NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION

Minnesota State University Mankato

Ryan Walerius

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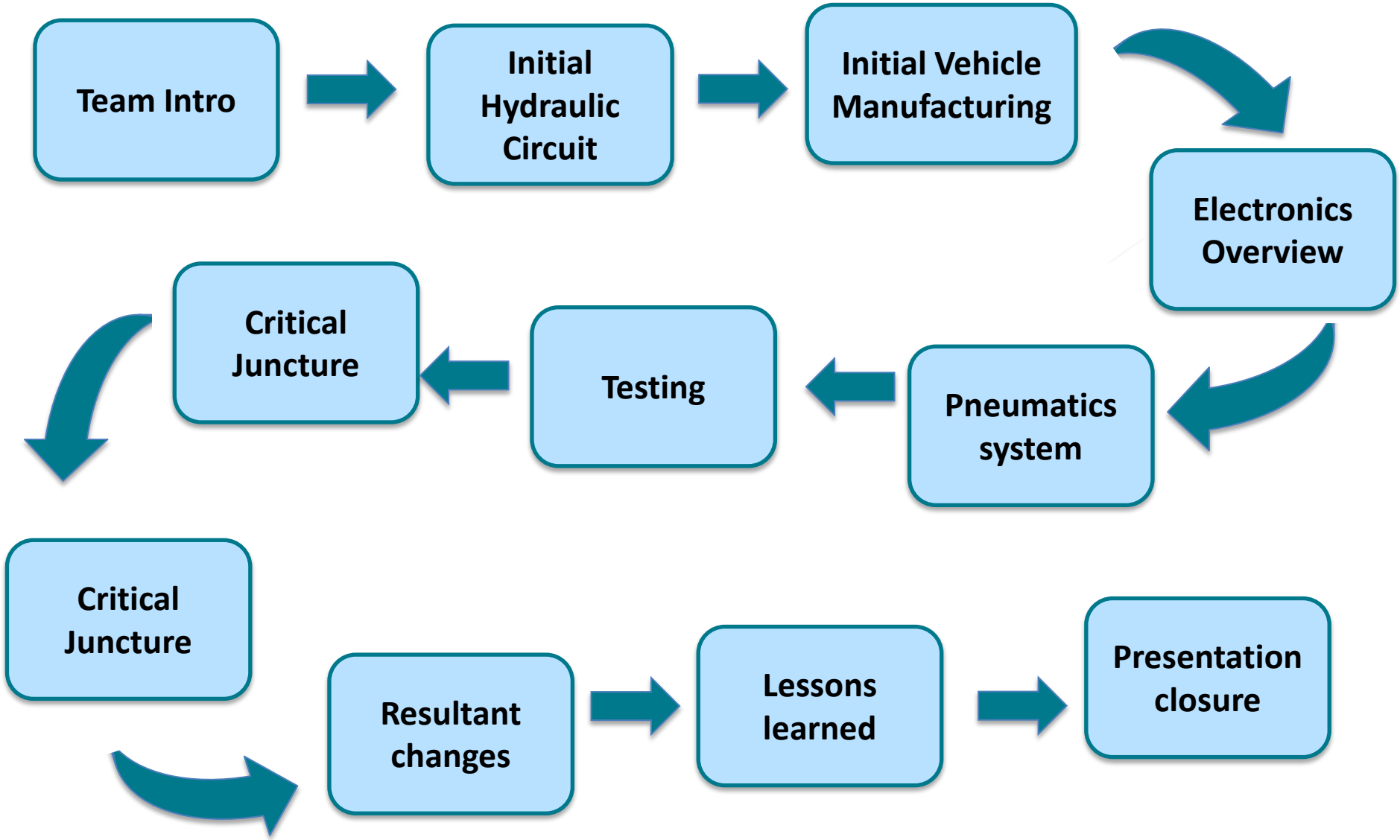
Twin Cities Engineering
Minnesota State University Mankato

Project Outline



MNSU Team

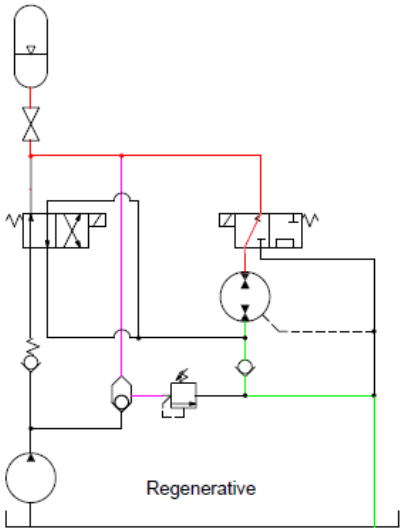
Stephan McGruder
Team Lead

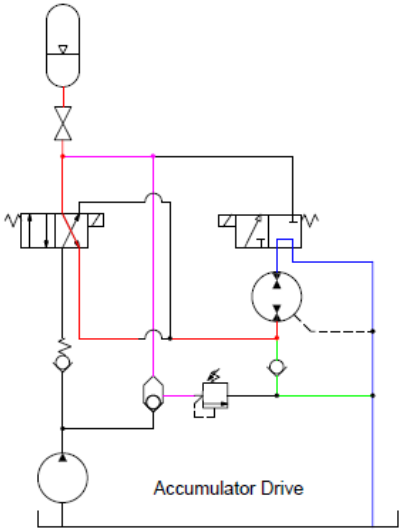
Jonathan Curillo
Engineer 1

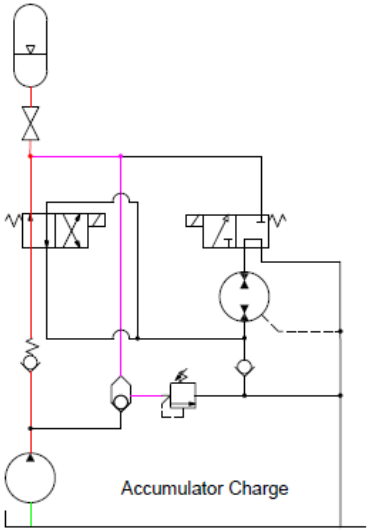
Jack Rhodes
Engineer 2

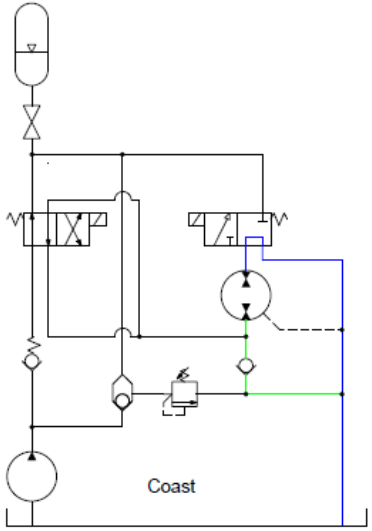
Mounkoka Francesca Goma
Engineer 3

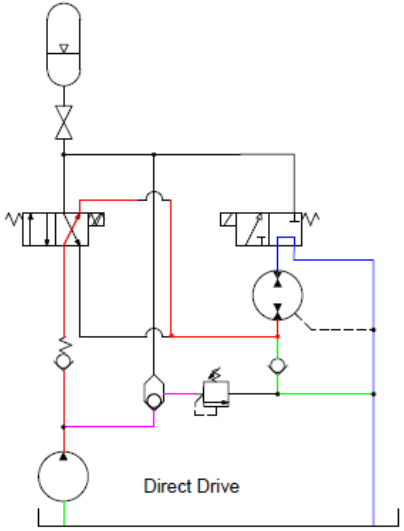
Initial Hydraulic Circuit







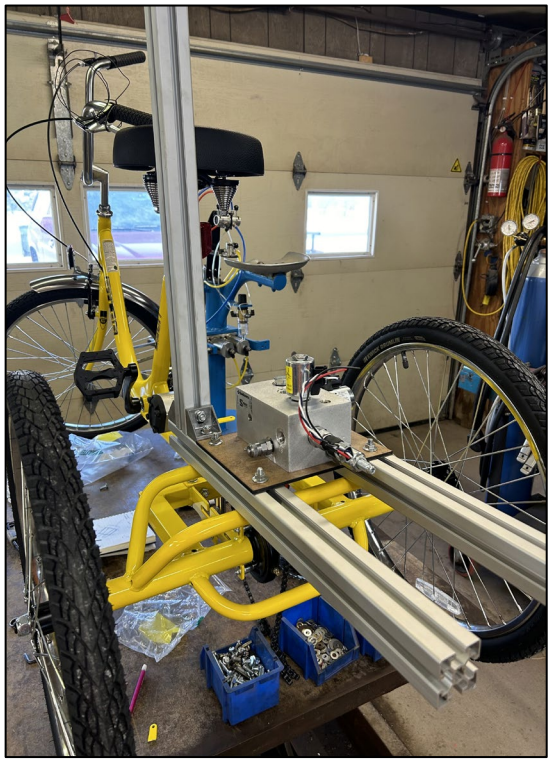




- Circuit design utilizes a custom manifold.
- 4 (+1) individual circuits
- Components selected for this circuit earlier in the project
- Circuit design around the sprint race event; Accumulator charging a central focus

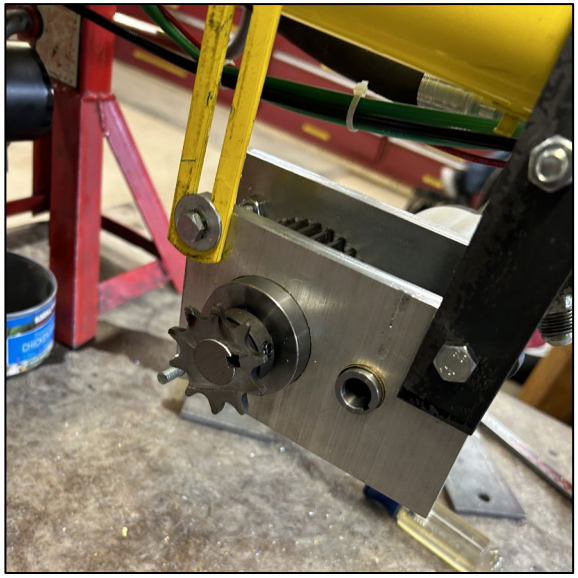
Initial Component Mounting

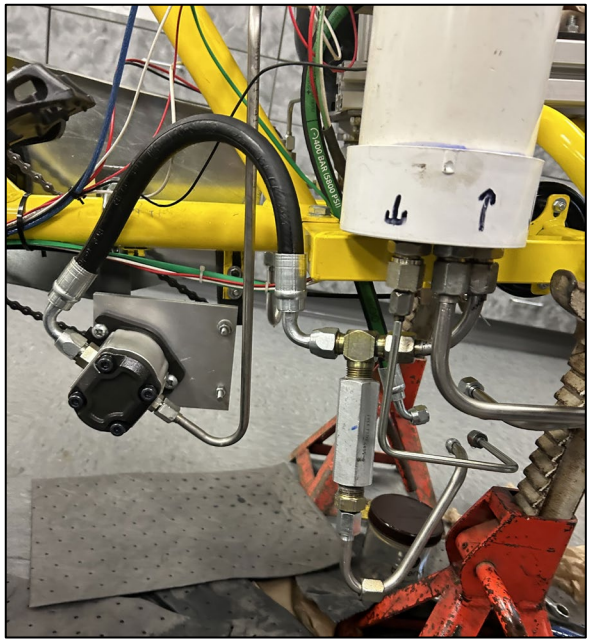
- Utilizes space between two rear wheels
- Aluminum Extrusion serves as Structural component for mounting
- Reservoir and accumulator surrounding the manifold.



Pump Gear Box

- Pump Gear Box with a target gear ratio of 15:1 (actual of 14.4)
- Both gears and sprockets were used.
- Estimated 900 rpm at the pump shaft
- Designed to supply ~1GPM to the circuit.





Motor to Wheel Gear Box

- Motor to wheel gear ratio designed for a 10:1 motor to wheel. Step down.
- Designed for torque to the wheel.
- Utilized using Gears.

ELECTRONICS

Two electronic control systems

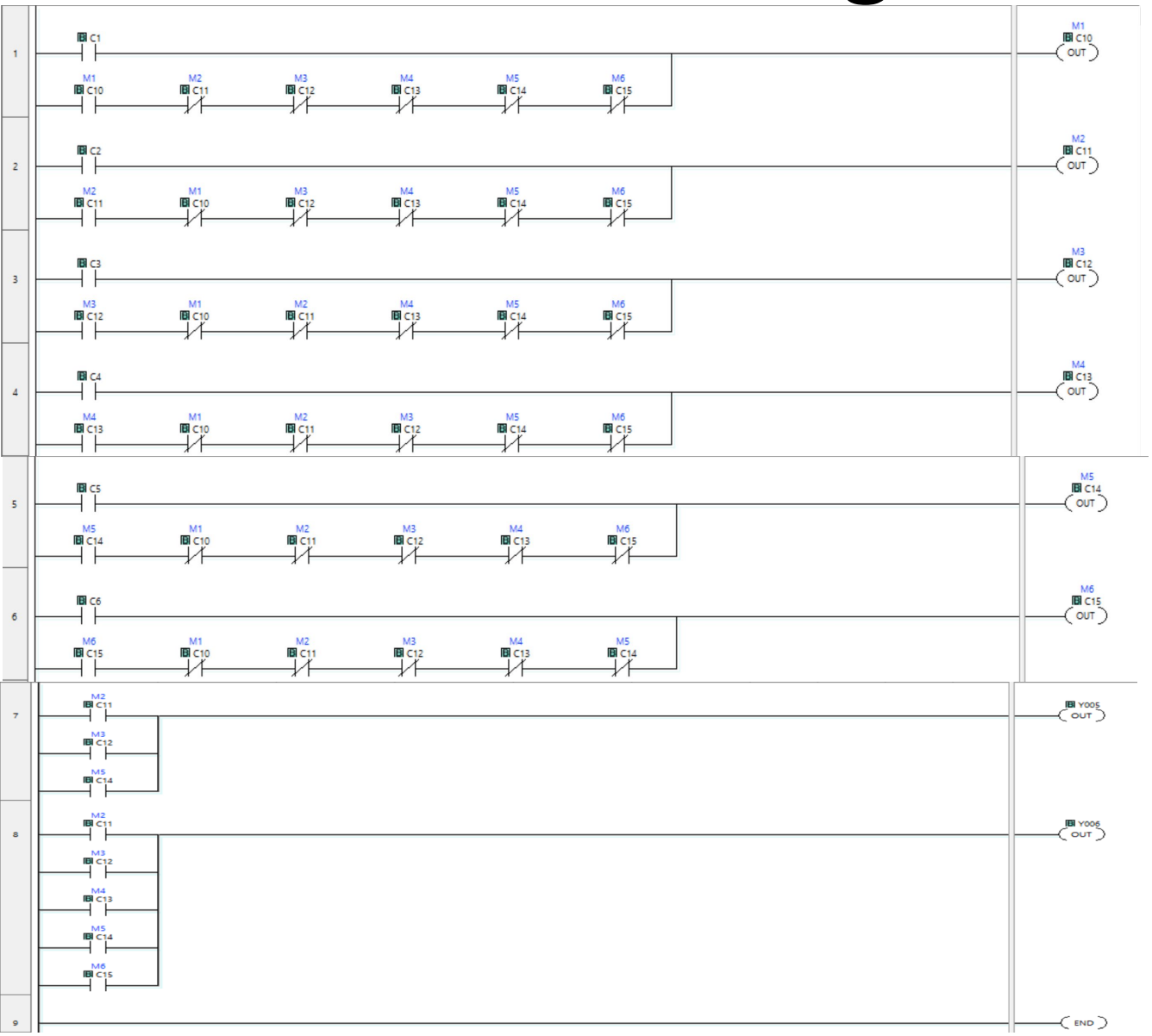
Click PLC

- HDMI
- Two outputs
- 6 modes

Arduino

- Two LCD Screens
- Two outputs
- Reads pressure

PLC and Ladder logic

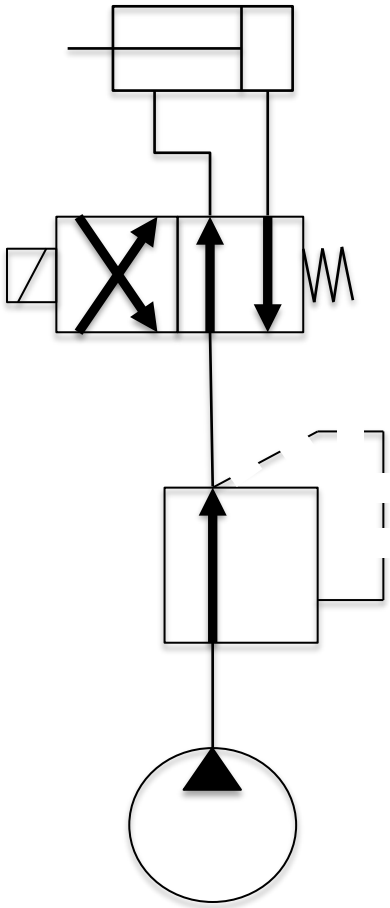


	A	B
C1	0	0
C6	0	1
C4	0	1
C5	1	1
C2	1	1
C3	1	1

C1: Regan
C2: Sprint
C3: Endurance
C4: Efficiency
C5: Pulse for Efficiency
C6: Coast

Pneumatic System

- Circuit to actuate hand valves ball valves within the hydraulic circuit
- Air is pre-charged.
- Valves linked to the hydraulic drive modes.



Initial Vehicle Components

- Gears boxes
- Accumulator
- Electronics
- Manifold
- Pneumatic system
- Reservoir

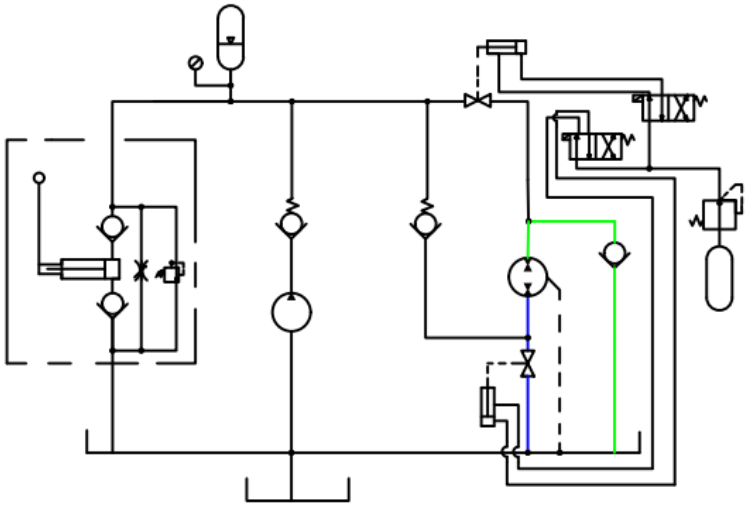
Vehicle Testing

- Motor testing
  - Adequate flow and pressure
- Manifold testing
  - Adequate pressure and flow.
  - Correct routing
  - Valves working properly.
- Pump testing
  - Pedaling resistance.
  - Leaks and correct flow.
  - Correct spin orientation.
- Gearbox testing
  - Correct meshing of gears.
  - Correct orientation.

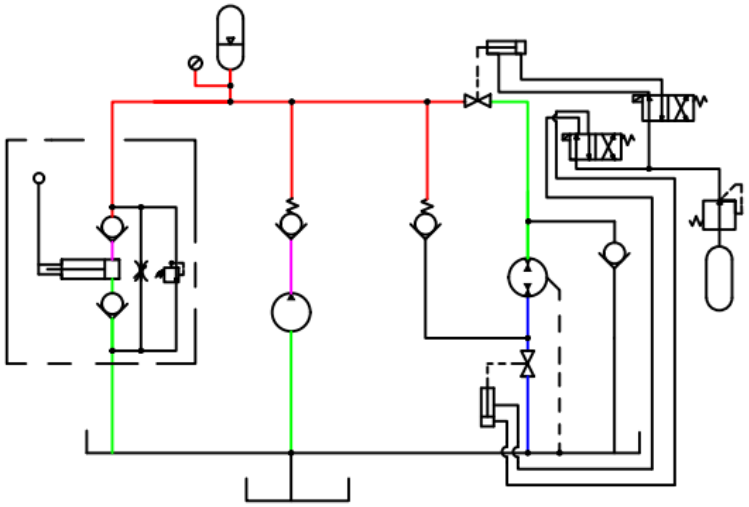
Critical Juncture

- Motor deemed inoperable due to not spinning under hydraulic pressure.
- Test conducted
  - Bench tested the motor.
  - Ensured proper assembly of motor with correct tolerances.
- Resulted in swapping motor for a known working one

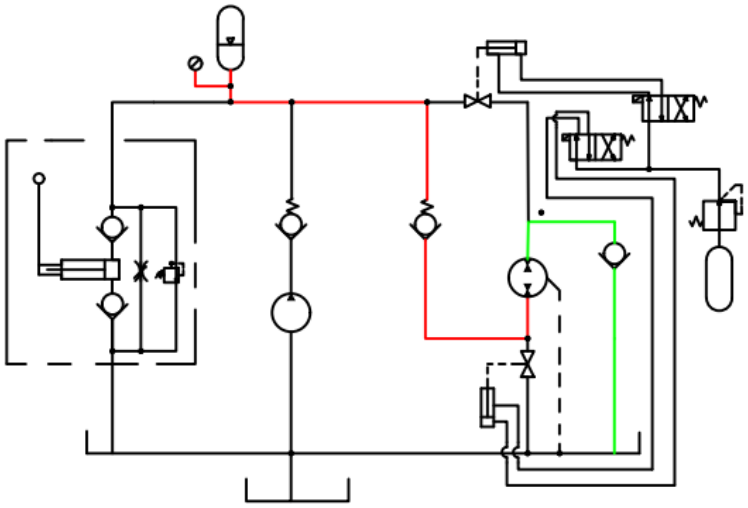
Current Hydraulic Circuit



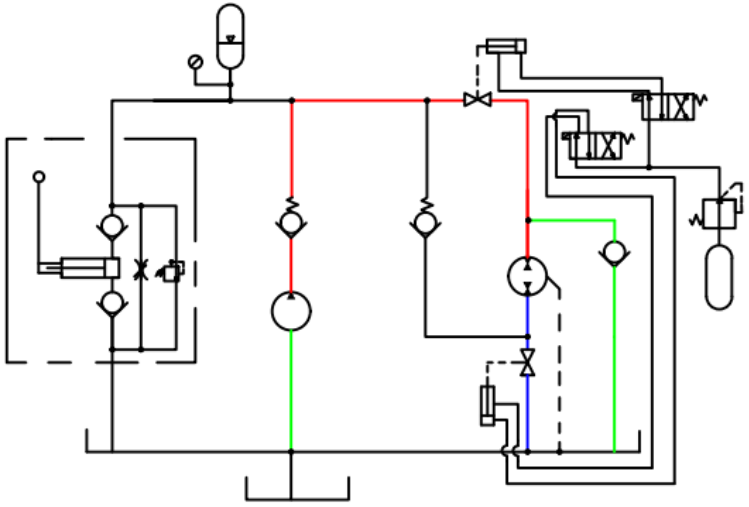
Coast



Sprint



Regenerative



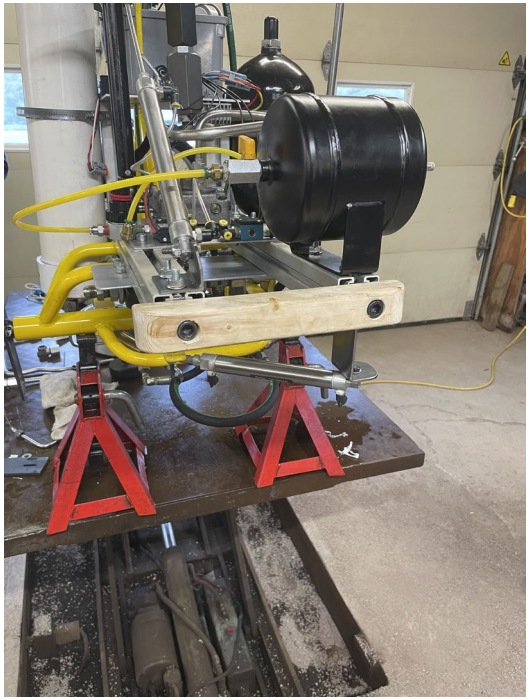
Endurance/Efficiency

Vehicle (Bike) Building

- **Changes**
  - Removed Manifold and inoperable motor.
  - Swapped motor from 0.25 CiD to 1.27CiD
  - Changed gear ratio for both the Pedals and the motor to align with the new motor.
  - Added hydraulic hand pump and a duplicate pneumatic valve circuit

Current Vehicle Iteration

Hand pump replacing the manifold



Wooden bumper (Wumper)

Rerouted accumulator hoses and analog pressure gauge

Lessons Learned

- Design conception
- Gear ratio/gear box
- Pressure readings
- Leaks and fittings
- Time management
- Flexibility in with design changes
- Resource management

Acknowledgements

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Special Thanks to:

NFPA Fluid Power Vehicle Challenge

iFP Motion Solutions Inc.

Danfoss

National Fluid Power Association NFPA

NFPA Education and Technology Foundation

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Questions?

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