NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION
FLUID POWER CLUB AT
SOUTH DAKOTA STATE
DOUG PRAIRIE
4/24/2023

Team Introductions: ABE

Nathaniel Post

Ty Schneider

Levi Sorensen

Team Introductions: ABE

Max Woods

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Design Objectives

- Utilize last year's bike
- Simplify hydraulic circuit
- Maximize efficiency – Regeneration
- "Coast" Mode
- Dual-speed transmission

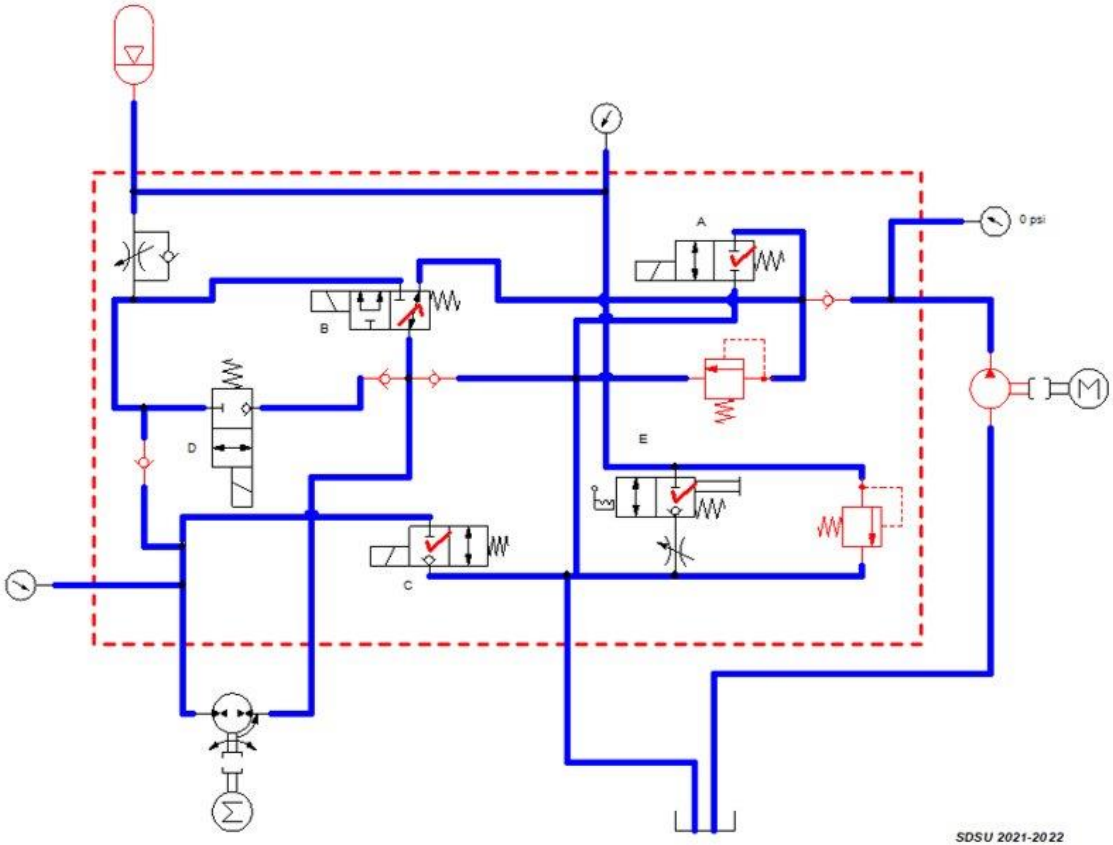
Midway Summary

- Validated circuit functions
- Gained understanding of charging with accumulator and regenerative charge
- Removed gear transmission from design to focus on other items
- Set a baseline to improve on

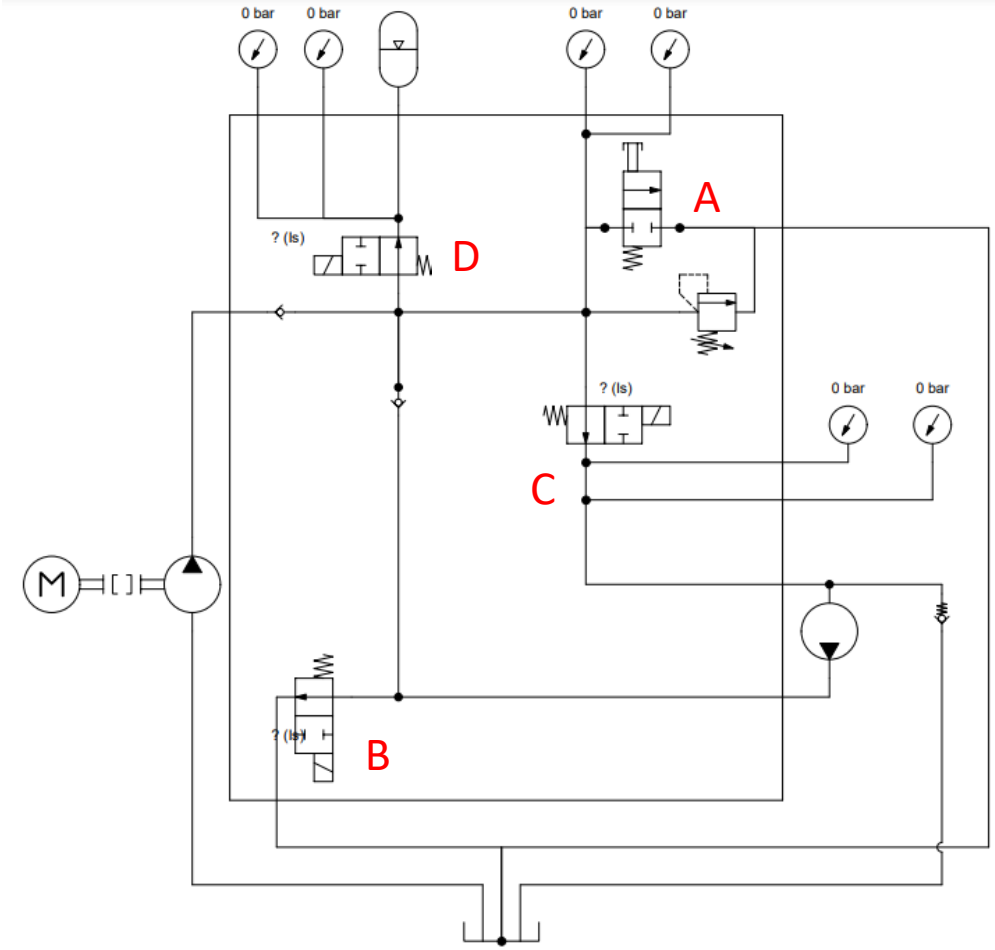
Design Choices

- Simplified manifold; size and circuit
  - Designed to have "coast" mode
- New tires
  - Previously mountain bike tires
  - Changed to smoother road bike tires
- Voltmeter addition
- Accumulator pulsing strategy

Hydraulics: Old Circuit



Hydraulics: New Circuit



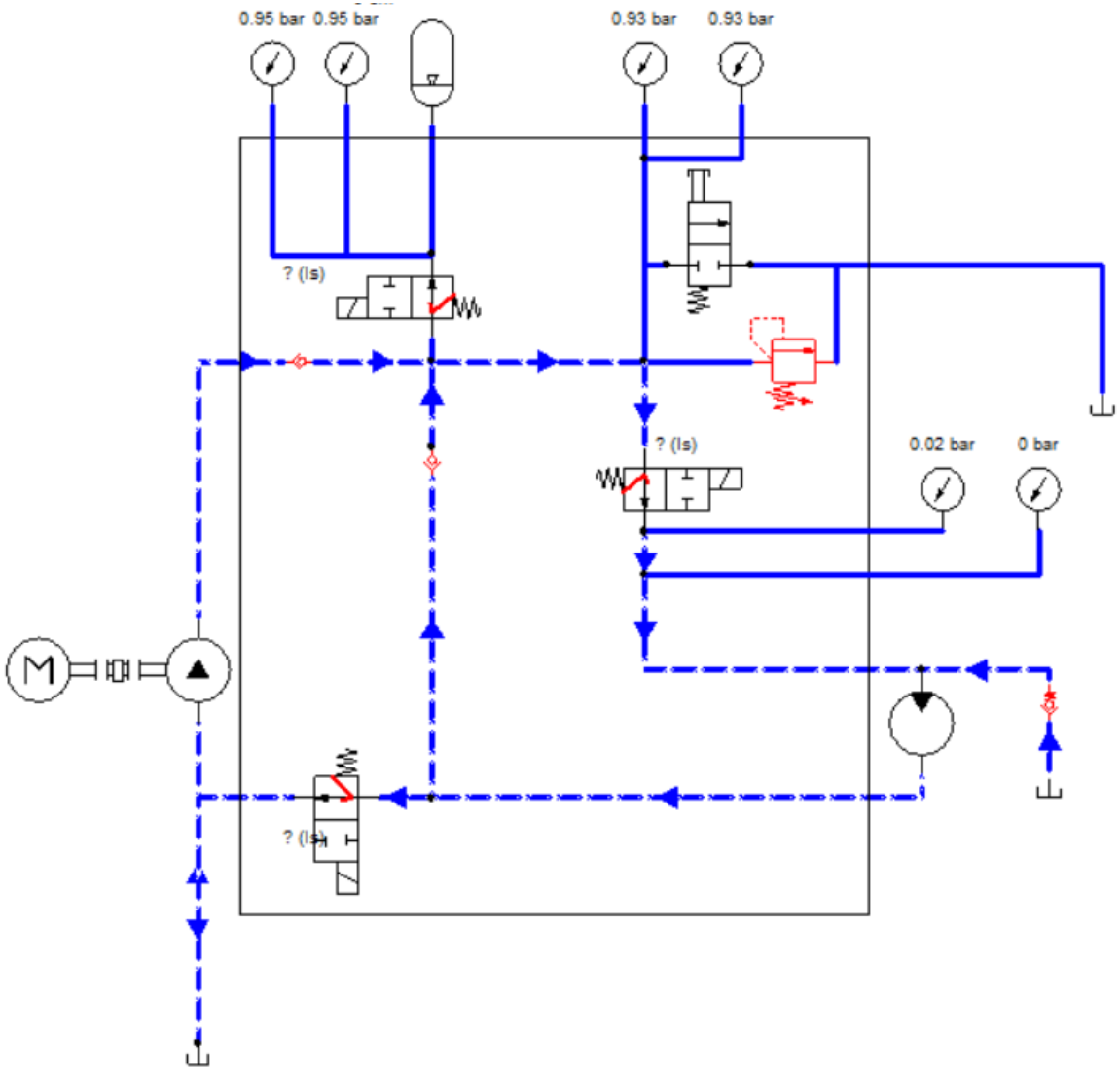
- Simpler Design
  - Less internal check valves
  - Eliminated one external valve
- Test Ports
  - Located at every component
  - Pressure transducers
  - Manual test ports
- "Coast Mode"
- Accumulator Valve Nominally Open
  - Change next year

Hydraulics: Valve Positions

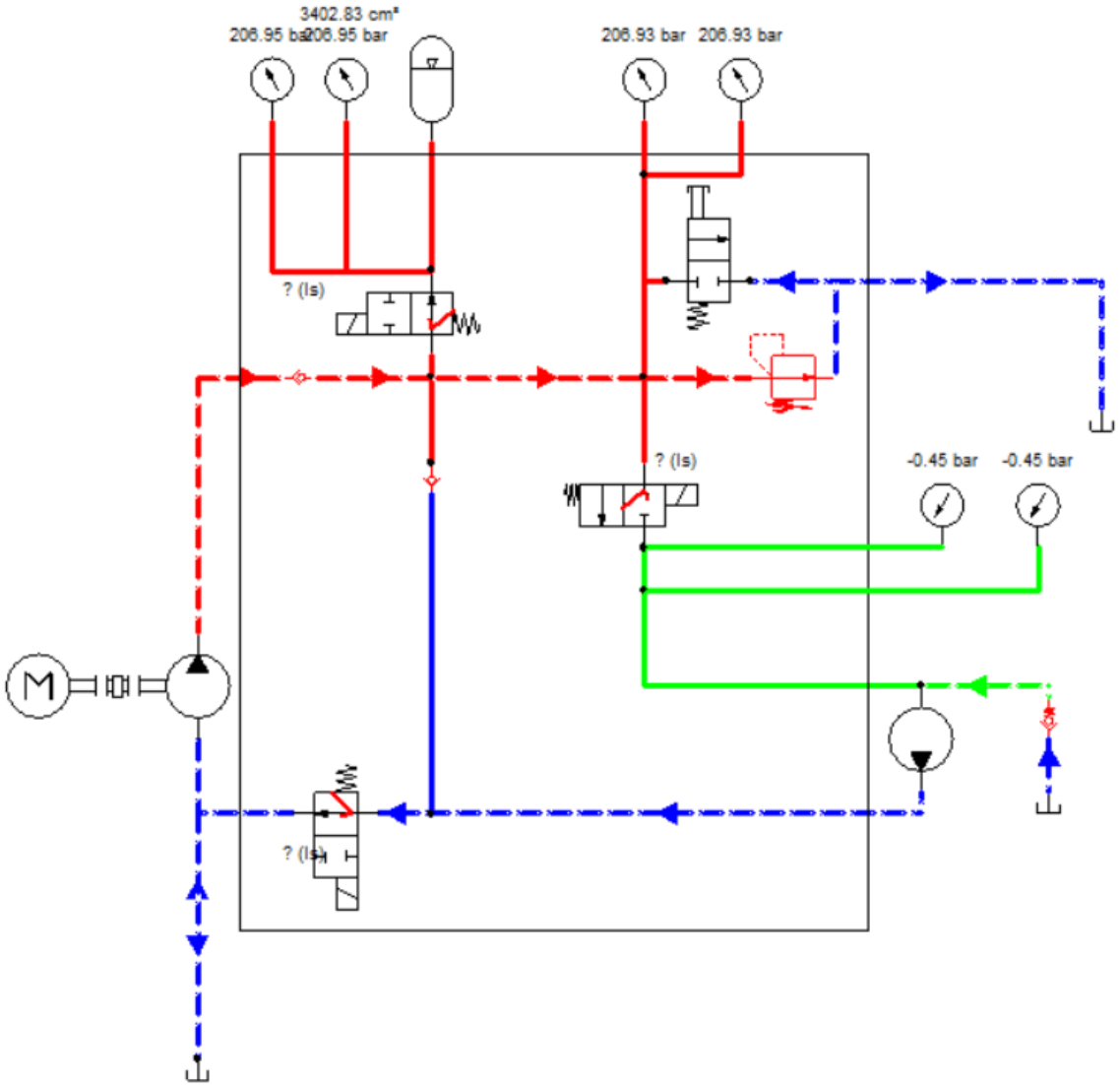
		Valve			
		A	B	C	D
Mode	Pedal to Power	0	0	0	1
	Accumulator Charge	0	0	1	0
	Regenerative Charge	0	1	1	0
	Accumulator Discharge	0	0	0	0
	System Dump	1	0	0	0

* Valve A is for manual discharge

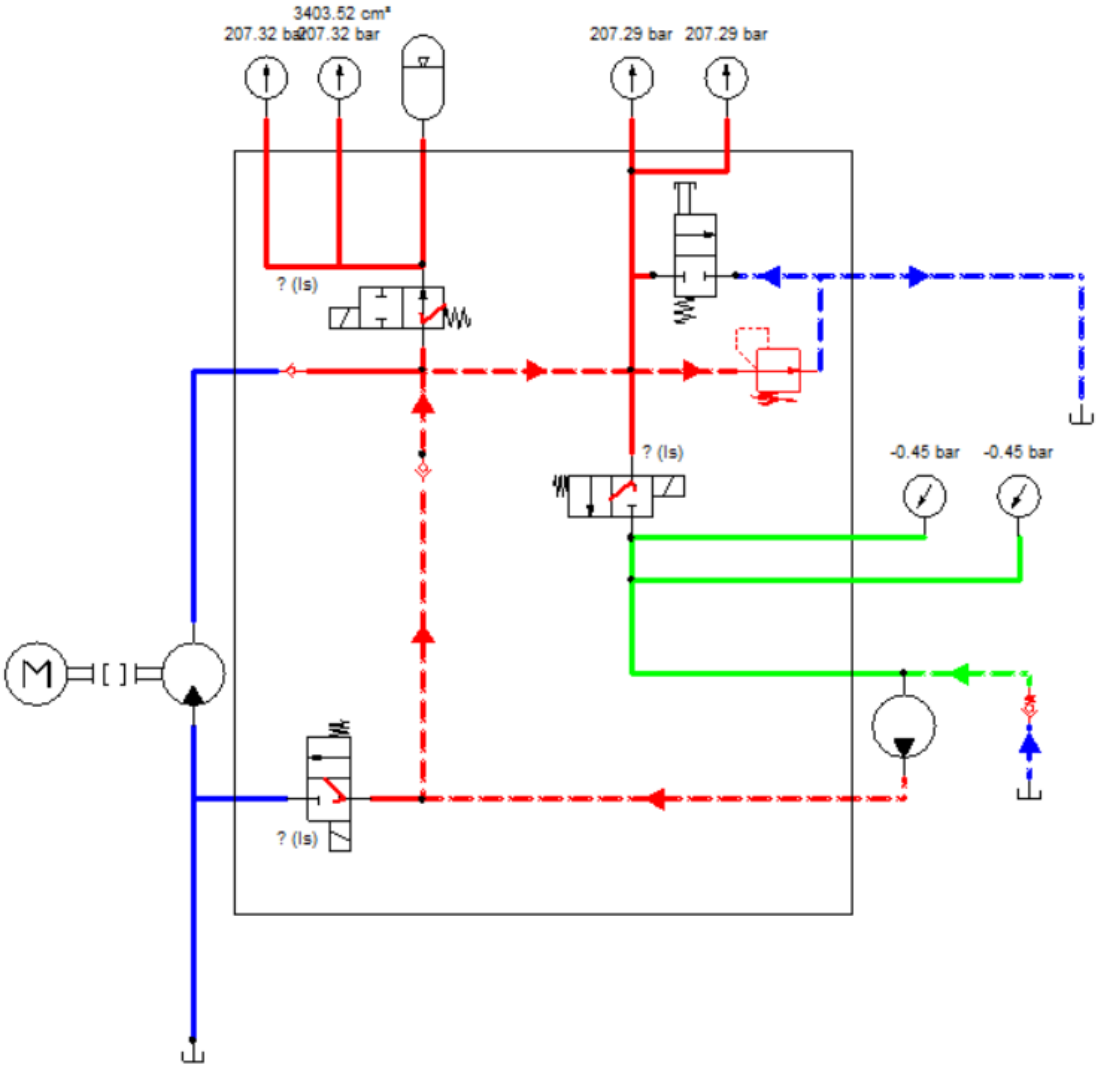
Hydraulics: Pedal to Power



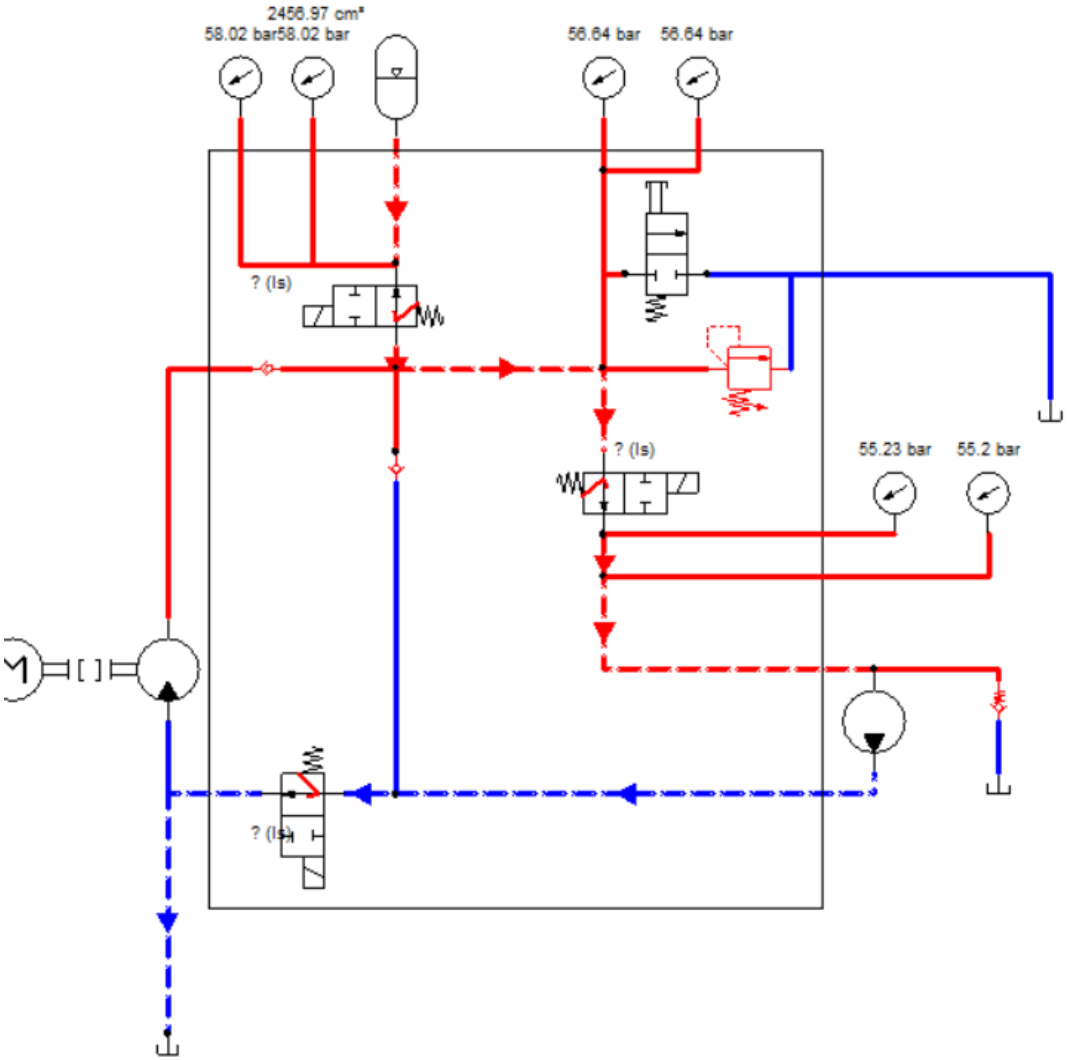
Hydraulics: Accumulator Charge



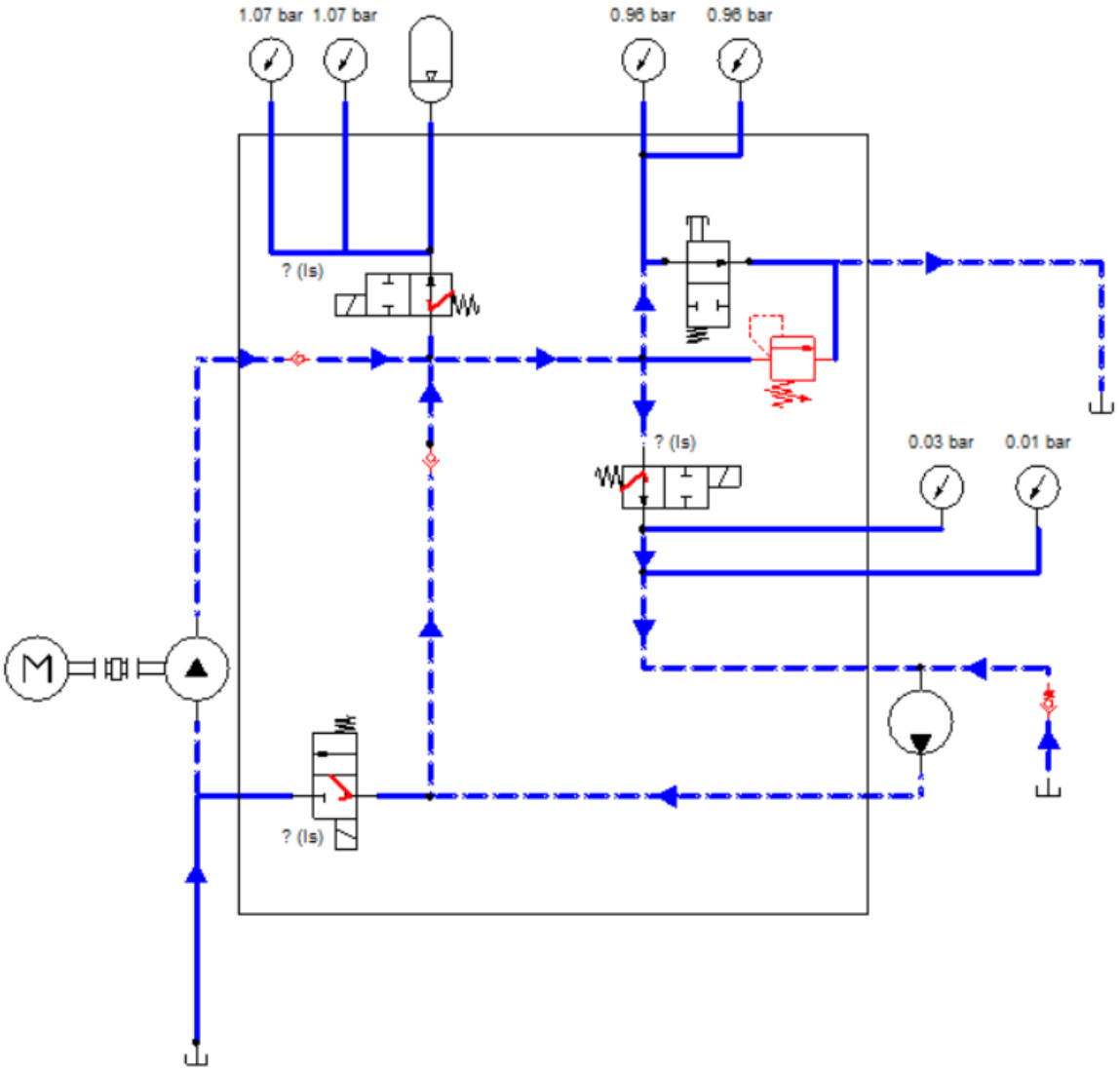
Hydraulics: Regenerative Charge



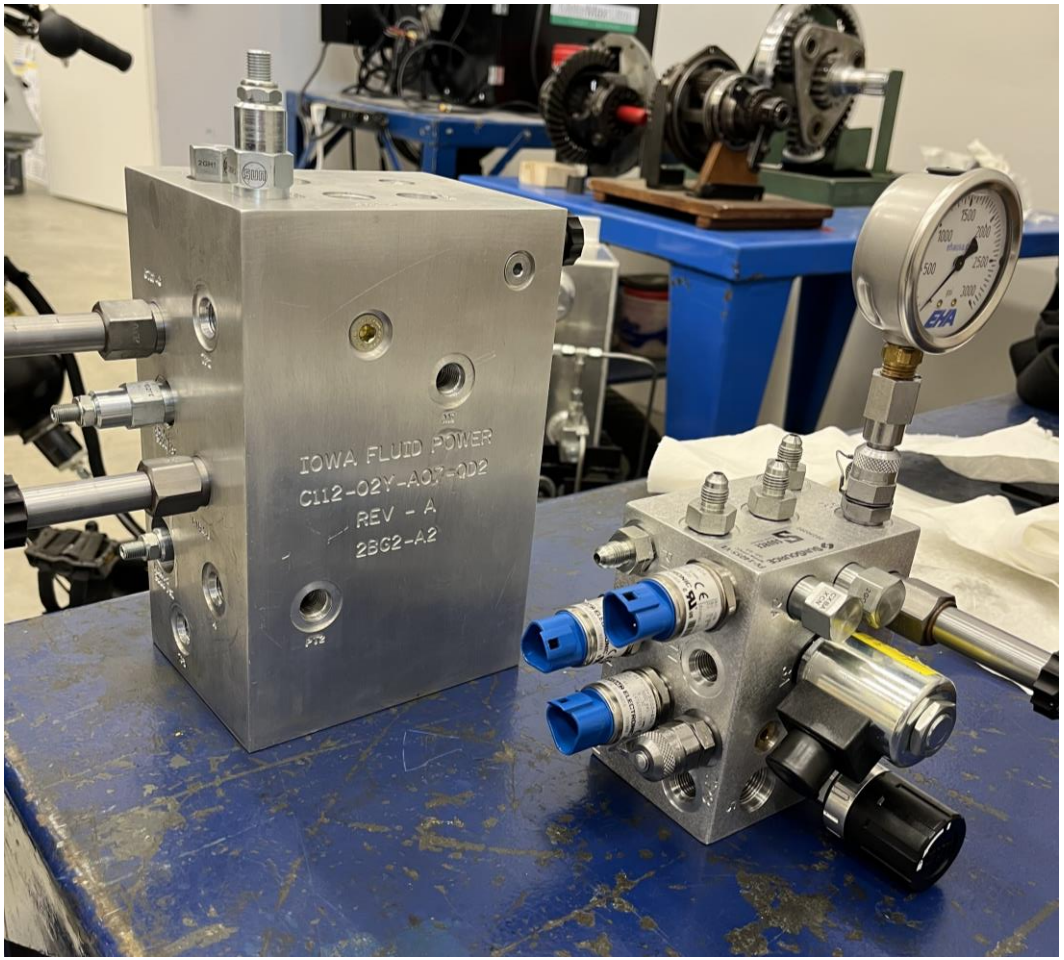
Hydraulics: Accumulator Discharge



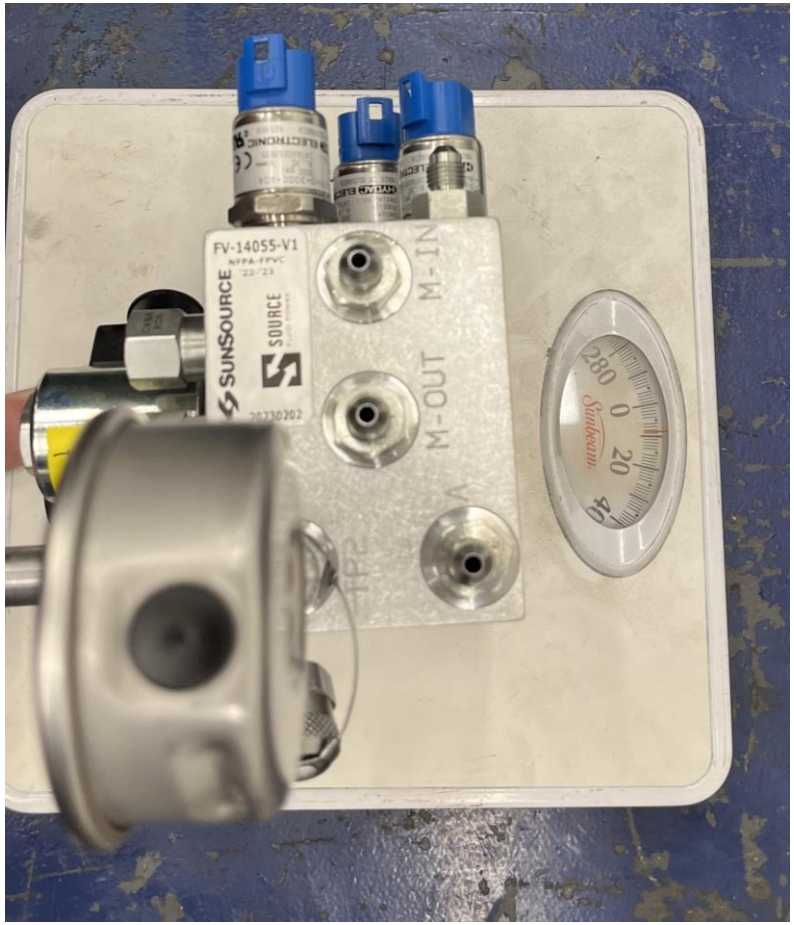
Hydraulics – System Dump



Manifold Comparison



Weight Reduction



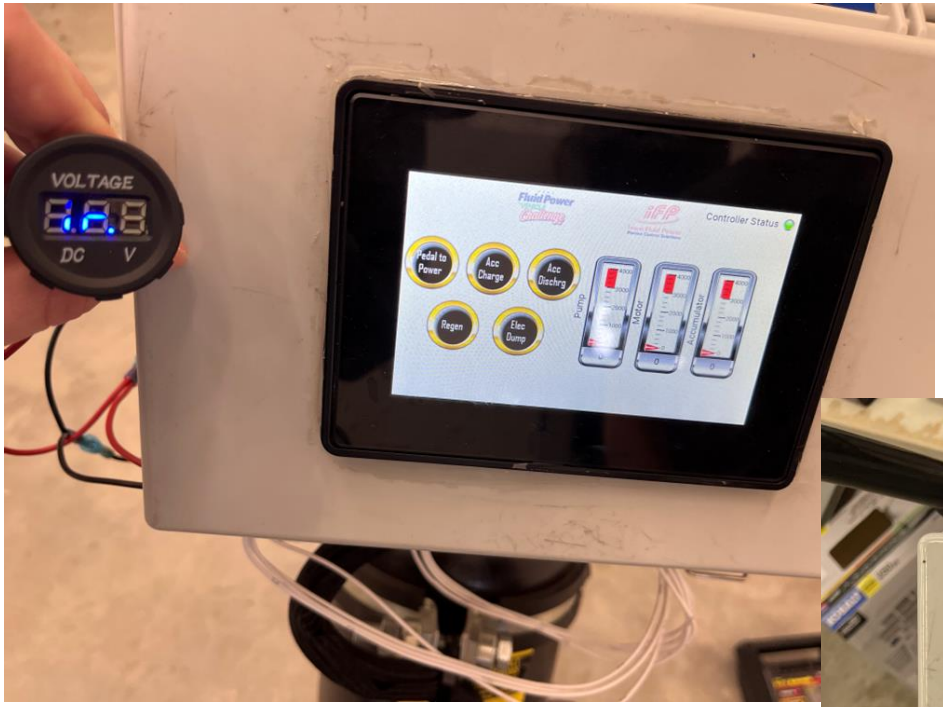
New Manifold: ~10lbs

Old Manifold: ~22lbs

New Tires

- Increased pressure
  - 55-65 PSI
- Less rolling resistance
- Better suited for competition

Display



This year's controller display

Testing:

- Accumulator pre-charged to 800psi
- Pulsing discharge for increased distance
- Adjusting pressure relief valve to just under 3,000 psi limit
- 50-yard speed testing (old vs new)

OLD MANIFOLD	
Person A Time (sec)	Person B Time (sec)
18.1	19.8
17.1	17.04
17.95	17.02

NEW MANIFOLD	
Person A Time (sec)	Person B Time (sec)
12.91	12.86
13.83	13.05
15.26	13.26

Testing:

- Pedal speed: 112 RPM
- Wheel speed: 150 RPM, 11 mph
- Built a max of 3,000 psi from pump
- Average pressure ~1,500 psi
- Accumulator can be built to ~3,000 psi

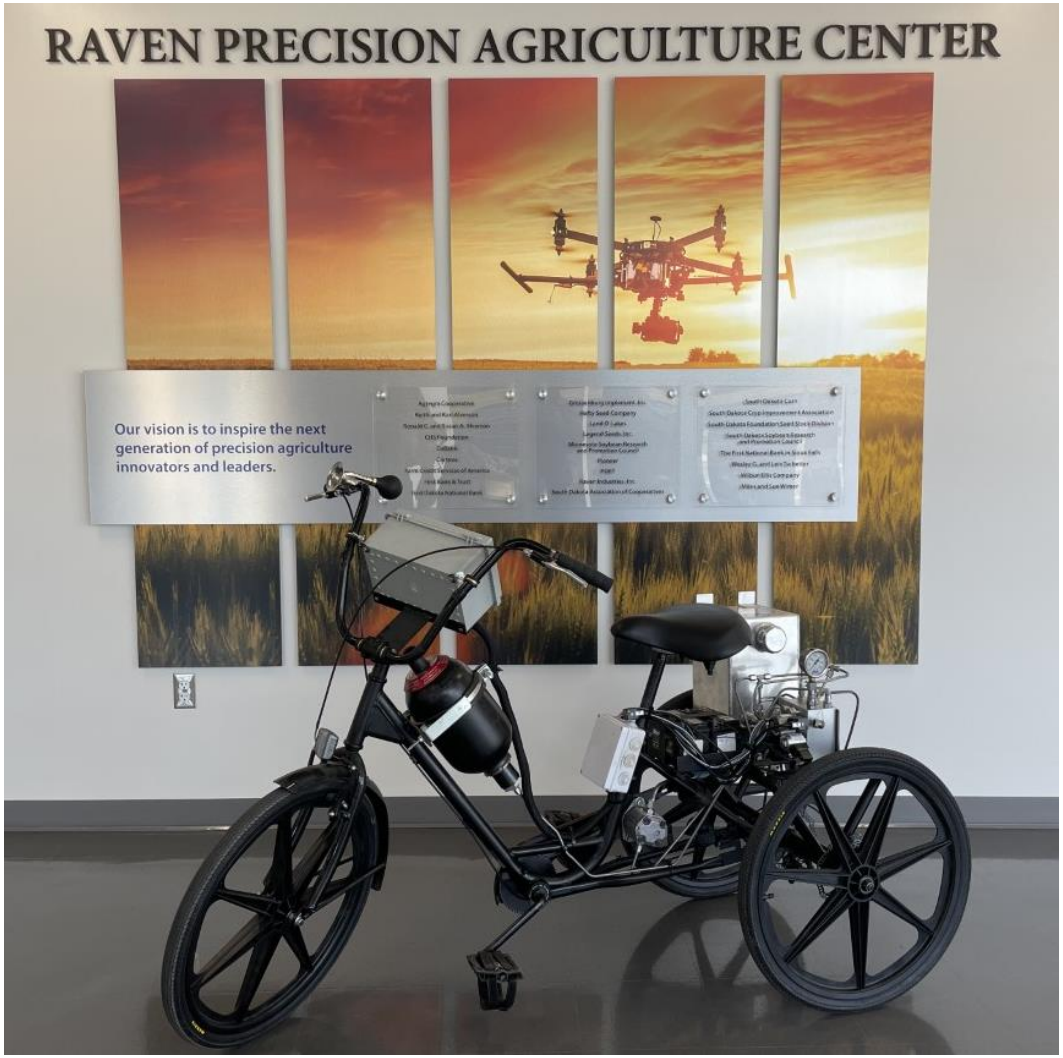
Hydraulic Calculations

Given			*Calculated*			*Measured*		
Motor Displacement:	5.34	cc/rev	**Pump Flow Rate:**	1.47	L/min	**Pump Flow Rate:**	1.13	L/min
Pump Displacement:	3.40	cc/rev	**Motor Shaft Speed:**	264.33	RPM	**Motor Shaft Speed:**	196.00	RPM
Pump Speed:	465.00	RPM	**Wheel Speed:**	132.16	RPM	**Wheel Speed:**	98.00	RPM
Pressure:	1500.00	PSI	**Shaft Power:**	337.91	Watts	**Shaft Power:**	258.65	Watts
						Driveline Efficiency:	76.54%	

Lessons Learned

- Accumulator – charging, valve, etc.
- Plumbing
- Transmission design
- Gear ratios and free wheel
- Time management
- Basic teamwork skills
- Communication skills
- Troubleshooting

Questions?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