NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

Final Presentation
Purdue University - WL
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PURDUE UNIVERSITY

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Outline

- Problem Statement & Objectives
- Pre- and Post-Midway Review
- Vehicle Construction
- Vehicle Testing
- Encountered Technical and Electrical Challenges
- Final Implemented Design
- Conclusions / Future Work
- Gained Values

Problem Statement

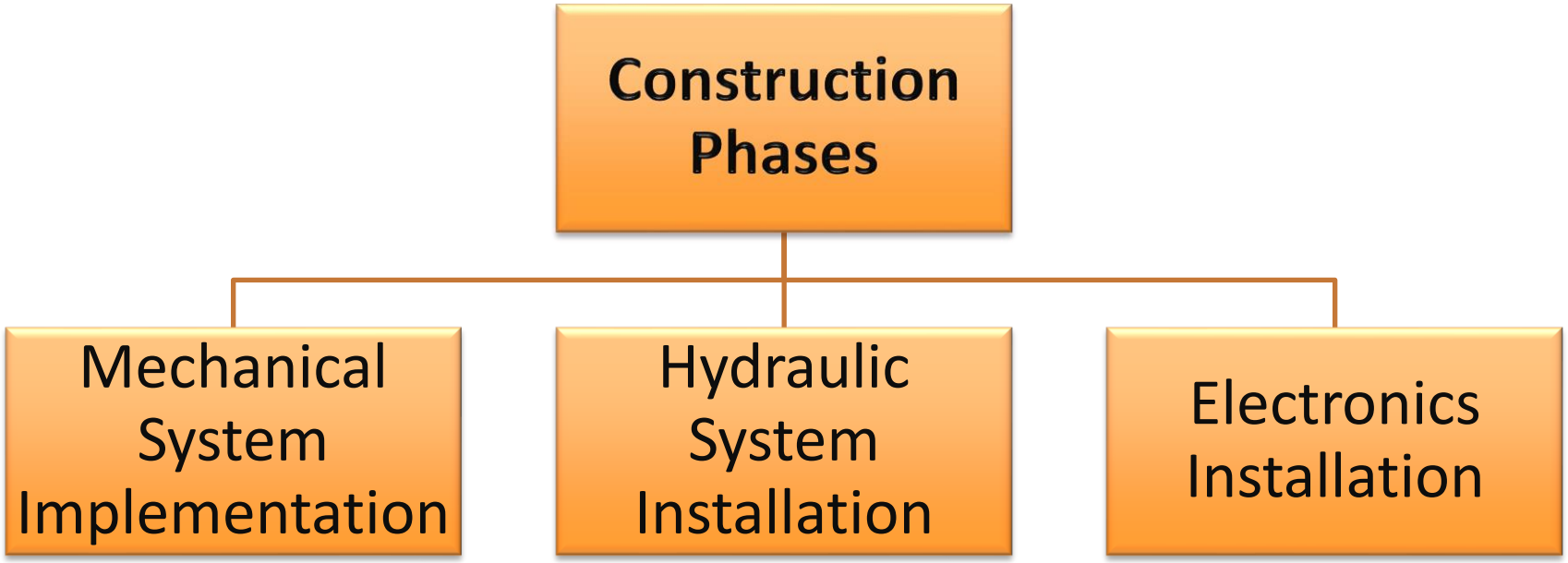
Objective:

- Create a human powered vehicle that transmits power hydraulically and is capable of recovering and storing energy

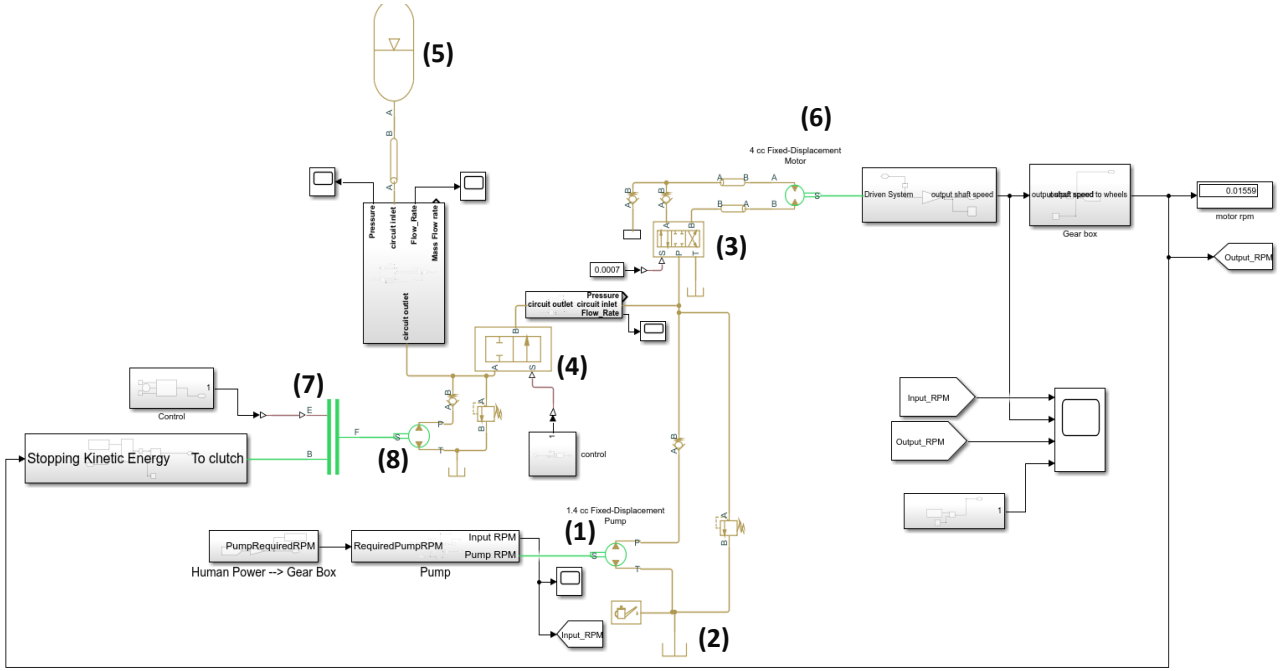
Challenges:

- Sprint
- Endurance
- Efficiency

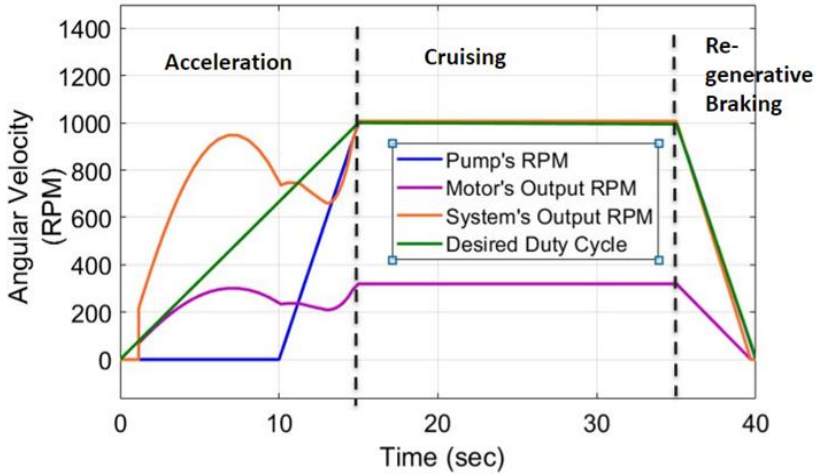
Vehicle Construction

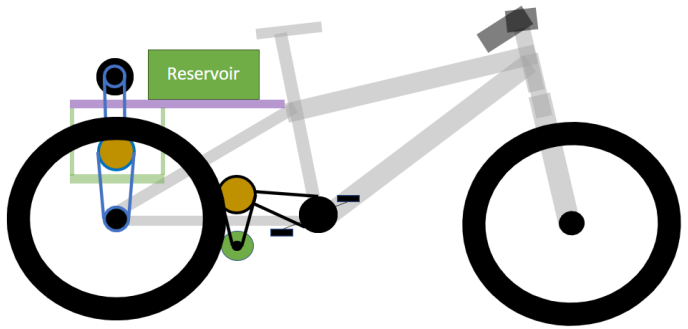


Pre-Midway Review
Simulation Outcomes



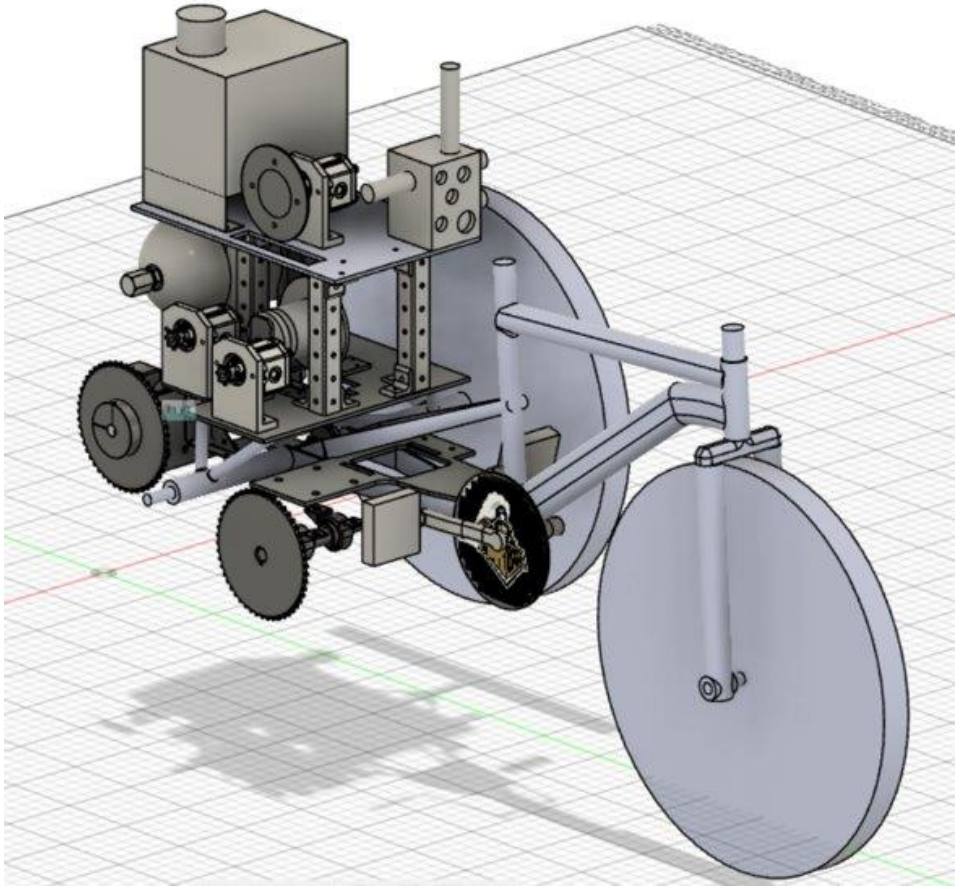
Item Number	Description
(1)	1.4 cc Hydraulic Pump
(2)	Low Pressure Reservoir
(3)	4/3 Directional Valve
(4)	2/1 Directional Valve
(5)	Gas Accumulator
(6)	3.5 ~ 4cc Hydraulic Motor
(7)	Mechanical Clutch
(8)	Auxiliary Reg-Pump





Post Midway Review

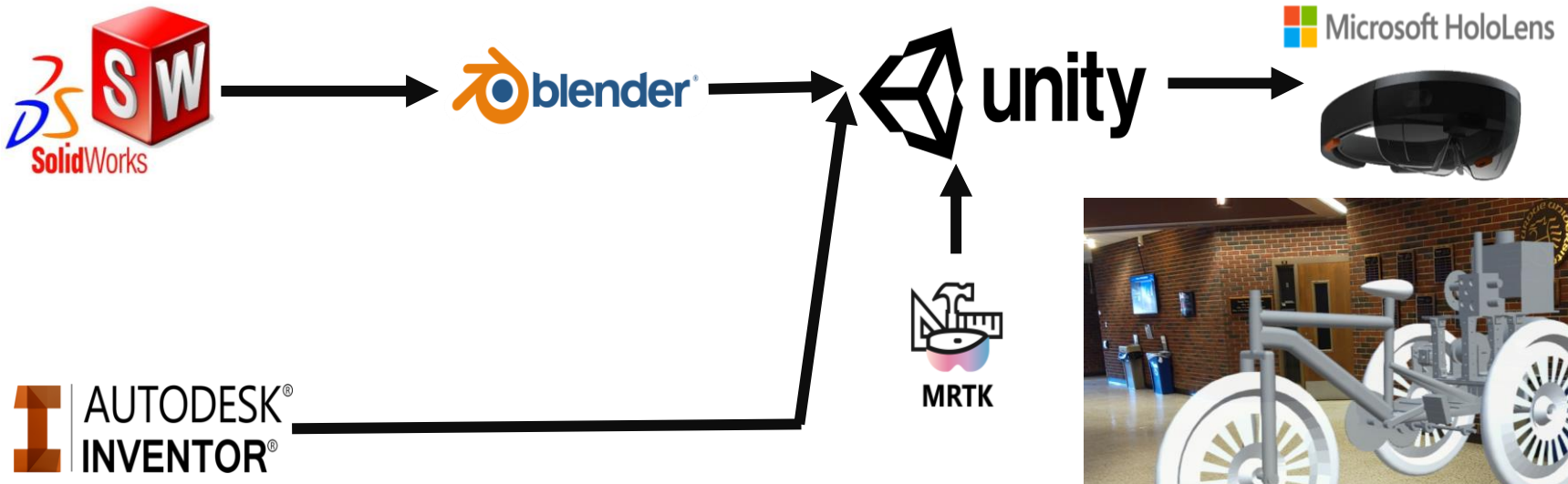
- ✓ Virtual assembly
- ✓ Gear ratios
- ✓ Electric design
- ✓ Programming language
- ✓ BOM



Vehicle Construction
Mechanical System

Utilization of Mixed Reality (MR) Technology

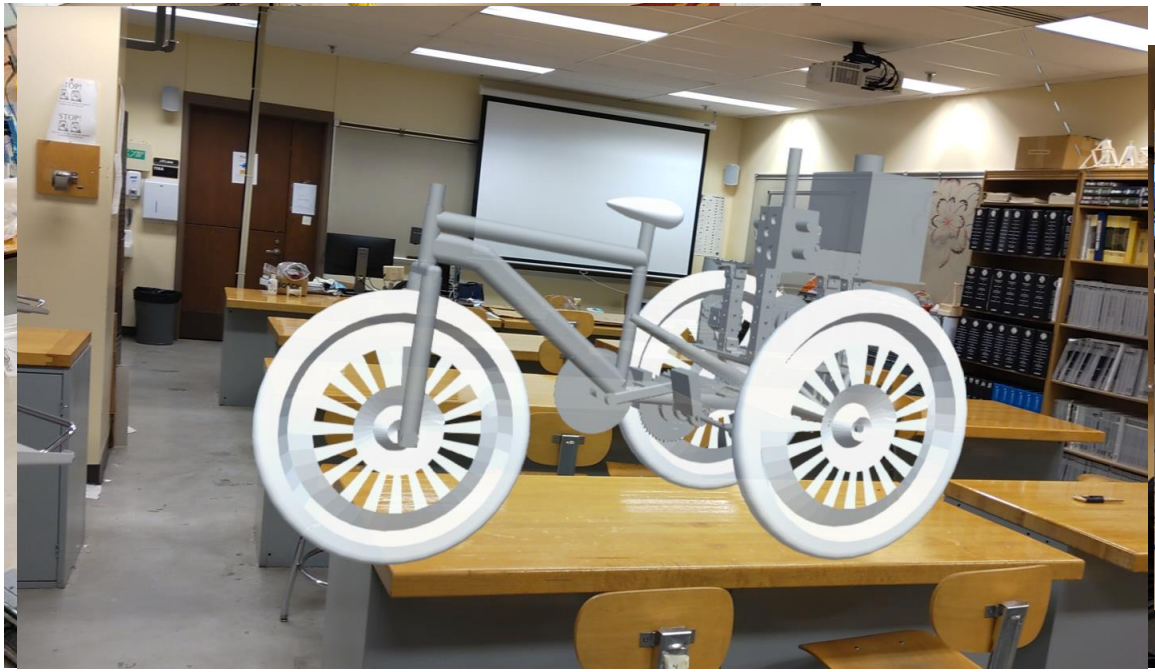
- An ***MR paradigm*** for the Bike Model was built and ***deployed*** to assist in ***studying*** the design during the construction phase.

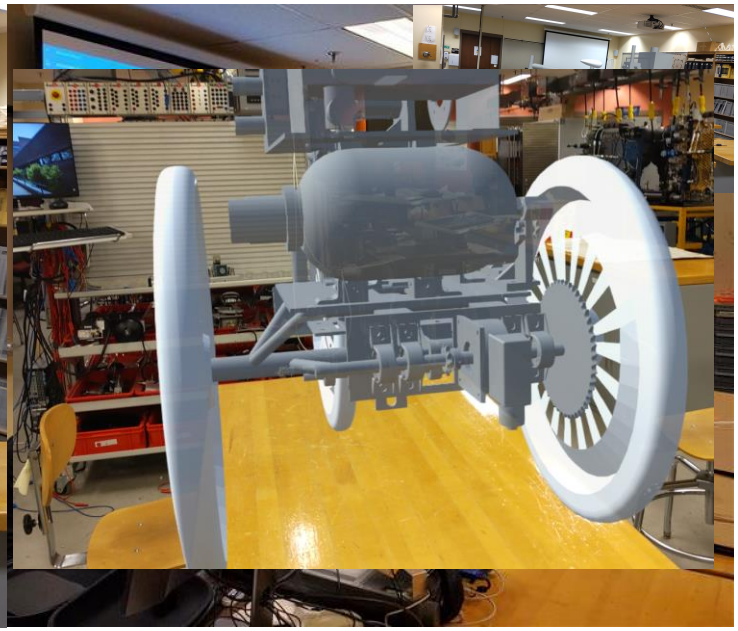


Vehicle Construction
Mechanical System

Utilization of Mixed Reality (MR) Technology

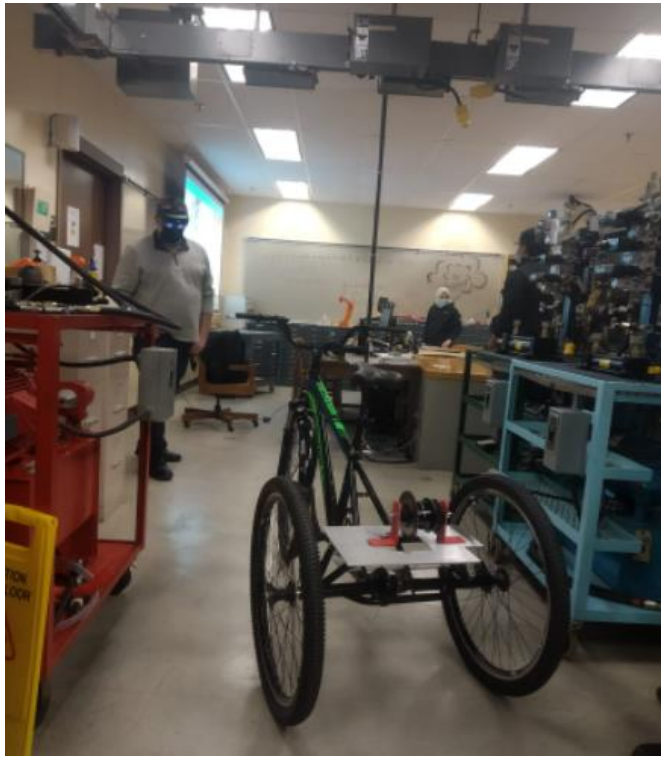
- Components and subsystems layout.





Vehicle Construction
Mechanical System

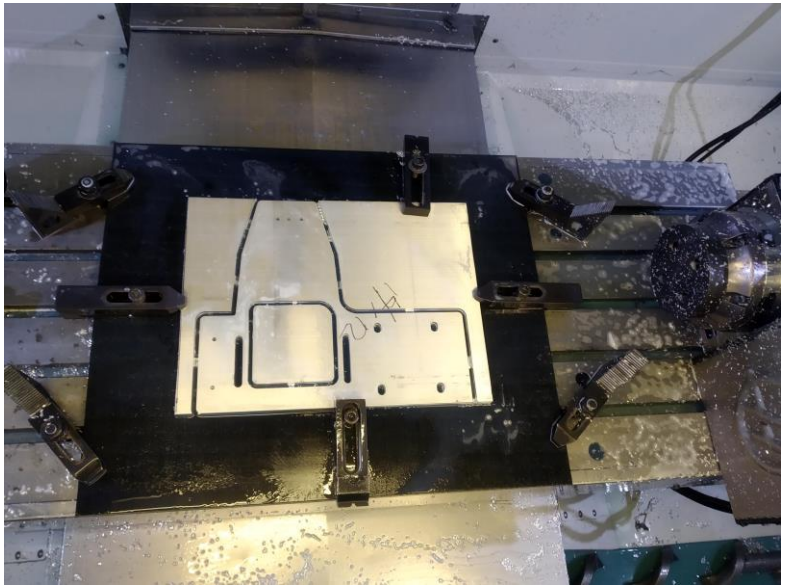
Utilization of Mixed Reality (MR) Technology

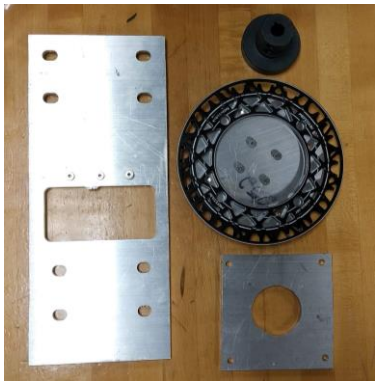


Vehicle Construction

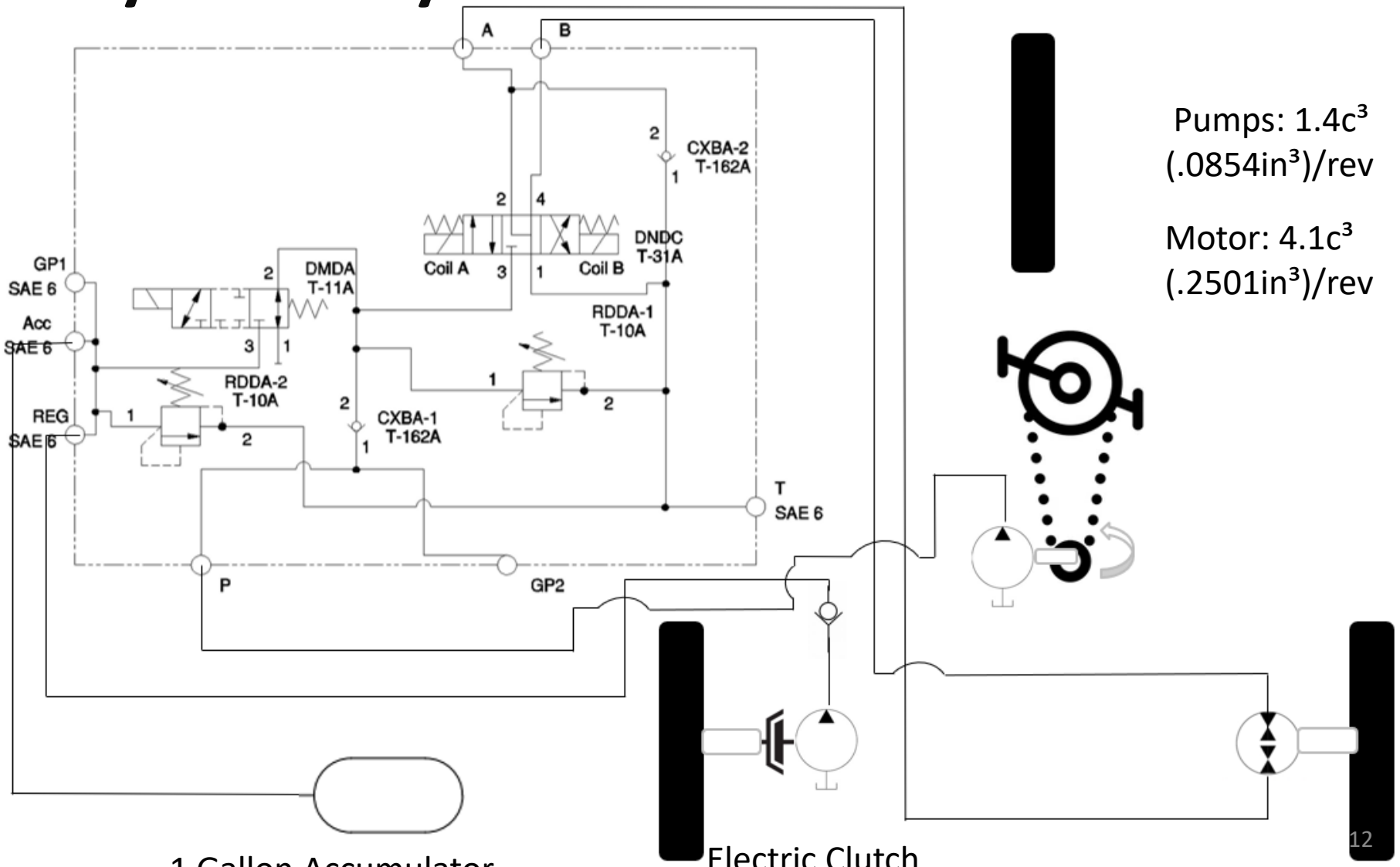
Mechanical System

Manufacturing & Assembly Process





Vehicle Construction
Hydraulic System



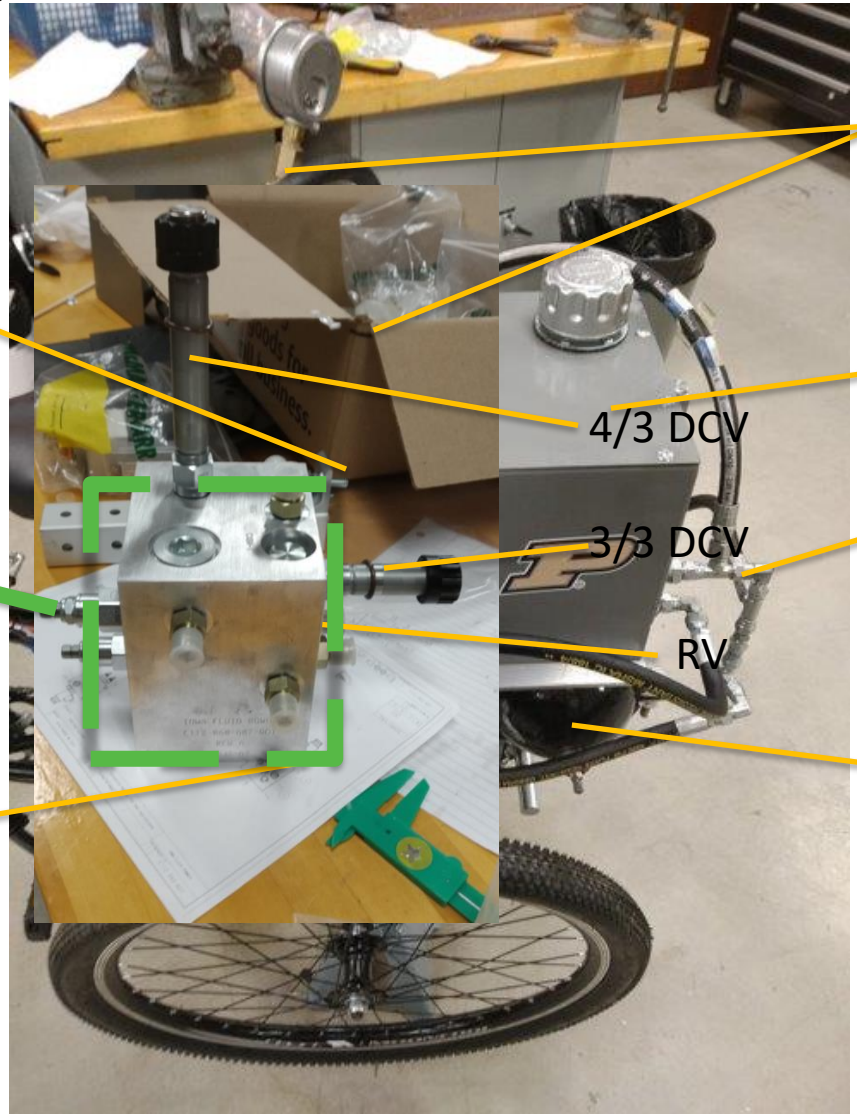
Pumps: 1.4c³ (.0854in³)/rev

Motor: 4.1c³ (.2501in³)/rev

1 Gallon Accumulator

Electric Clutch

Vehicle Construction
Hydraulic System



JIC 6, SAE 6

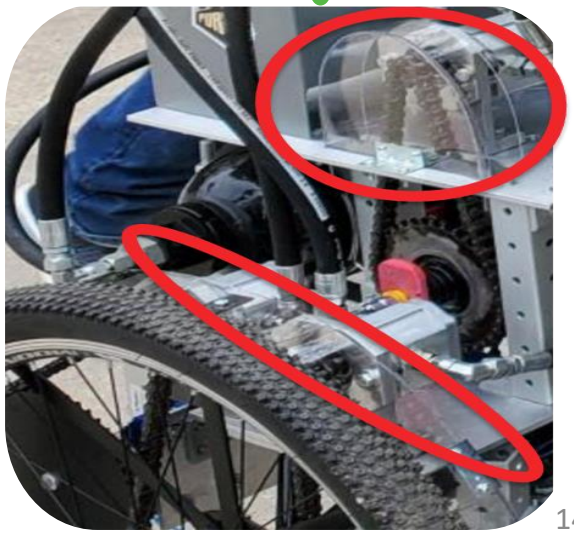
Vehicle Construction

Safety Chain Guards

- ***Lexan*** ***Clear Polycarbonate*** Sheets were used for ***chain guards***.

Lexan Clear Polycarbonate

- ***Lexan*** allowed ***achieving safety*** while still ***viewing the bike components***.



Vehicle Construction
Electronics

Mode	Coil A (4/3 DCV)	Coil B (3/3 DCV)	Electric Clutch
Coast	ON	OFF	OFF
Boost	ON	ON	OFF
Regenerative	OFF	OFF	ON
Charge	OFF	ON	OFF

- **Coast**: Direct Drive
- **Boost**: Releases accumulator pressure
- **Regenerative**: Builds pressure in the accumulator
- **Charge**: Enables user to store energy in the accumulator

Vehicle Construction
Electronics

XOSS G+ Bike computer

HMI - eX705

Data Acquisition

Cadence
- Max, Avg, Current

Speed
- Max, Avg, Current

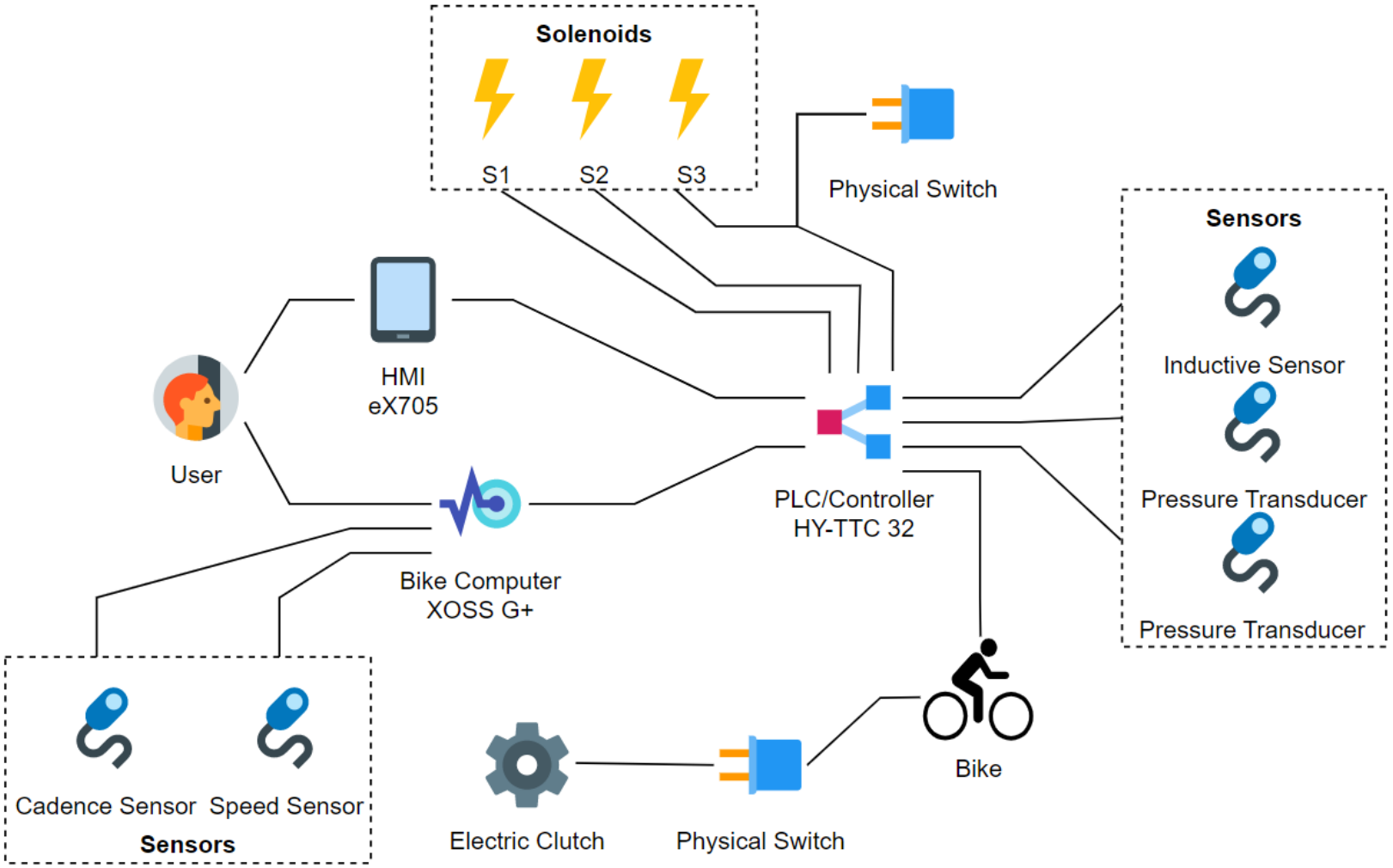
Time
Odometer
Distance
Altitude

Control System

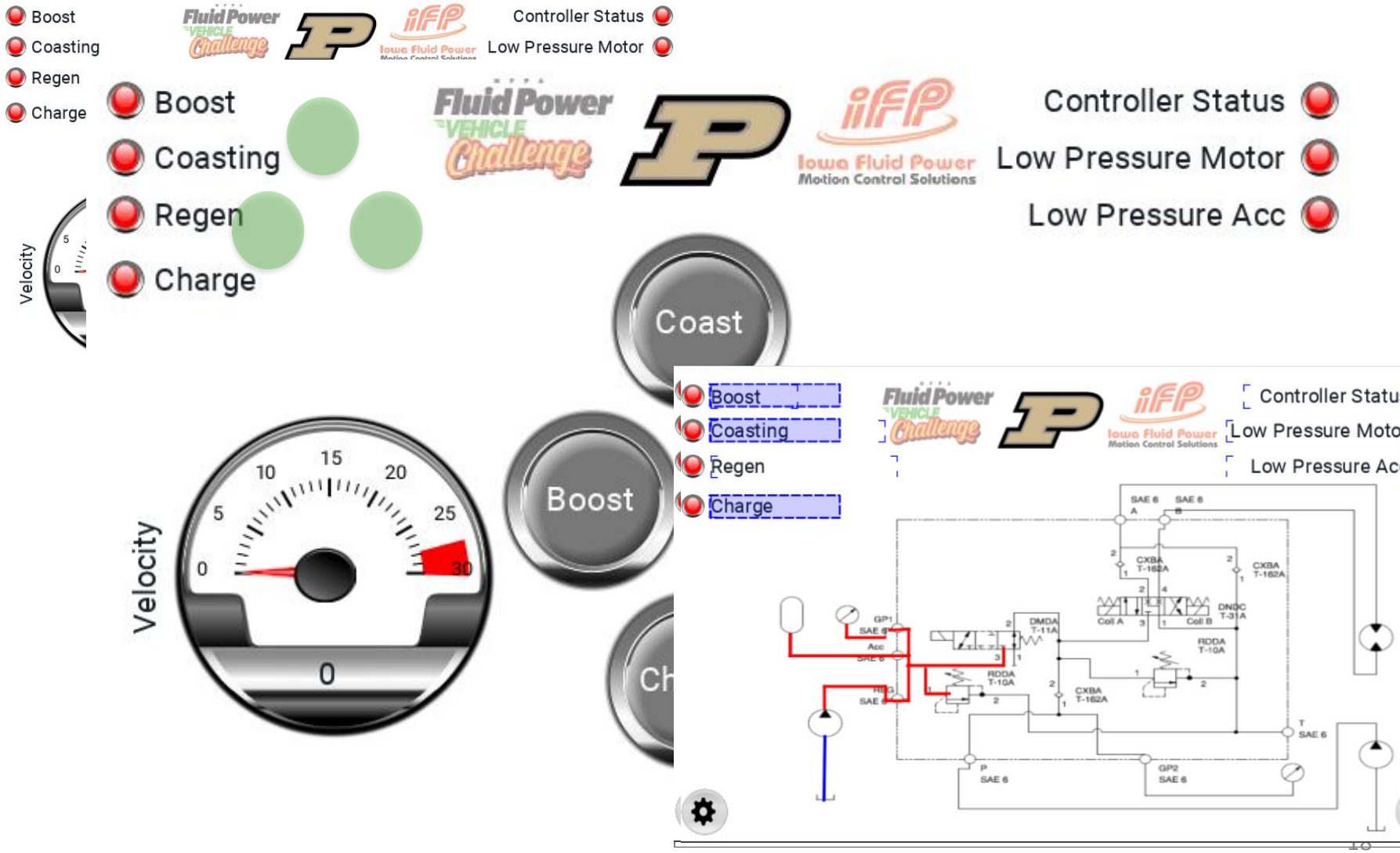
Current Speed
Hydraulic Pressure
- Motor
- Accumulator
- Low-Pressure Alarms

Solenoid valves' state
Hydraulic System current state

Vehicle Construction
Electronics



Vehicle Construction
Electronics



Vehicle Testing

Technical and Electrical Challenges

Manufacturing challenges

- Chain alignment and tension
- Gear ratio: motor to gearbox and gearbox to the driveshaft

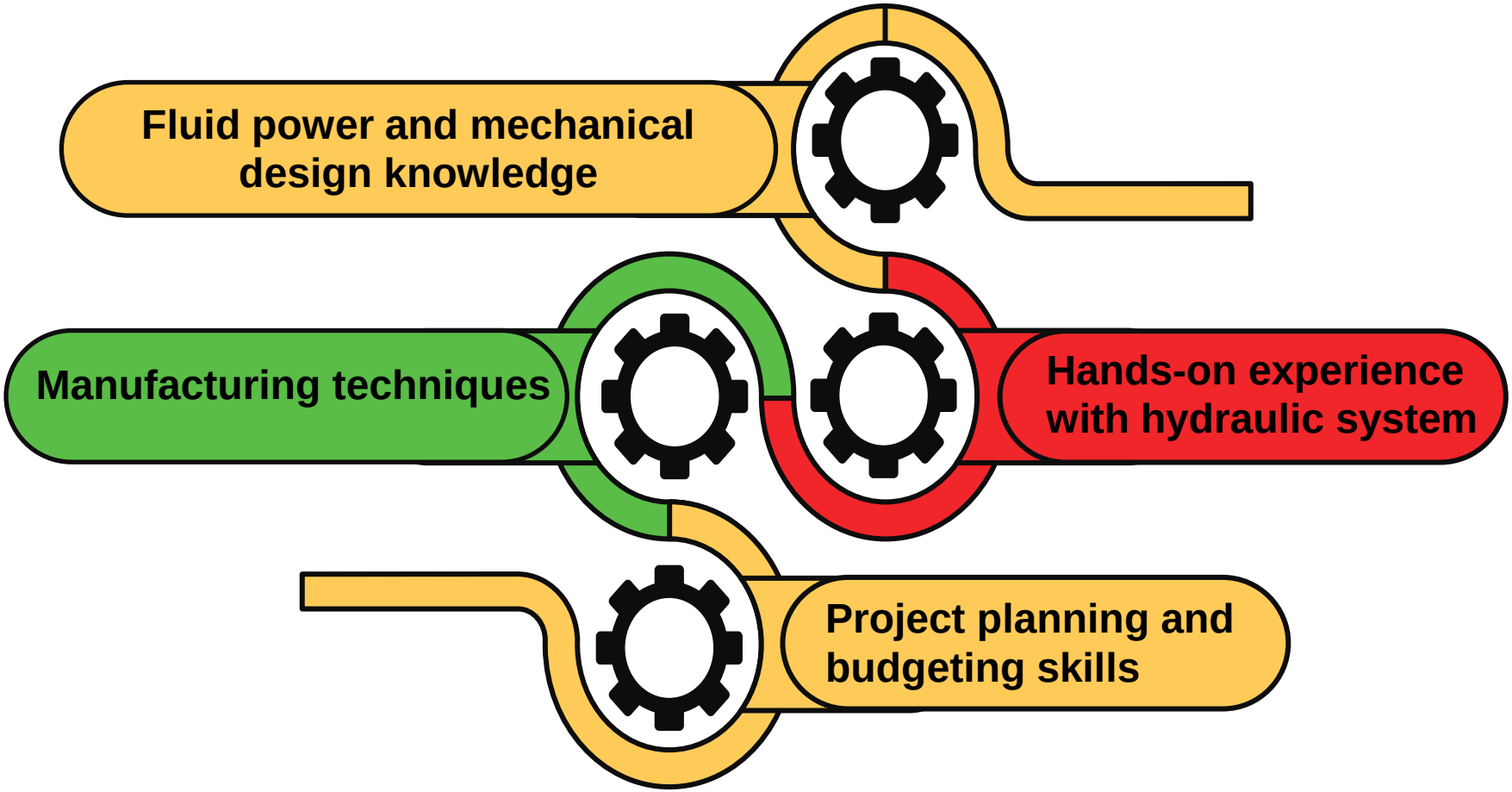
  66-204:1 --> 1.5-4.7:1

Component Issues

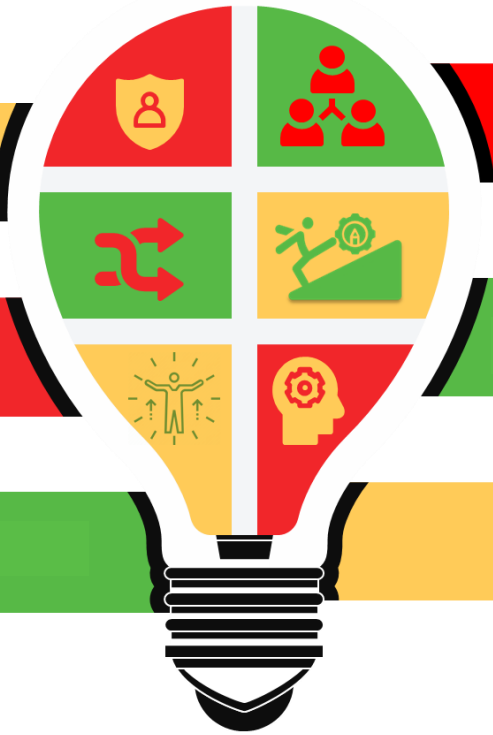
- Missing check valve for regenerative braking pump
- Accumulator's bladder – Leak
- Burnt Solenoid

Final Implemented Design

Acquired Skillset



Gained Values



- Always check with our advisors.
- Work on tasks assigned by the club president.

- Work together to finish the bike on time.

- Be flexible in our design.
- Look for flexible solutions.

- Work till the end!
- Never give up!

- Work under pressure.
- Manage our time more effectively.

- Accept each other's opinions and suggestions.
- Plan for the worst-case scenario.

Conclusion & Next Steps

Created a human powered vehicle that:

- Transmits power hydraulically
- Capable of recovering energy
- Capable of storing energy

Opportunities

- Improving 3D model and simulation model
- Component Selection
  - Actuators
  - Valves
- Reducing Weight of Vehicle

Thank you!

- NFPA
- NORGREN
- TRELLEBORG
- Iowa Fluid Power
- Maha Fluid Power Lab
- Ernie Parker
- Stephanie Scaccianoce
- Advisors