NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

Final Presentation
MSOE RATT Pack
Dr. Luis A Rodriguez
04/21/2022

MSOE UNIVERSITY

The RATT Pack

- From right: Darrian, Jason, Jacob S., Jacob B., Matthew, Adam

Problem Statement

- Human-powered, hydraulically-driven vehicle
- Must comply with NFPA Rules and Regulations
- Able to compete in three different competitions, with four different circuit functionalities
- Competition helps create the next generation of engineers who are knowledgeable about fluid power

Objectives

Create an innovative vehicle

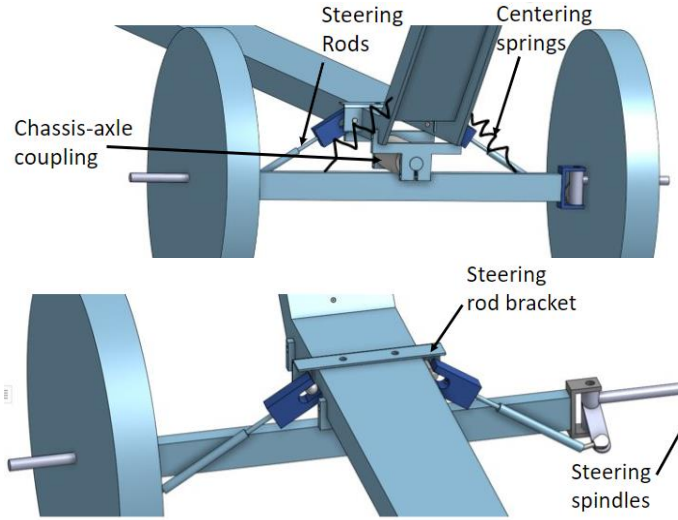
Ensure the rider can ride the vehicle safely

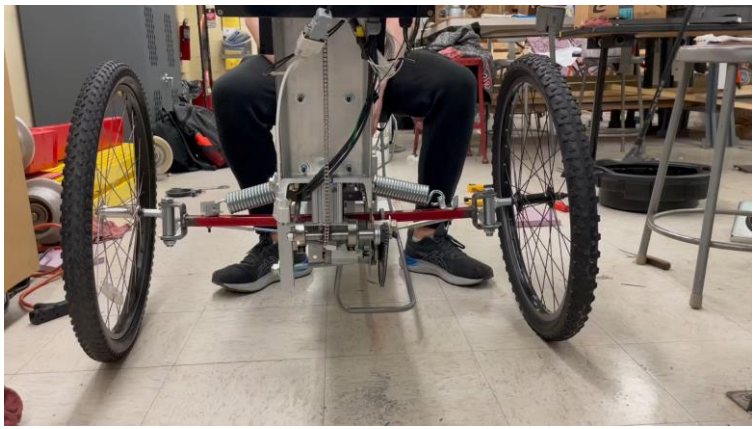
Compete in all 3 challenges

Make the steering system easy to use

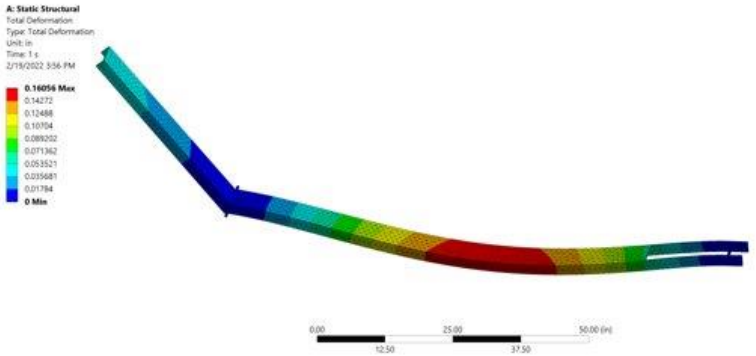
Summary of Midway Presentation

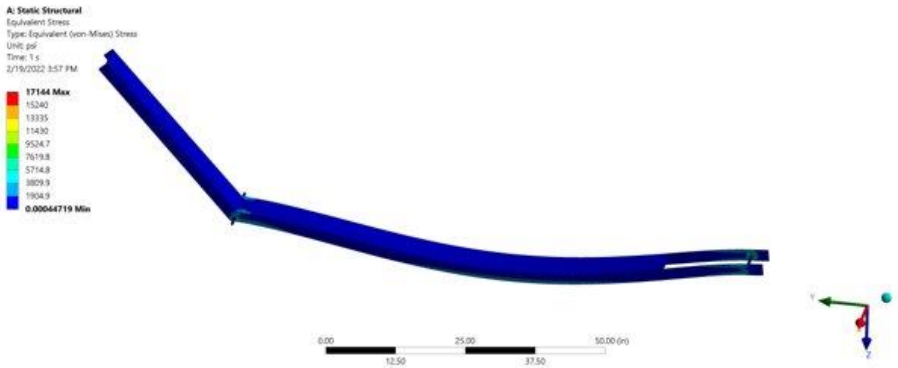
Tilt Steering Assembly:





Finite Element Analysis:



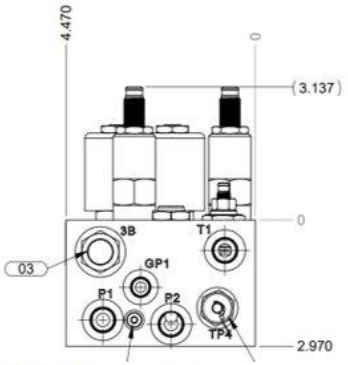


Summary of Midway Presentation Cont.

Hydraulic Selection:

Hydro Leduc Bent-Axis Piston Motor
M5_093840

(2) Marzocchi Fixed-Displacement Gear Pump
ALP1A-D-5



Custom manifold courtesy of SunSource

Pneumatic Selection:

Bimba ¾” x 2” Line Cylinder
SR-042-RP

Bimba 1-1/16” x 3” Line Cylinder
SR-093-P

Controls Selection:

Programmable Logic Controller (PLC)
HY-TTC 32

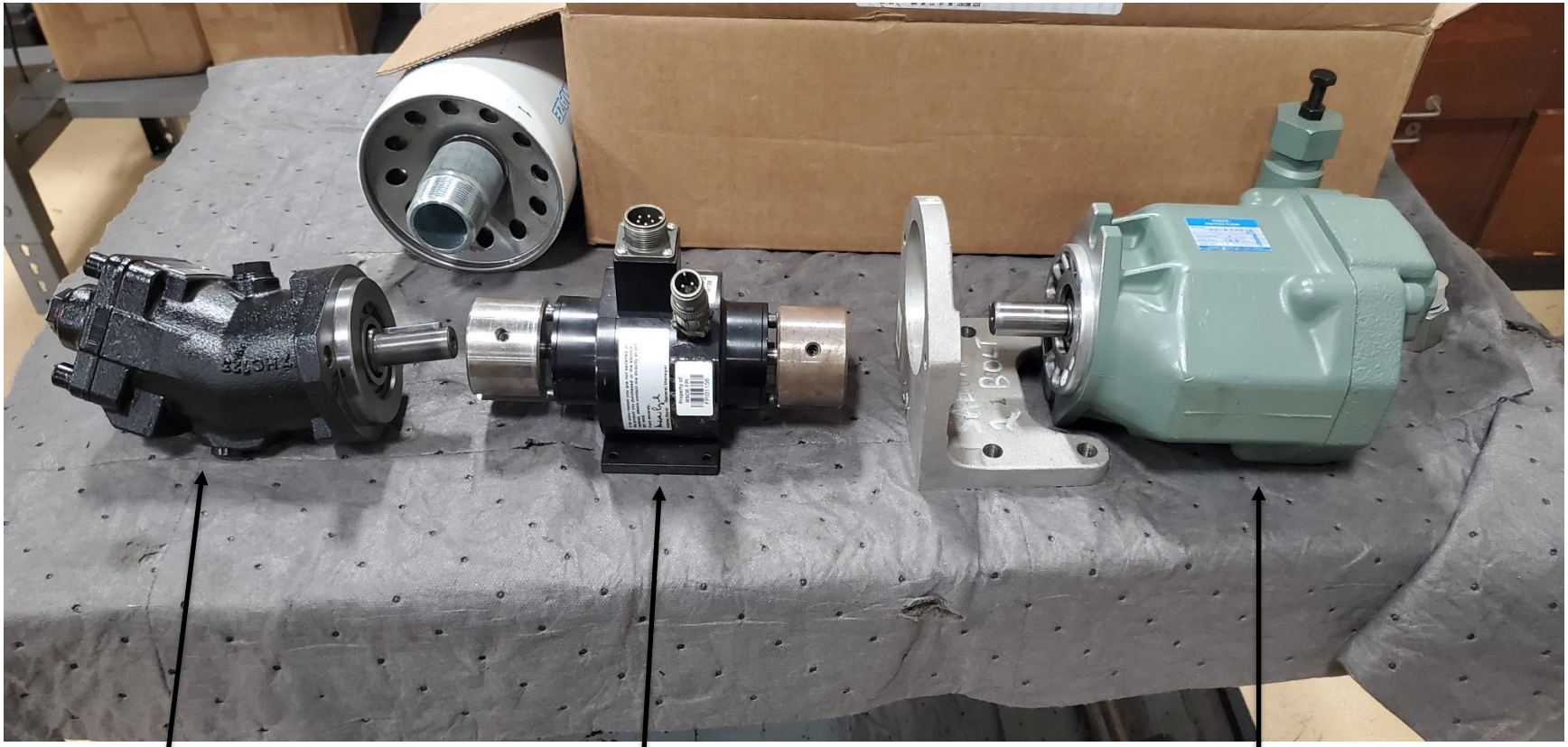
5” TFT Multitouch Capacitive Touchscreen
eX705

Vehicle Construction

Vehicle frame was designed and constructed from scratch. We used all sorts of tools for fabrication:

- Bandsaw
- Welder
- Mill
- Drill Press
- Belt Sander
- Hand File
- Die & Tap
- Tube Bender
- Flare Tool
- Angle Grinder
- Lathe

Vehicle Testing



Hydraulic Motor

Torque Meter

Hydraulic Pump

Vehicle Testing

After construction wrapped up, we tested every aspect of our vehicle and made modifications as needed to boost performance.

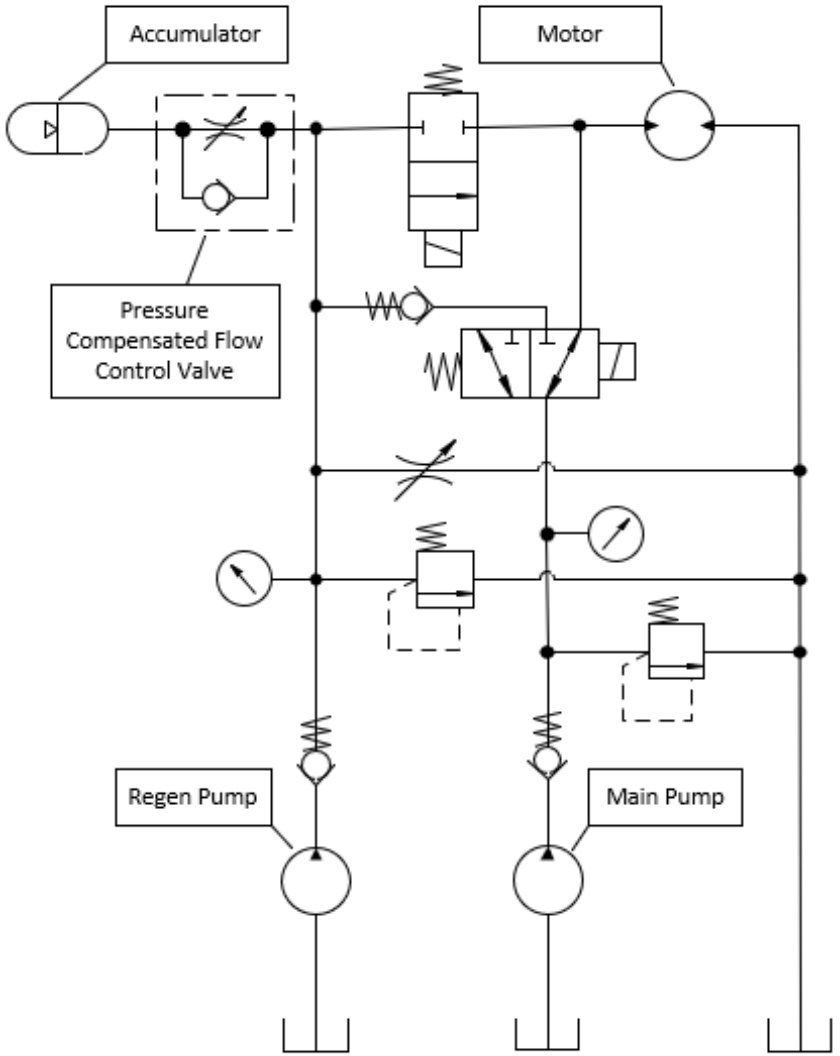
We tested things such as:

- Optimal accumulator pre-charge
- Ideal chain tension
- Preferred spring stiffness for steering
- Best FCV (Flow Control Valve) setting
- Prime idler pulley positioning

Final Hydraulic Circuit

Four Drive Modes:

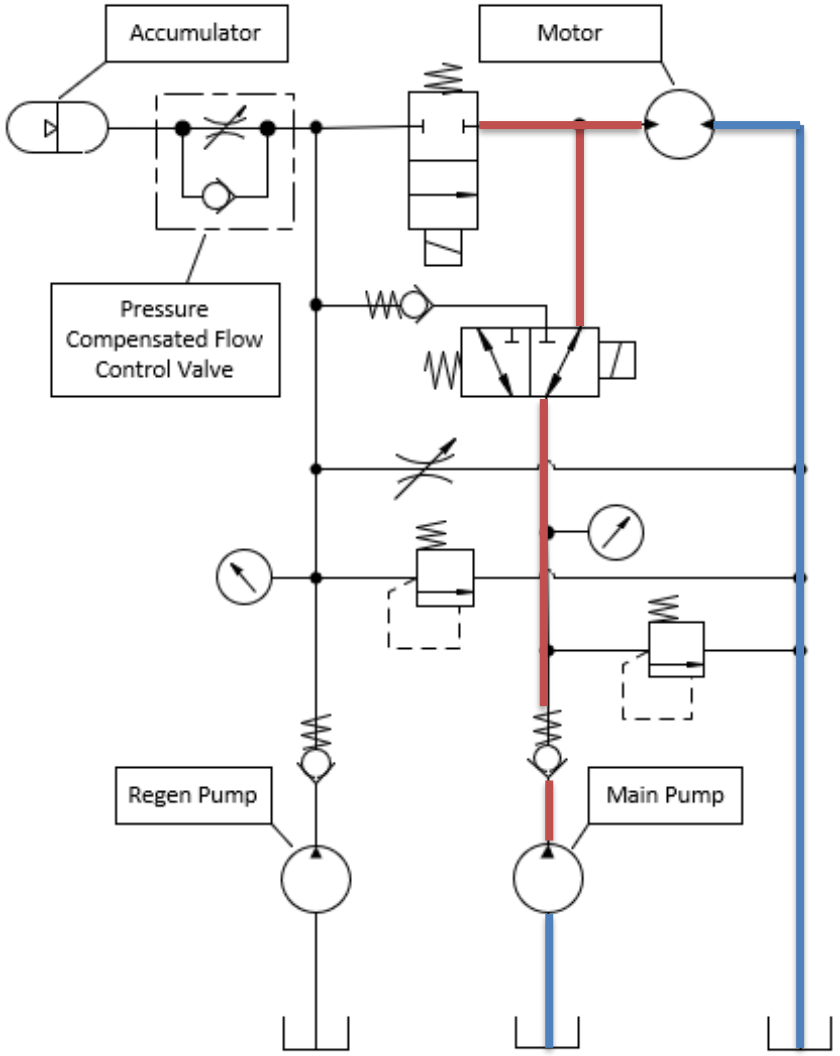
- Direct Drive
- Direct Charge
- Regen Brake
- Accumulator Discharge



Final Hydraulic Circuit

Four Drive Modes:

- **Direct Drive**
- Direct Charge
- Regen Brake
- Accumulator Discharge



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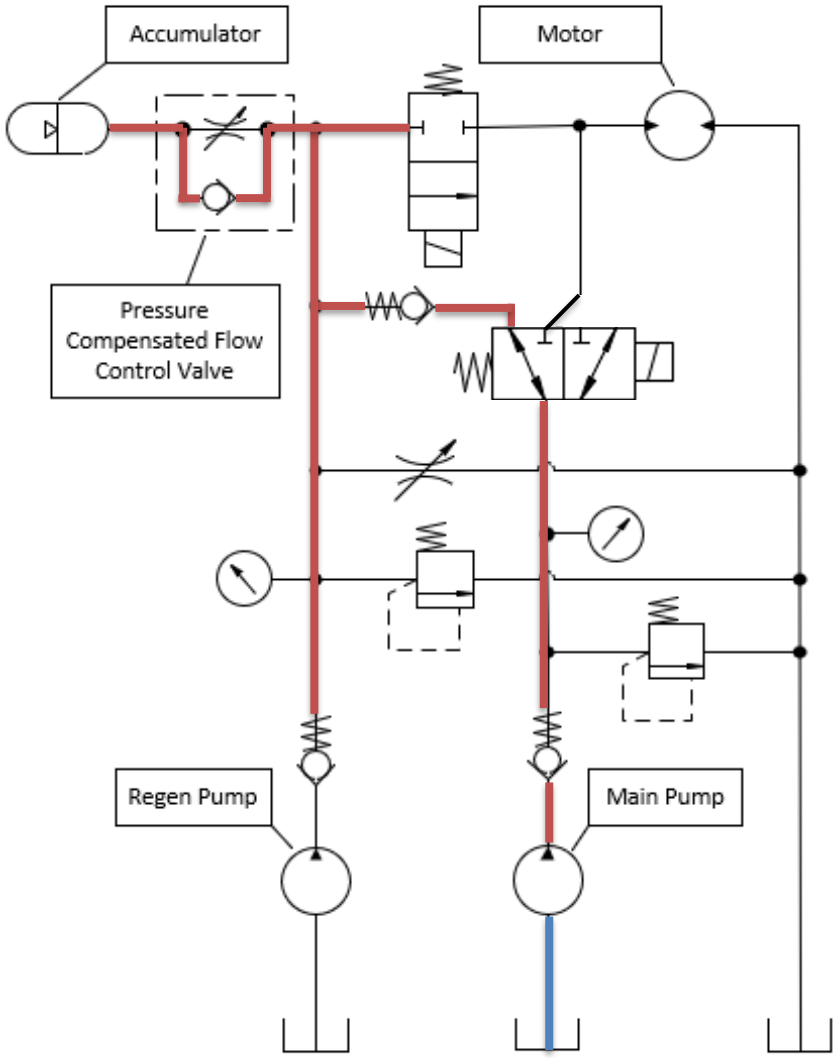

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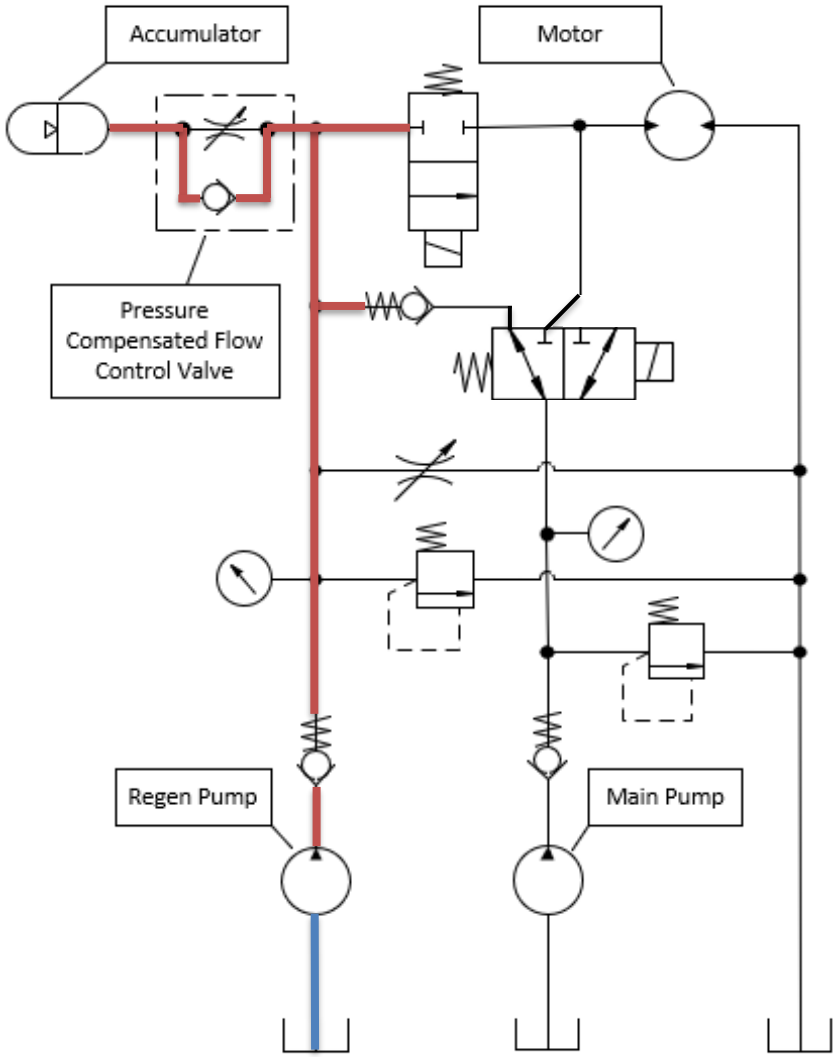

Final Hydraulic Circuit

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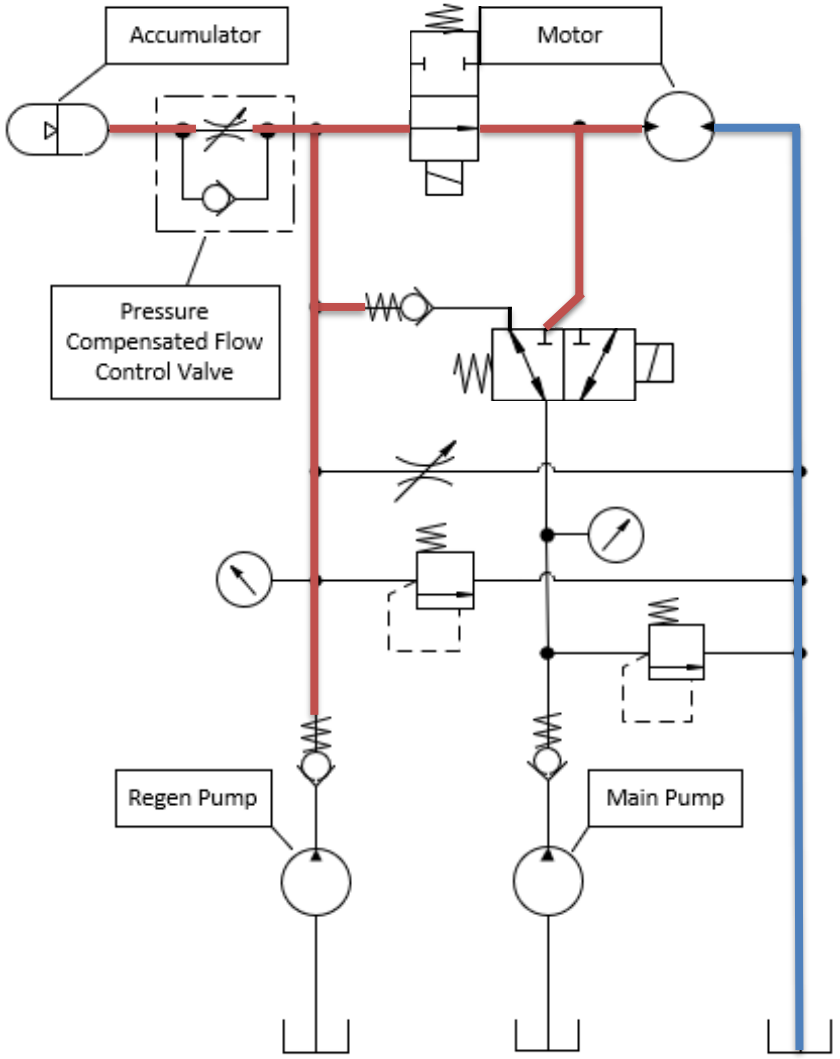
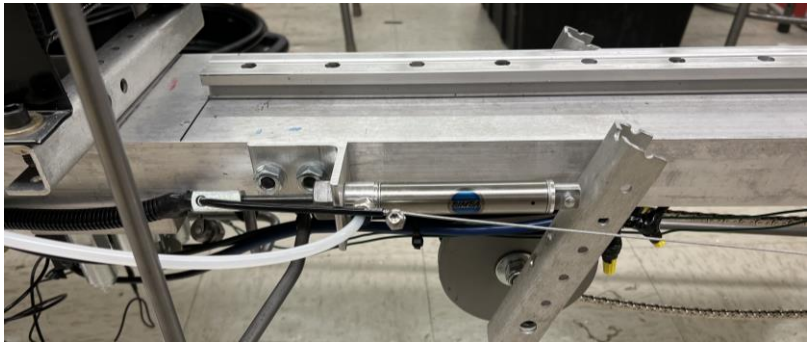


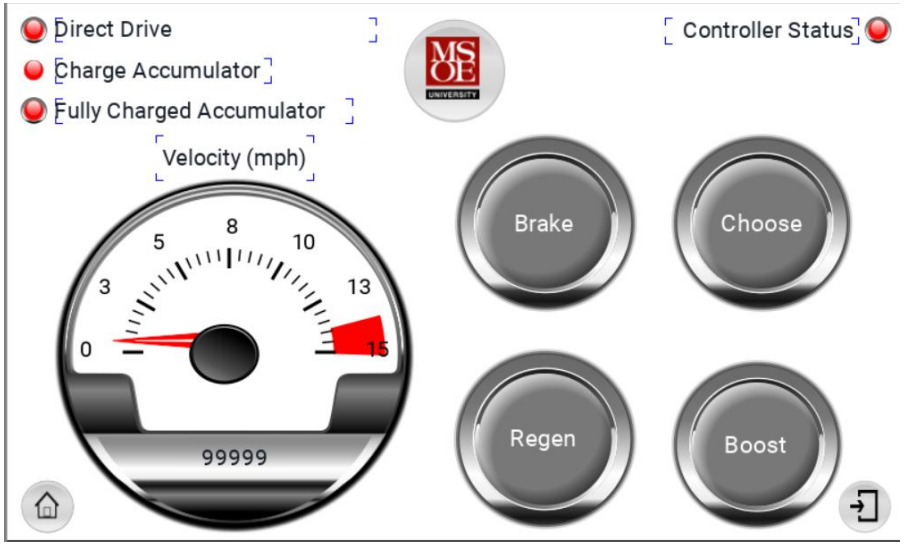
Pneumatics

- Used one single pneumatic circuit in two applications.
  - Pneumatic Brake
  - Pneumatically Actuated Regenerative Brake
- Added pressure regulators to vary the force applied by the cylinders



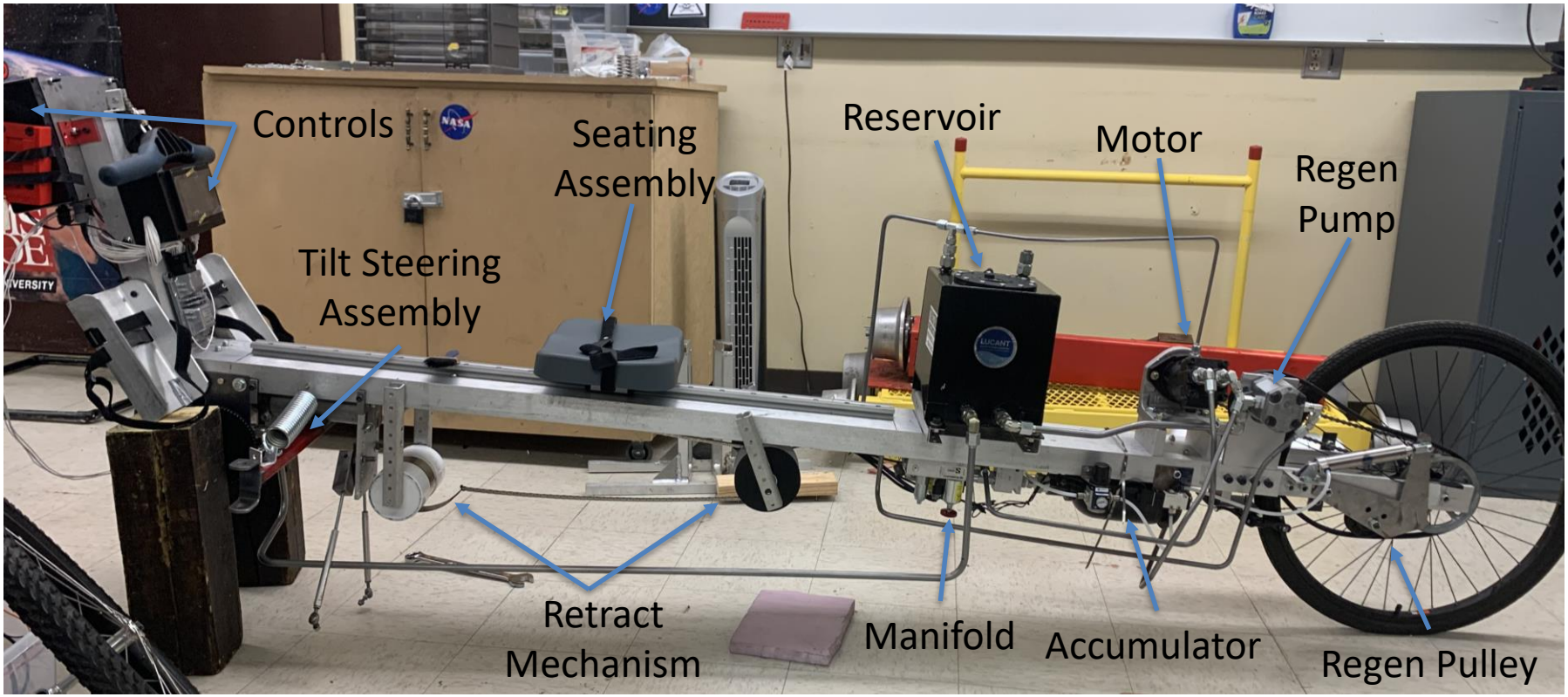
Controls

- Mobile PLC:
  - Digital inputs
    - Hydraulic switch
  - Digital outputs
    - Solenoids
  - Analog inputs
    - 3 Axis accelerometer
- HMI:
  - Velocity
  - Forward acceleration
  - Buttons
    - Choose
    - Boost
    - Brake
    - Regen



Final Vehicle

Vehicle layout is shown with front wheels removed



Vehicle Characteristics

- Rowing design
- Tilt steering
- Hydraulic pressure switch
- Regenerative braking
- Manual/pneumatic brake
- Isolation from high pressure portions of hydraulic circuits

Lessons Learned

- Don't be afraid to try new ideas
- Nothing worth doing is easy
- Consult all your teammates, you never know when someone will have an approach you wouldn’t have considered
- Allocate more time for materials to arrive via shipping
- Measure twice, cut once

Acknowledgements

Thank you to all those who helped along the way!

- Dr. Luis A Rodriguez
- Mike Helbig
- Dr. Daniel Williams
- Russell Steinmetz
- Terry McCart
- Mike McCarthy
- Ernie Parker
- Stephanie Scaccianoce

Questions

Thank you for your time, any questions?