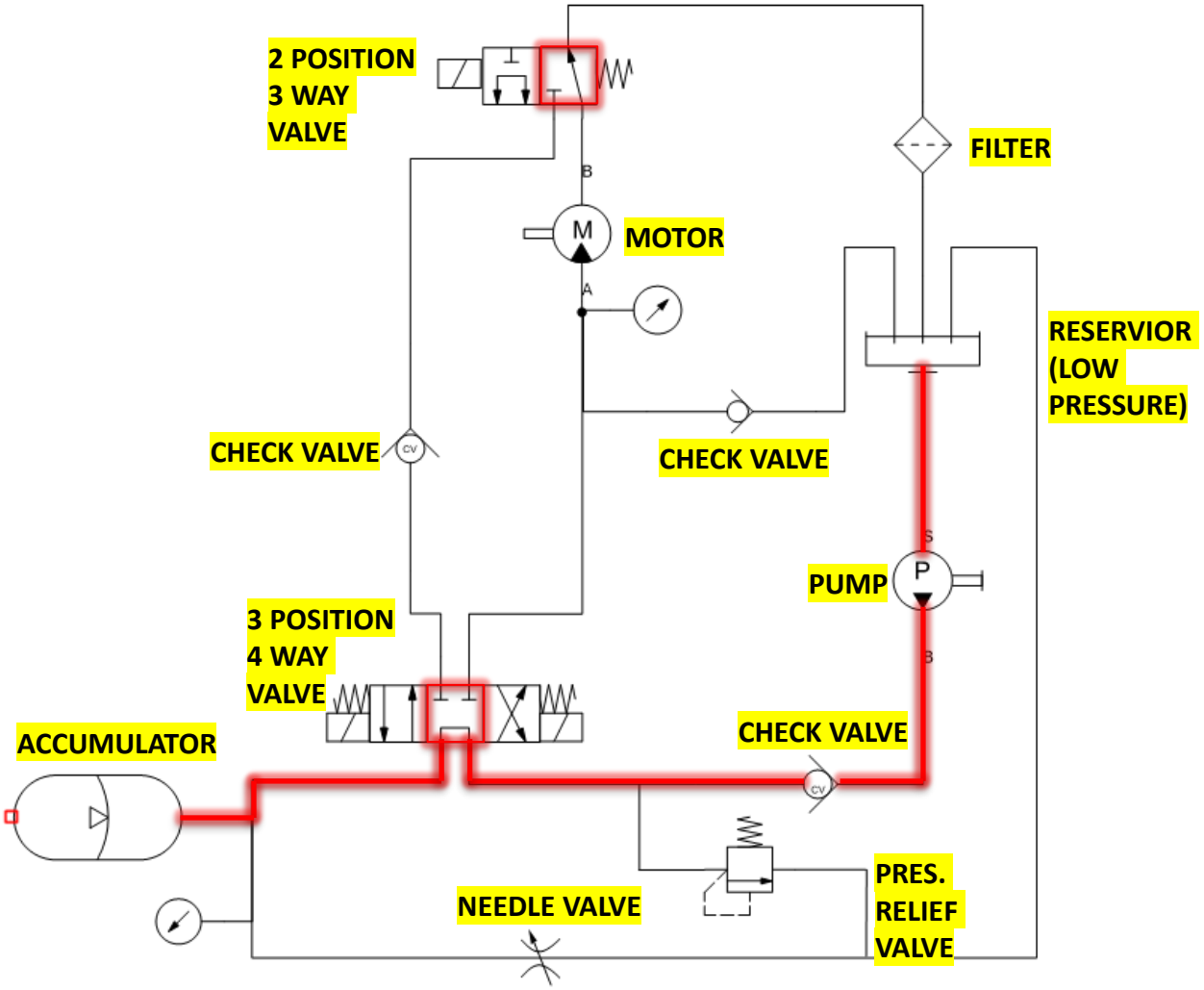
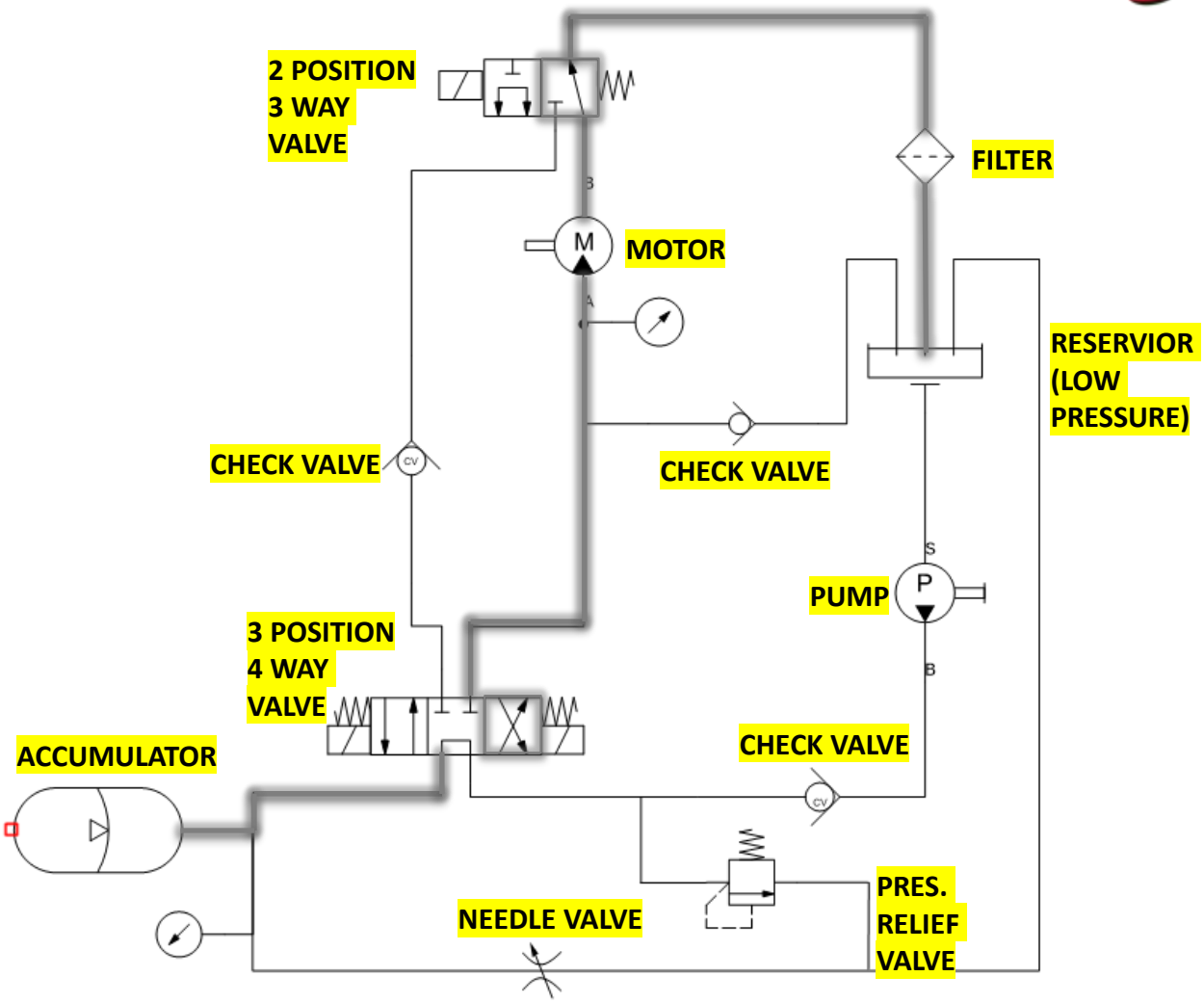
# Accumulator Charge



# Accumulator Drive

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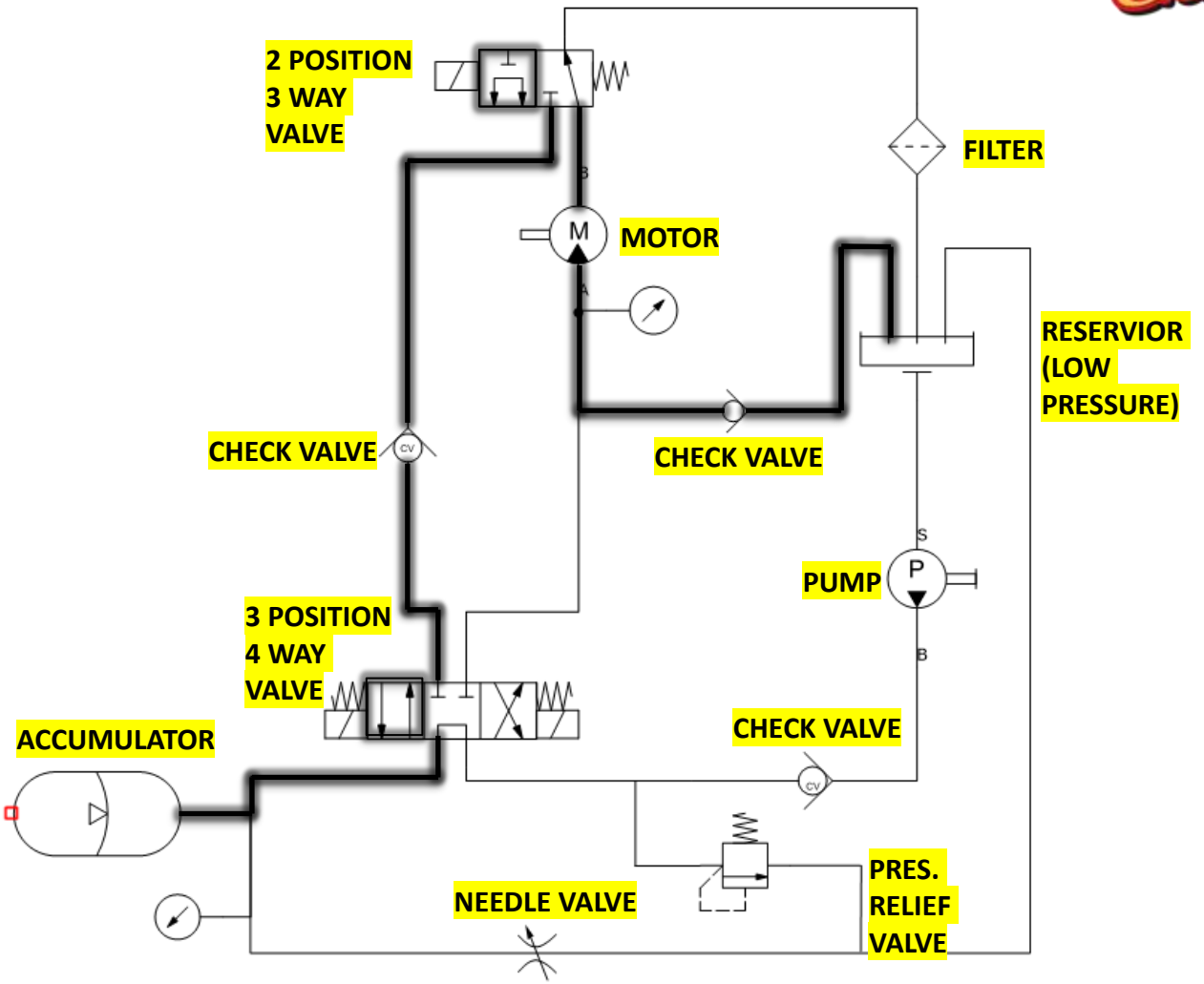
# Regenerative

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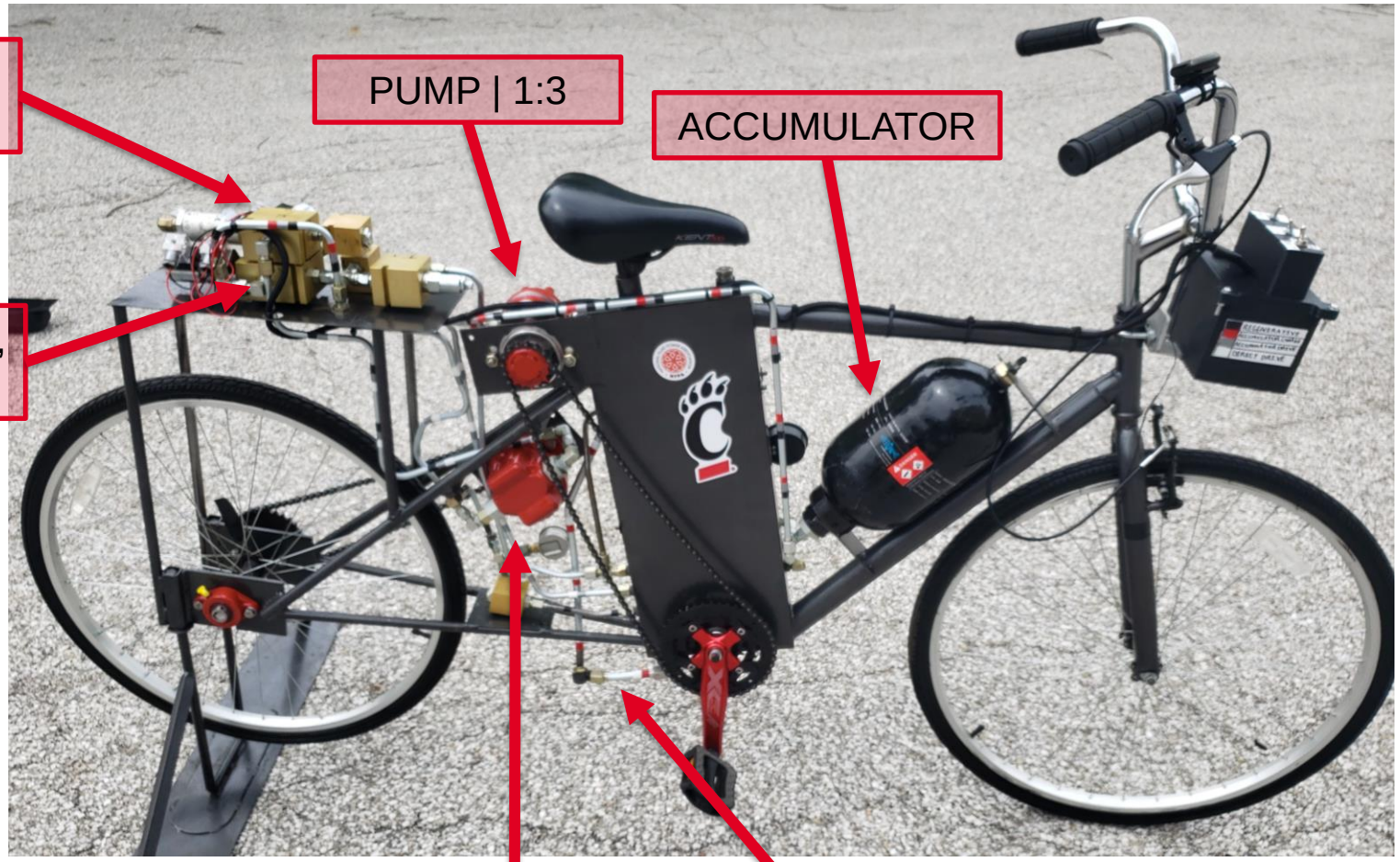
# Selection of Components



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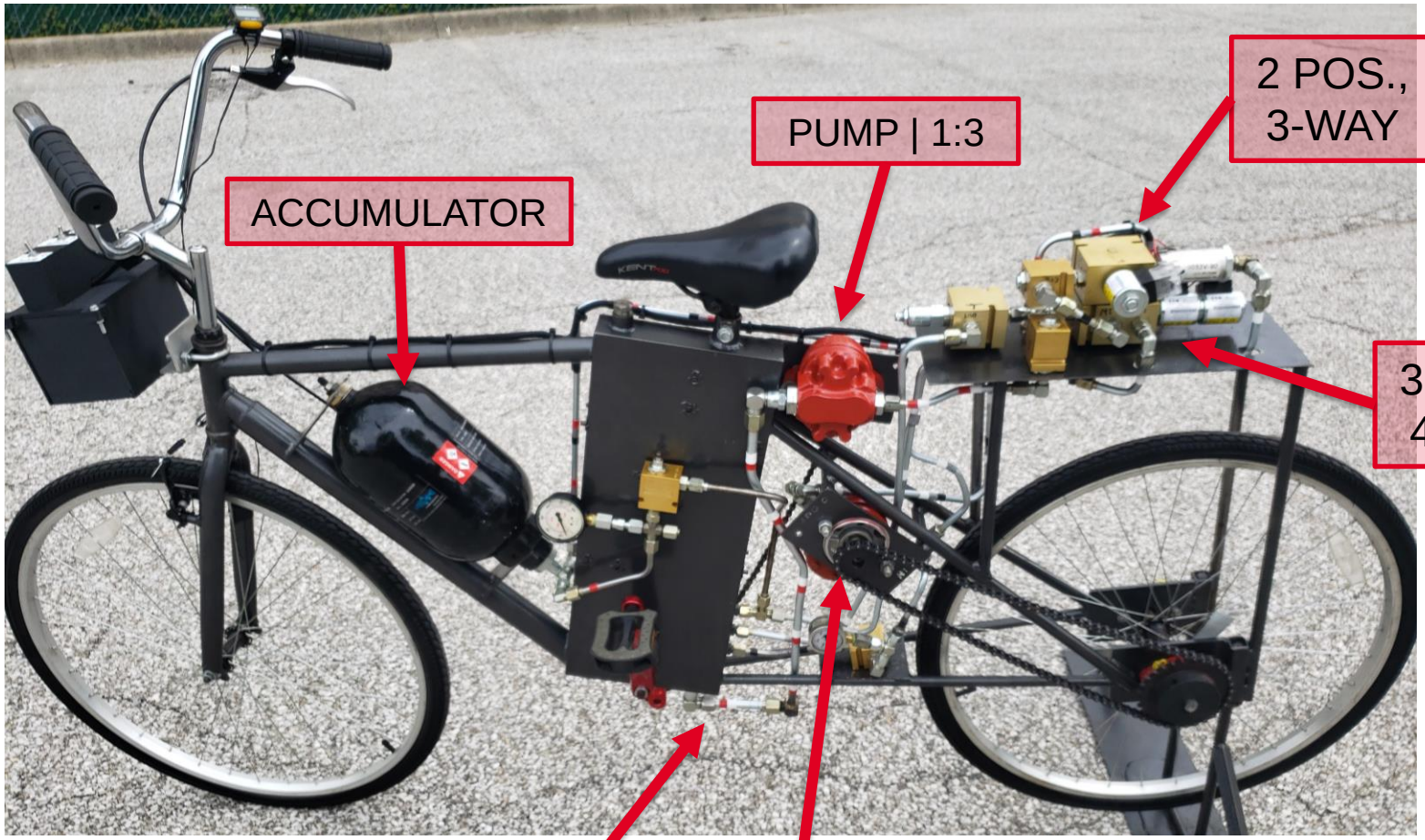
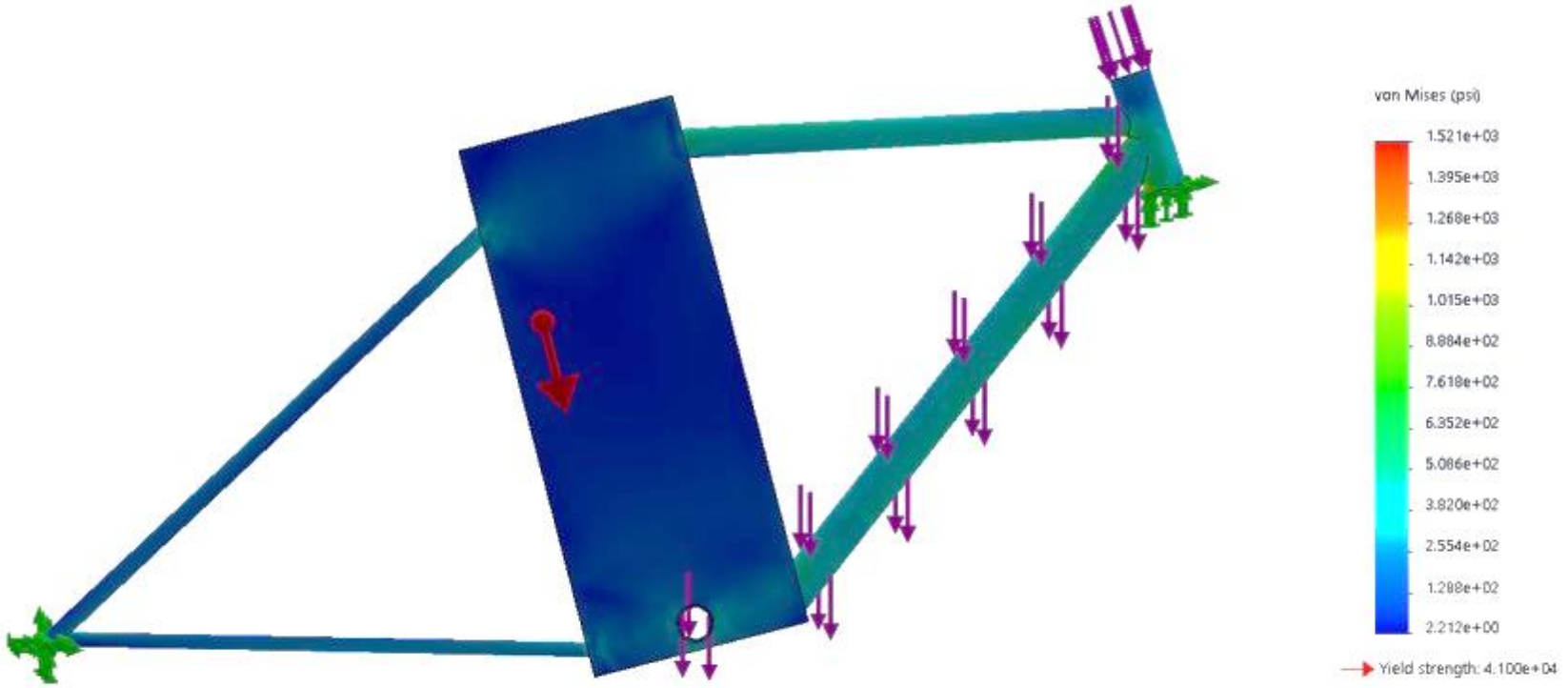


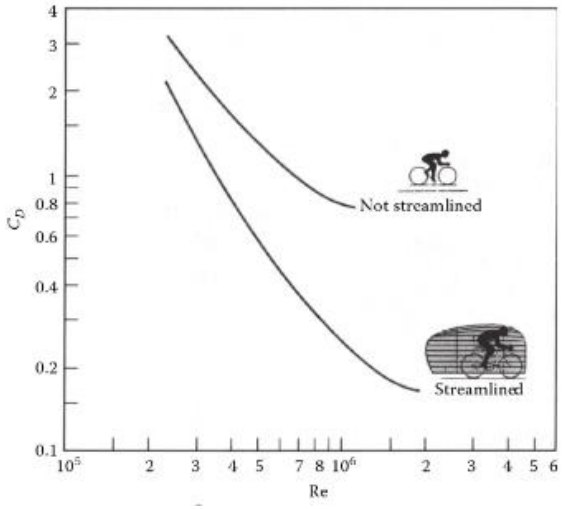
# Stress Analysis




| Forces on Bike | | |
|---|---|---|
| **Weight** | **Type** | **Location** |
| 200 lbs | Bearing | Pedals |
| 60 lbs | Bearing | Handlebars |
| 20 lbs | Bearing | Lower Frame Pipe |

# Drag Force Graphs

| Configuration | | | Drag Force, $D_f$ lbg | Drag Force, $D_f$ N | Rolling Resistance lbg | Rolling Resistance N | Drag Coefficient $C_D = \frac{Df}{\frac{1}{2}\rho U_\infty^2 A}$ | Frontal Area, $A$ ft² | Frontal Area, $A$ m² |
|---|---|---|---|---|---|---|---|---|---|
| European upright commuter | 40 lb bike, 160 lb rider, tires: 27 in. diameter, 90 psi |  | 6.14 | 27.3 | 1.20 | 5.34 | 1.1 | 5.5 | 0.51 |
| Touring (arms straight) | 25 lb bike, 160 lb rider, tires: 27 in. diameter, 90 psi |  | 4.40 | 19.6 | 0.33 | 3.69 | 1.0 | 4.3 | 0.40 |




| Assumptions | | |
|---|---|---|
| **Velocity** | 15 | mph |
| | 22 | ft/s |
| **Frontal Area** | 5.87 | ft^2 |
| **Bike Rider Weight** | 200 | lb |
| **Tire Diameter** | 27 | in |
| **Tire Pressure** | 40 | psi |

$$Re = \frac{VD}{\nu} = \frac{22 * 5.42}{1.69 * 10^{-4}} = 7 * 10^5 \mid From\ Chart\ C_D = 1$$

$$D_f = \frac{1}{2}\rho C_D V^2 A = \frac{1}{2}\left(.0022\ \frac{slug}{ft^3}\right)(1)(22^2)(5.87) = 3.13 lb_f$$

$$Power = D_f V = 3.13(22) = 68.86\ \frac{ft * lb_f}{s} \mid 1hp = 550\frac{ft * lb_f}{s}$$

$$Power = .125\ hp$$

$$Drag\ force\ from\ chart\ given\ (V = 15\ mph) = 3.46\ lb_f$$

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# Vehicle Construction & Progress Made

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# Lessons Learned

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- Create a legacy
- Underclassmen involvement
- Alumni review
- Fully functioning bike for following team
- Plan to finish early in case of pandemic


EATON



Parker

SunSource

# *Thank you!*

# Questions?