

N F P A

Fluid Power

VEHICLE

Challenge



NFPA
Education and
Technology
Foundation

FINAL PRESENTATION

The University of Utah
Professor M Dillon
April 10th, 2025



Meet the Team



Christopher West, Jonathan Moriel Ortiz, Cole Huseby, John Vaughey, Talon Rencher, Jon Dromey

2023-2024 Team Design



Accomplishments	
Direct Drive Speed	8 mph
Boost Mode Speed	25 mph
Team Placement	5th
Issues	
Leakage	Broken Motor Seal
Torque Input (Direct Drive)	12 ft-lb (Estimated)
Circuit Complexity	3 Solenoids + Electric Circuit + Pneumatic Circuit
Frame Weight	225 lb
Test Time and Part Orders	1 Month Behind on Deadlines
Component Adjustability	No Part Flexibility

Vehicle Design Overview

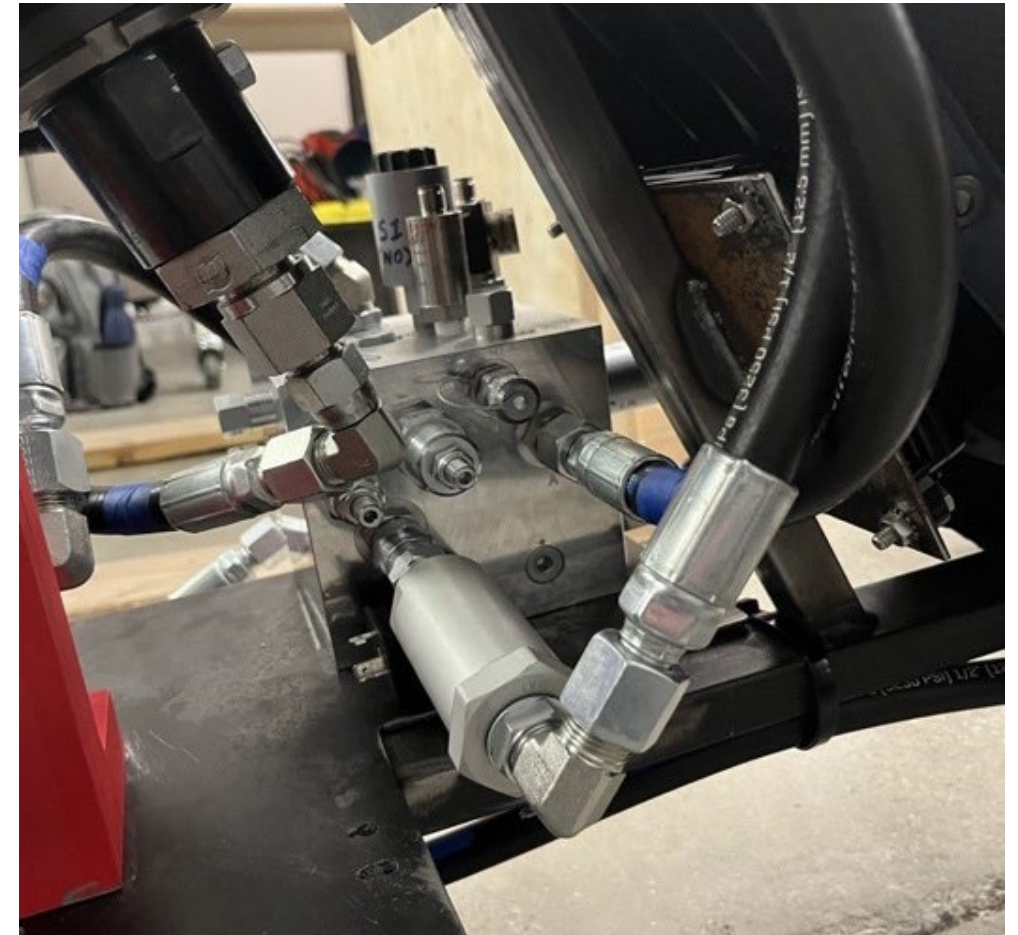
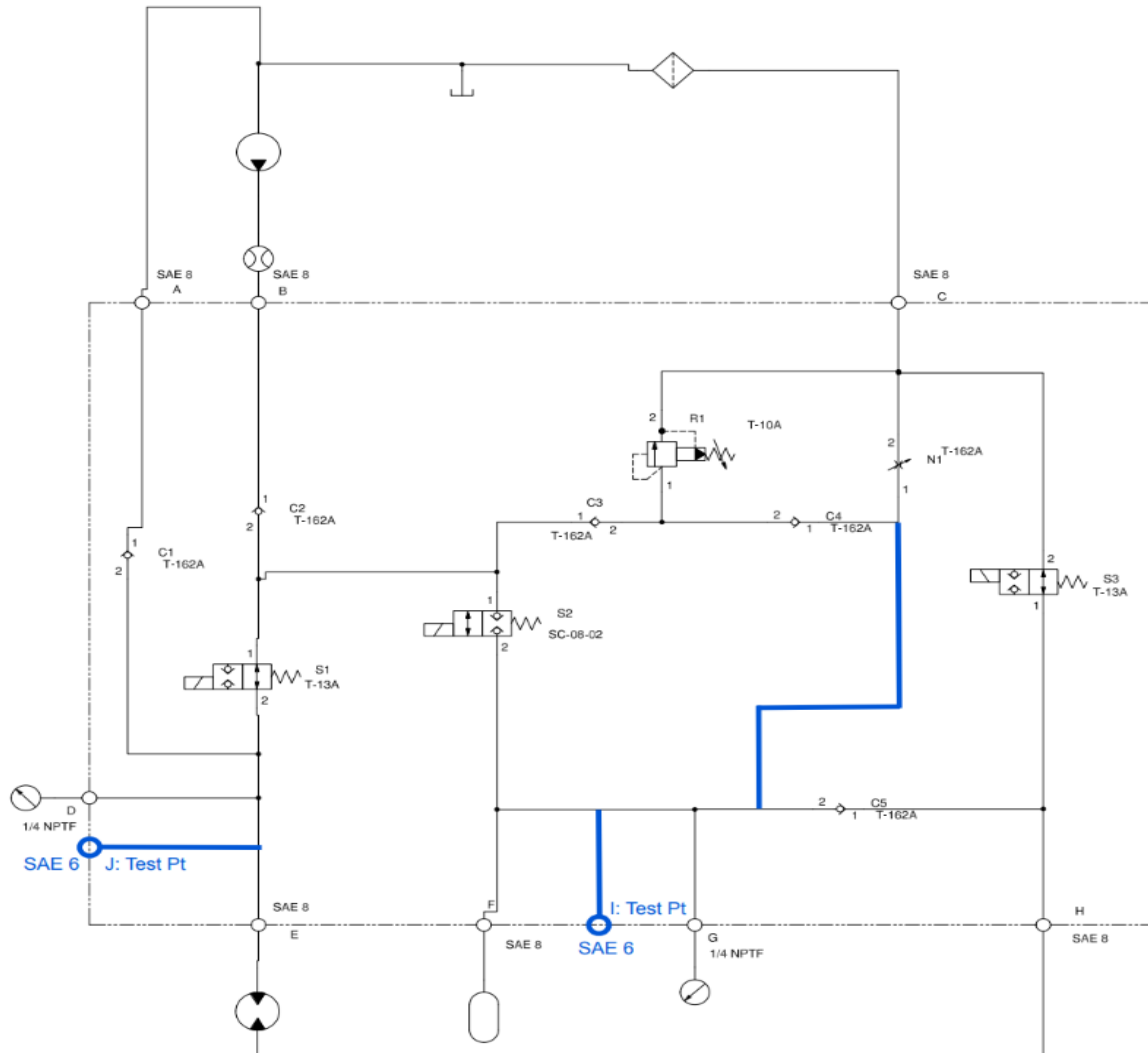


Change Summary:

- Removed Manifold / New Hydraulic Circuit
- New Frame
- Mounted Components using A36 steel
- Updated Gear Trains for Pump and Motor
- Removed Electrical Circuit
- Incorporate Ball Valves into Pneumatic Circuit
- Updated Rider Controls

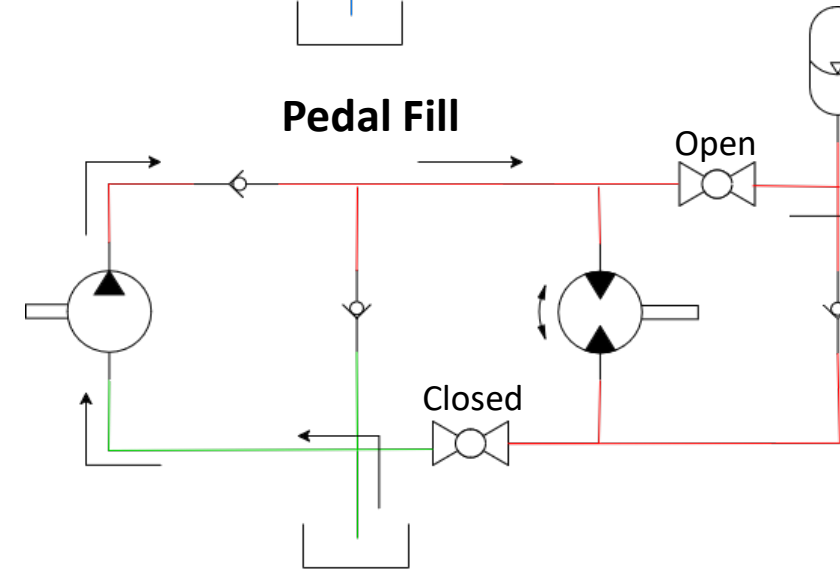
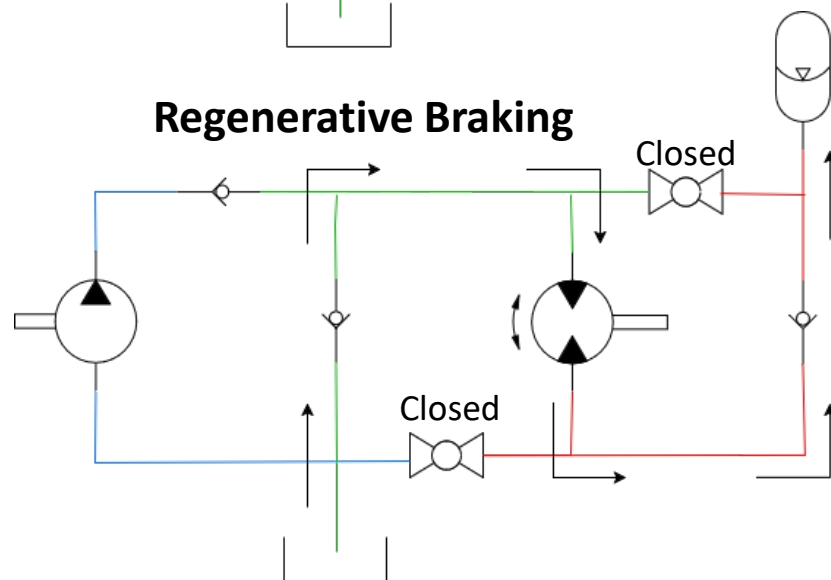
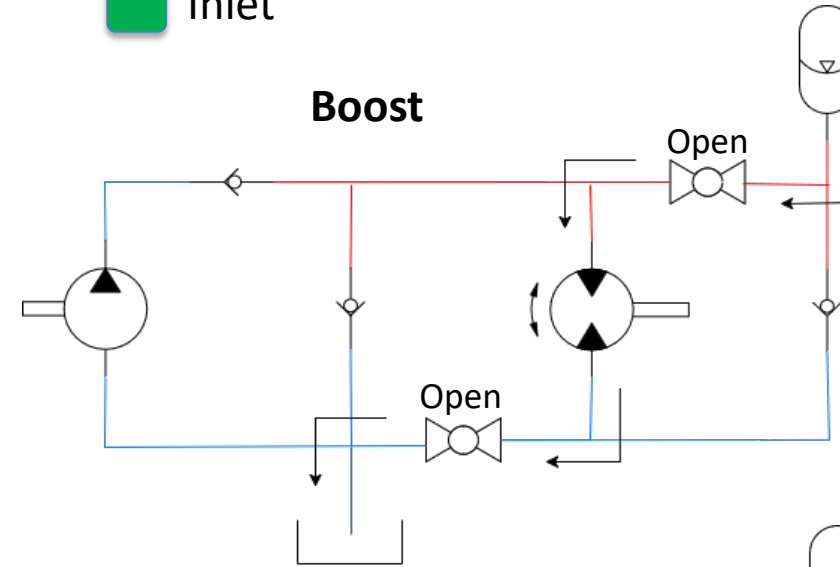
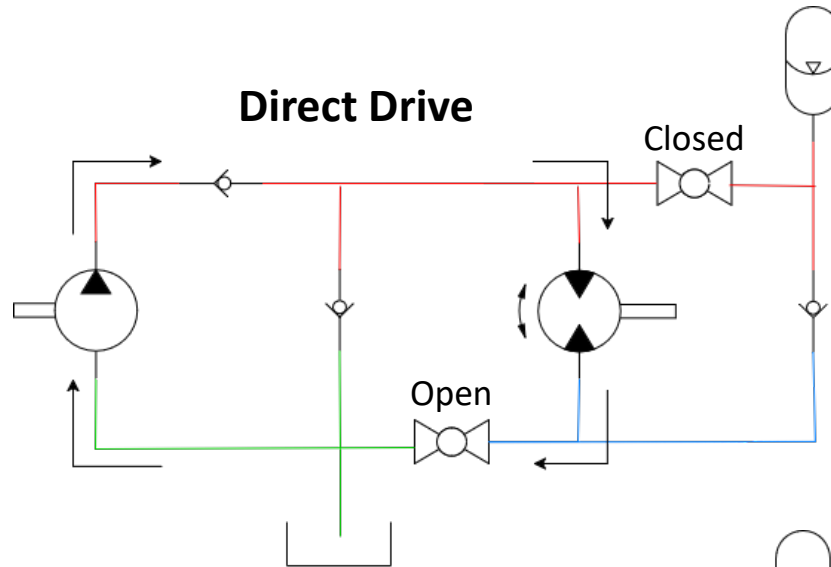
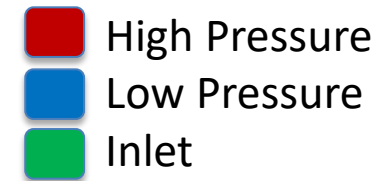
Hydraulic Circuit

Last Years Design



Hydraulic Circuit

In Depth



Control System

Last Year

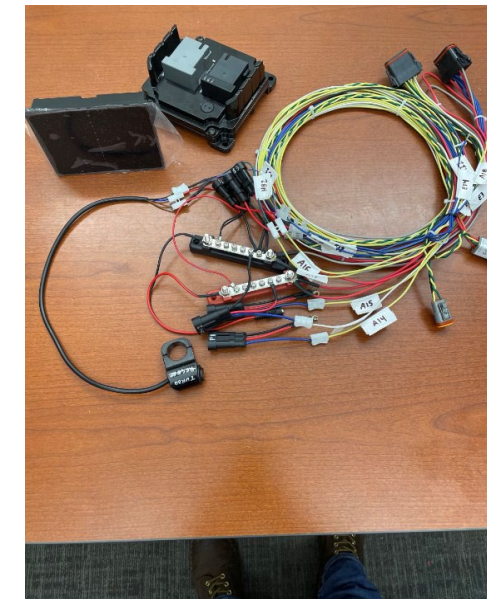


Pneumatics:

- Single switch to disengage the clutch

Electrical:

- Controlled drive modes through a difficult to reach touch screen located in front of the rider
- IFP programming with help from Josh Scarbrough to control electronics

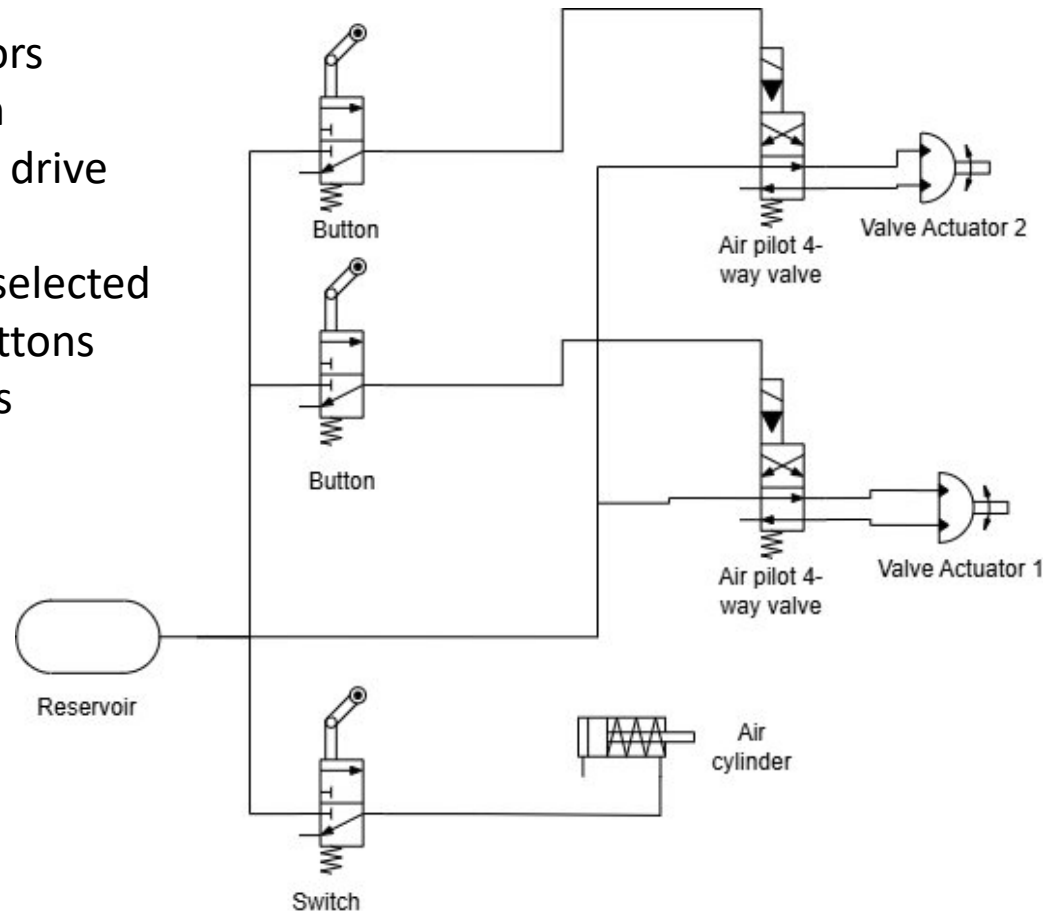


Control System

This Year



- Fully pneumatic
- Two valve actuators allow us to switch between the four drive modes
- Drive modes are selected via pneumatic buttons on the handlebars



Actuator

Ball valve

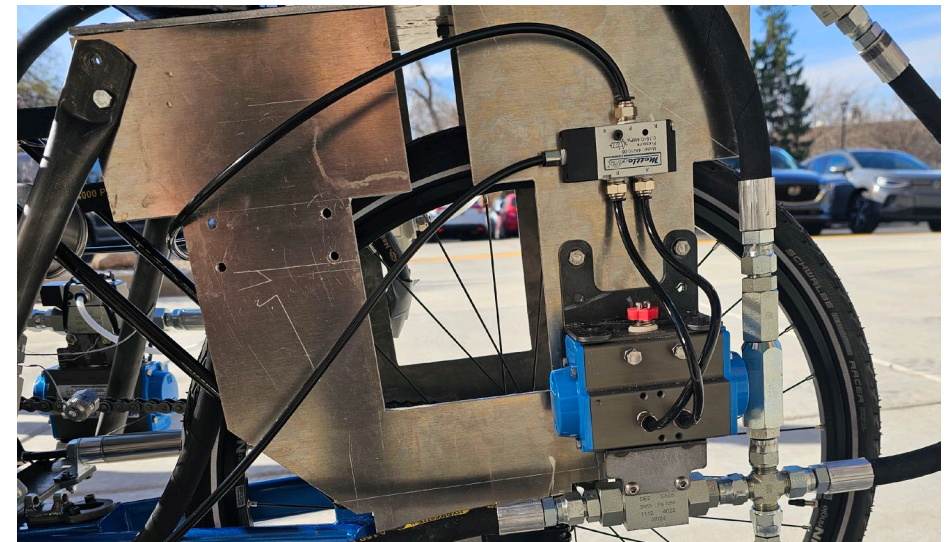
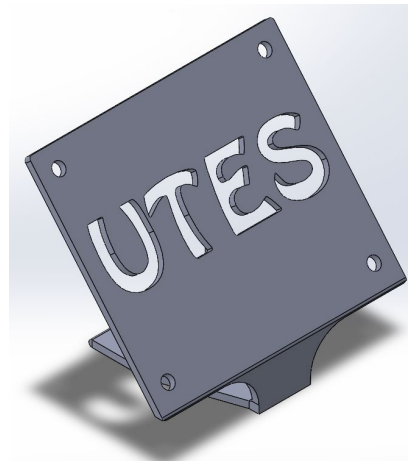
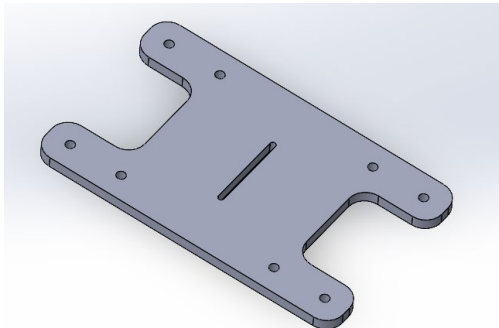
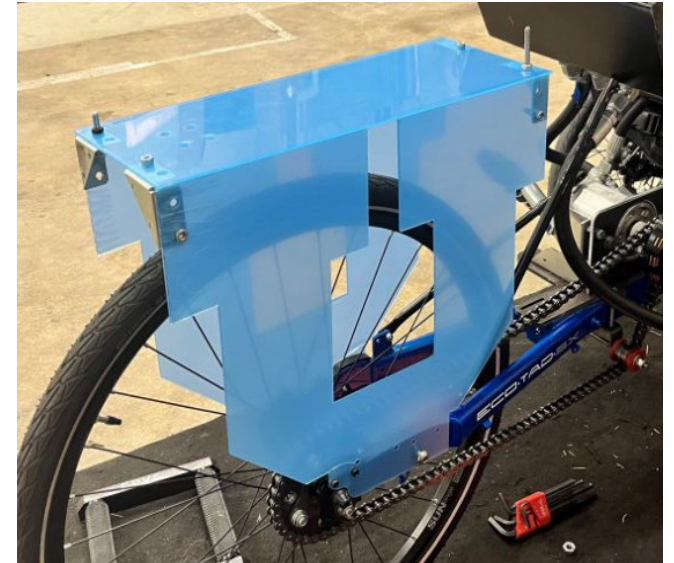
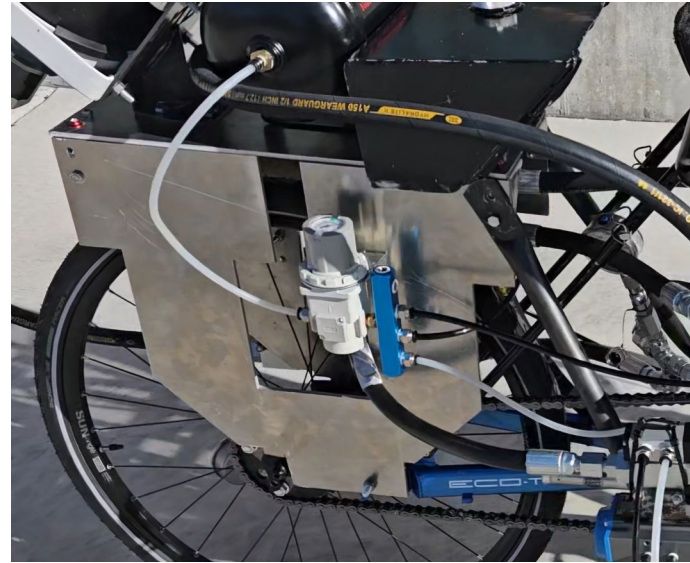


The U Mount

6061 Aluminum Sheets:

- Lightweight
- Durable
- Provides Enough Strength to Mount Components
- Cheap

The U holds most of our components. It mounts the accumulator, air tank, hydraulic reservoir, air regulator, and one of the pneumatic ball valves.

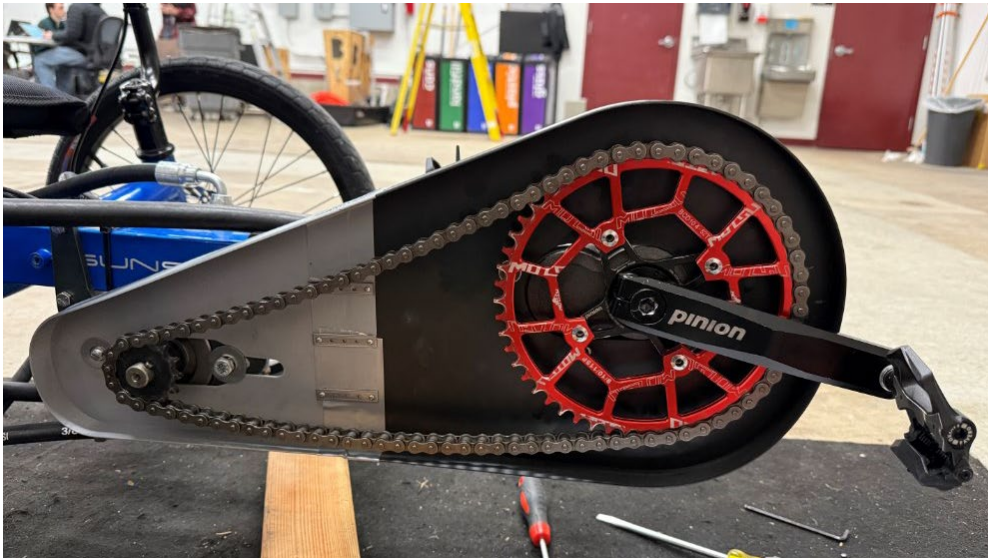


Pump Assembly Overview



Gear pump 0.39 CID from Danfoss:

- Worked well for last year's team
- Ordered very early to insure we got the parts
- Keyed shaft to a 13-tooth sprocket
- #40 Roller Chain
- 3D Printed Chain Guard (PLA)

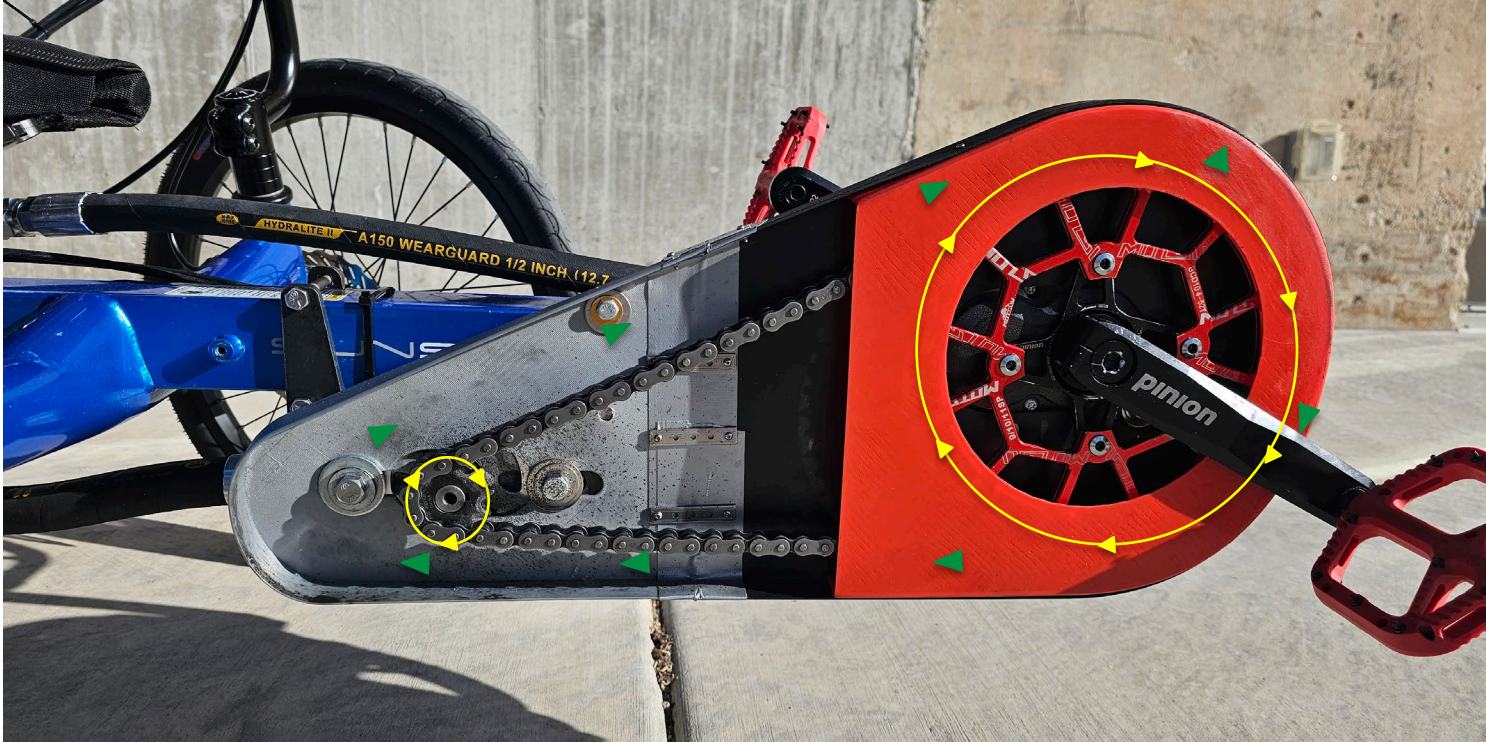


This Year



Last Year

Pump Assembly: Gear Train

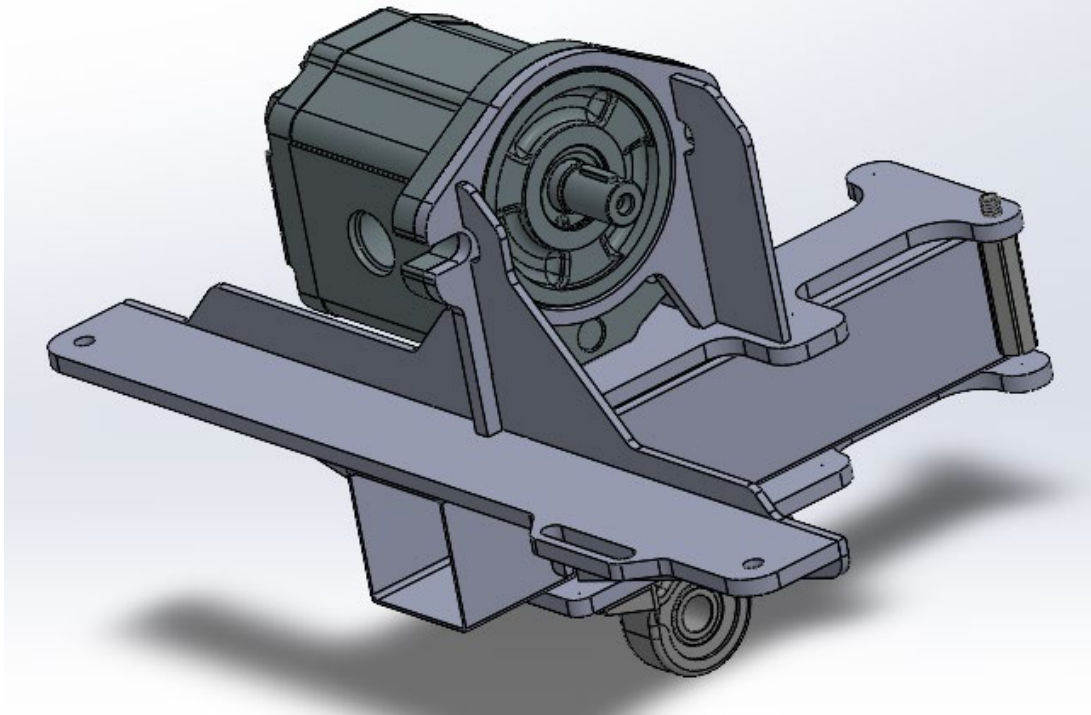


Components	Gear Ratio
Gear Box	1:0.55 - 1:3.3
Gear Train	52:13
Total Pump Ratio	1:2.2 - 1: 13.3

Considerations:

- Reduce torque input
- Adjustability in pump location
- Ability to switch gears through rider input

Motor Assembly Overview



This Year



Last Year

Motor Mount Iterations



Testing revealed that the motor mount allowed the motor to shift, and the chain started jumping during regenerative braking from the high torque. This issue led to a major re-design of the motor mount.



Motor Assembly: Drive Train



Components	Gear Ratio
Motor Gear Train	14:32

Pneumatic Clutch:

- Activated through pneumatic cylinder
- Resists 43 lb-ft of torque
- Ability to disengage the motor to coast, reducing friction from moving parts

Vehicle testing



Test	Outcome	Method
Max accumulator pressure	3000 psi	Measured via gauge; achieved in regen
Direct drive max speed	10.9 mph	Measured on a flat surface via GPS
Direct drive max flowrate	0.67 gal/min	Calculated based on vehicle speed
Boost max speed	23.9 mph	Measured on a flat surface via GPS
Boost max flowrate	1.46 gal/min	Calculated based on vehicle speed
Boost Acceleration	0.076 g's	Measured on a flat surface via GPS



Lessons learned

- Use a flow regulator for the accumulator discharge to limit clutch slippage
- Use a stronger clutch to prevent slippage
- Stiffer motor mount to prevent chain misalignment during regenerative braking
- Order extra parts in case designs change or parts break

Questions?

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