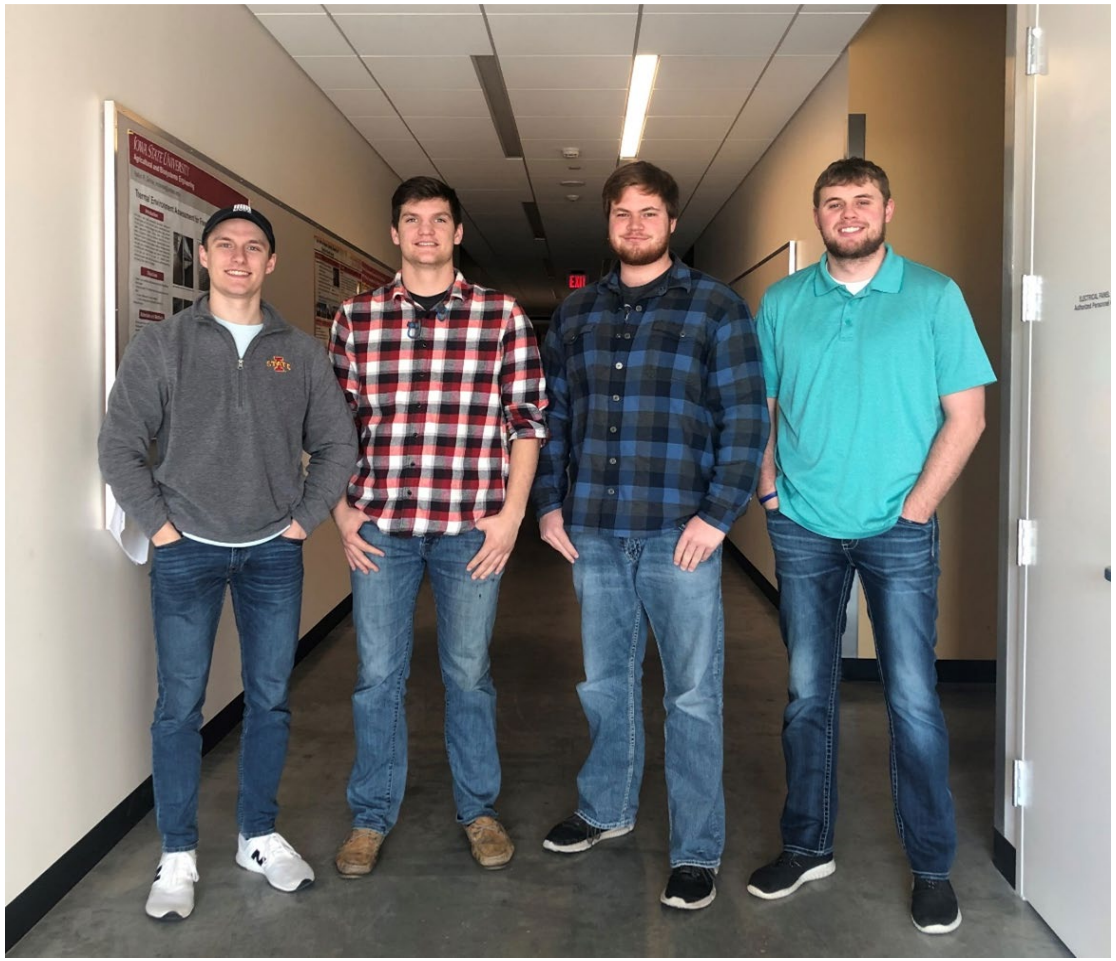
NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION
IOWA STATE UNIVERSITY
TEAM ADVISOR: Aaron Darnell
DATE: 04/11/19

Photo of Vehicle

Team Introduction



Mitchell Hoefling

- Year
  - Senior
- Major
  - Agriculture Power and Machinery Engineer
- Hobbies
  - Restoring vehicles
  - Working out
  - Carpentry
  - Hiking/ Camping

Jordan Peterson

- Year
  - Senior
- Major
  - Agriculture Power and Machinery Engineering
- Hobbies
  - Fishing
  - Working on vehicles
  - Golfing

Logan Darnall

- Year
  - Senior
- Major
  - Agriculture Power and Machinery Engineering
- Hobbies
  - Basketball
  - Weight lifting
  - Trap shooting

Dylan Stouder

- Year
  - Senior
- Major
  - Agriculture Power and Machinery Engineering
- Hobbies
  - Sports
  - Traveling
  - Spending time with friends

School Mentor: Dr. Brian Steward

- Professor of Agricultural and Biosystems Engineering at Iowa State University
- Education:
  - BS and MS in Electrical Engineering from South Dakota State University
  - Ph.D. in Agricultural Engineering from the University of Illinois at Urbana-Champaign.
- Teaching areas include:
  - Fluid power engineering and technology
  - Sustainable engineering
  - Dynamic systems modeling and simulation
- Research topics:
  - Fluid Power: Modeling and simulation, sensors, contamination control
  - Virtual prototyping of off-road machine systems

Problem Statement and Objective

- Design and build a vehicle that is driven using hydraulic components to compete in sprint, endurance, and efficiency races. The vehicle must be clean, concise, and easy to modify while satisfying all design criteria.

Summary of Midway Review

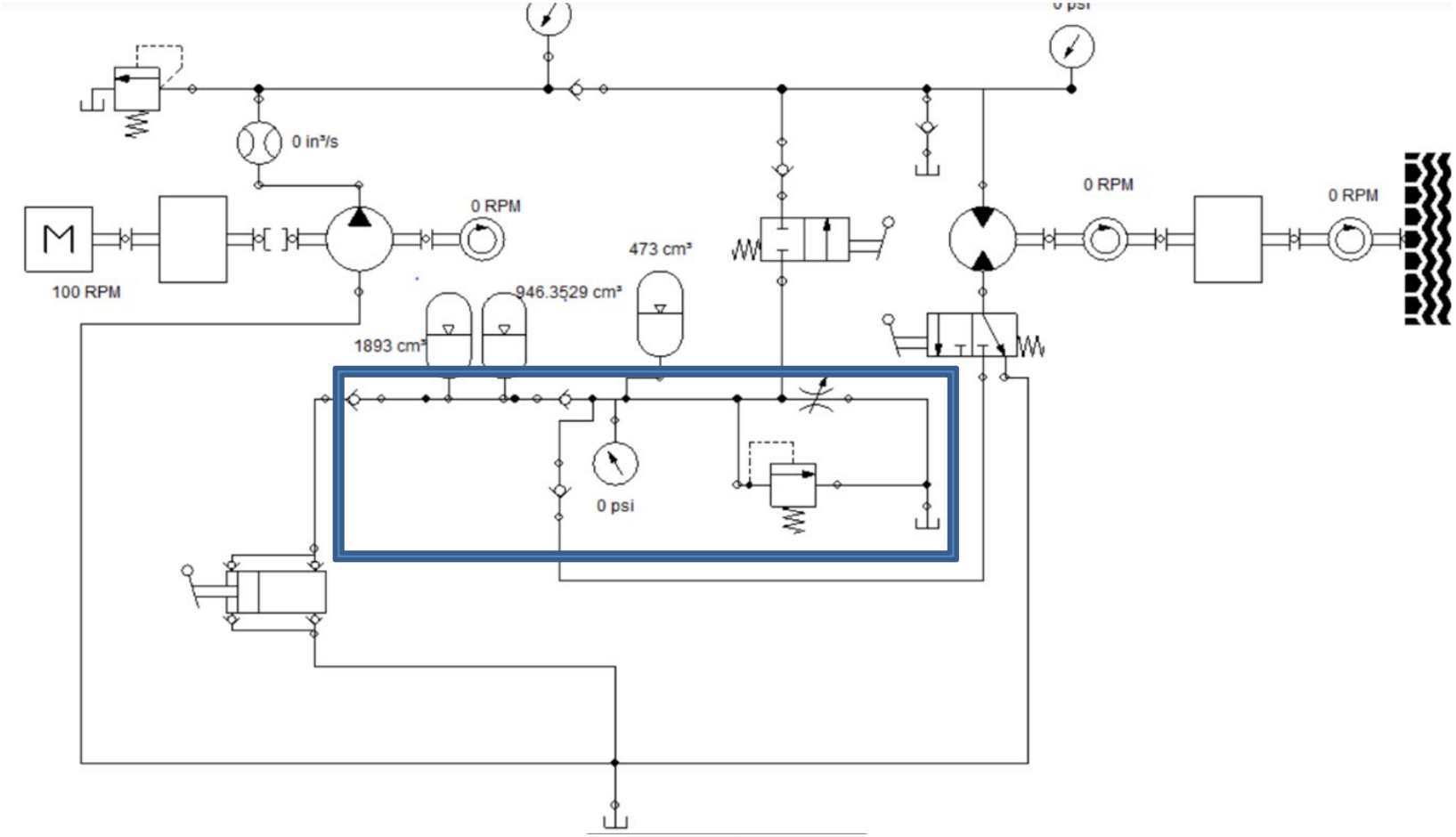
Bike Decision Matrix

	6	3	4	2	2	17		
	35%	18%	24%	12%	12%	100%		
Option	Price	Weight	Stability	Ease of Operation	Ease of Installation	Score		Rank
2 wheel design	4	4	0	1	2	2	II	3
3 wheel trike design	3	3	3	4	4	3	III	1
4 wheel design	1	1	4	4	3	2	II	2
3 wheel recumbent design	0	3	3	4	4	2	II	3
*If any category had a 0 we automatically took that design out								

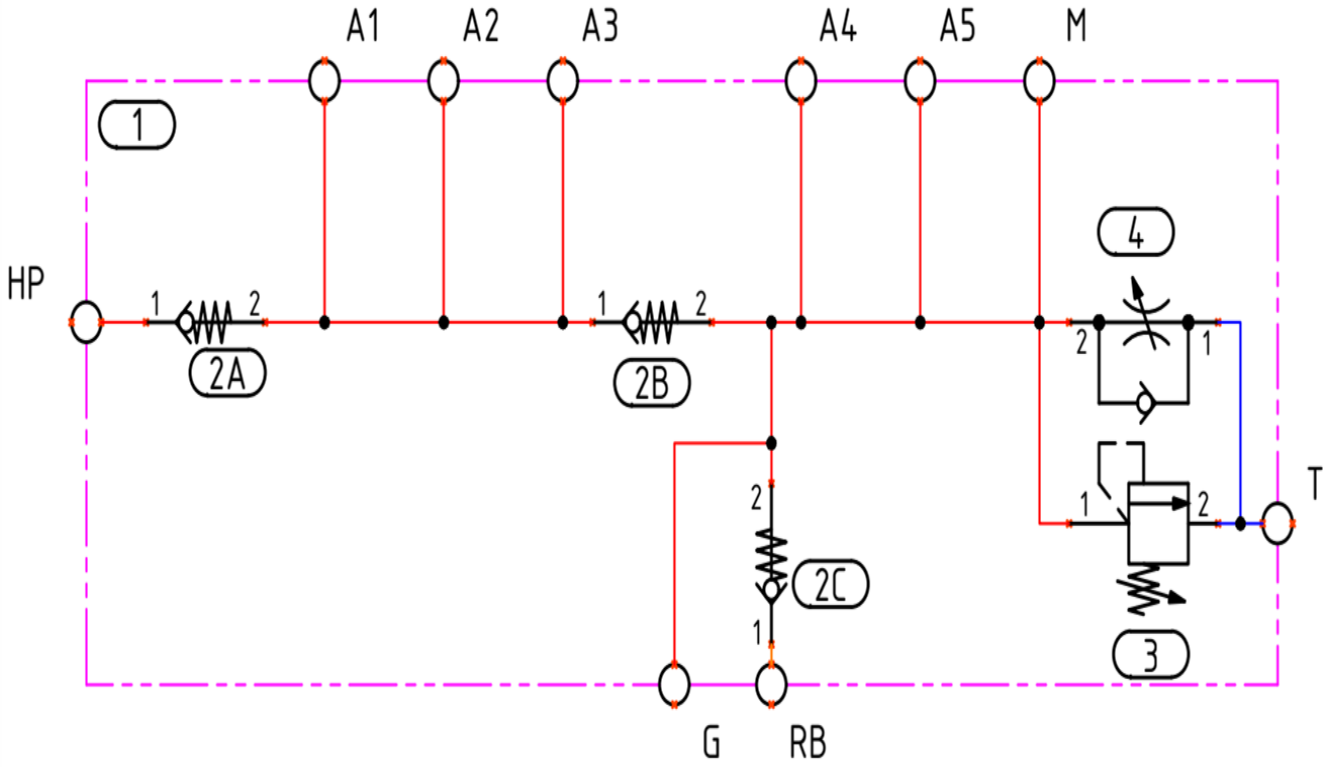
Last Year's Bike

New Trike

System Schematic



Manifold Schematic



Port Code	Port Name
A1,A2,A3,A4, A5	Available Accumulator Ports
M	Motor
HP	Hand Pump
G	Gauge
RB	Regenerative Braking
T	Tank

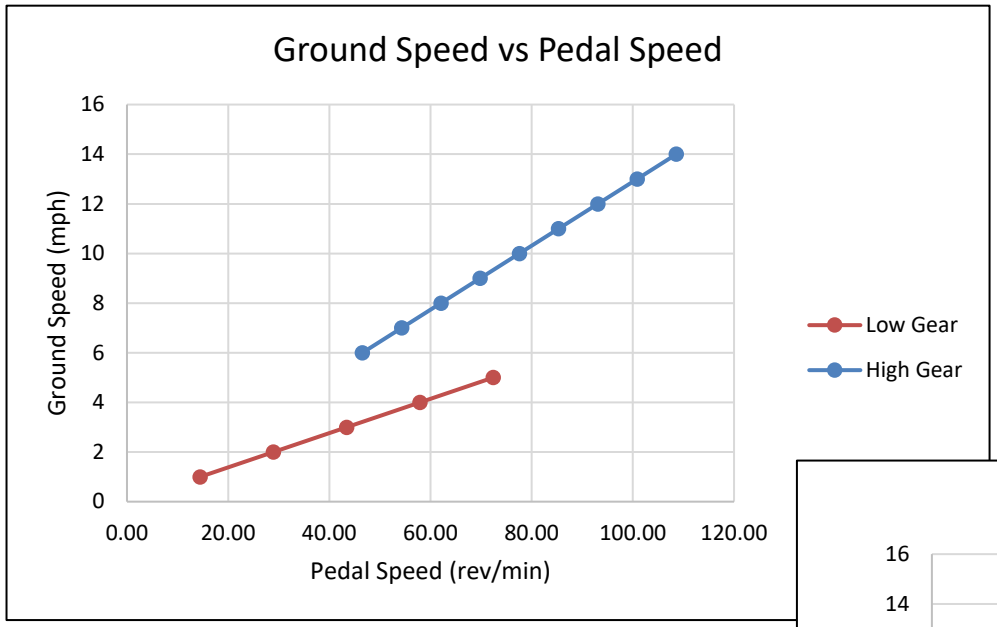
Parts List

- 1 quart accumulator x 2
- 0.601 in^3/stroke hand pump
- 0.40 in^3/rev Eaton 26001 pump
- 0.62 in^3/rev Eaton 26703-DAA gear motor
- 2-position, 2-way NC solenoid valve x 2
- 2-position, 2-way NO solenoid valve x 2
- Direct acting pressure relief valves x 2
- Manual 2-position, 2-way NC valve
- Flow control needle valve
- Check valves x 6
- SAE-6 hoses ranging from 12,18,20,24,30 inches in length
- Required line bodies and fittings for above components

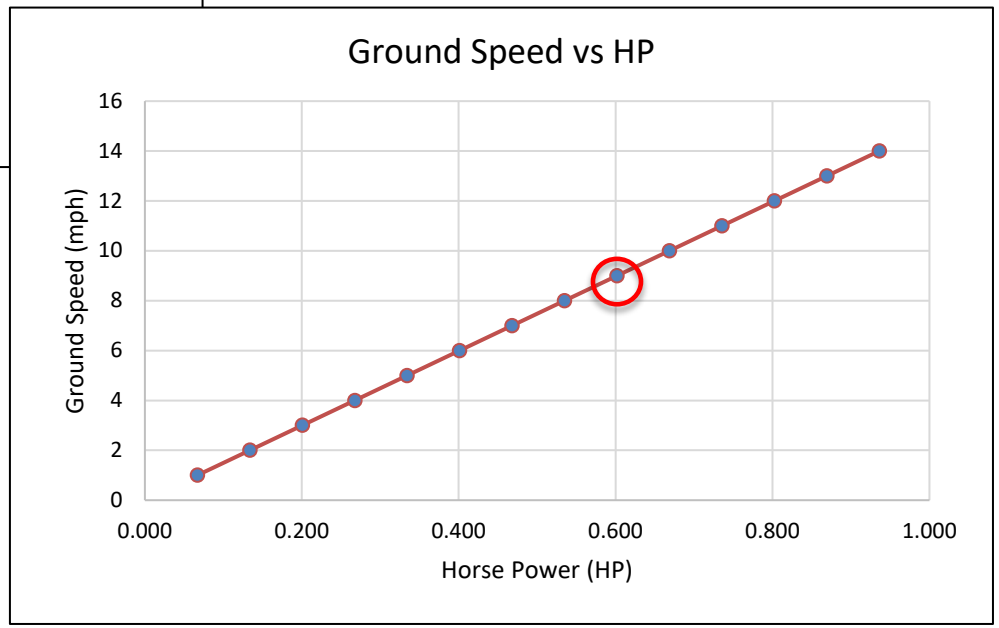
Primary Mover Testing

- Rode workout bikes to find maximum torque and power output of rider
  - Sprint (45 second trial) , 0.90 HP at 110 RPM and 50-60 ft-lb resistance
  - Endurance (8 min trial) , 0.60 HP at 90 RPM and 20-30 ft-lb resistance

System Calculations



-By using multiple gear ratios we are able to achieve 8-9 miles per hour while pedaling 70 rev/min.



- From this graph at a ground speed of 8 miles per hour, the rider will need to output about 0.53 HP.

*All calculations assuming 70% efficiency

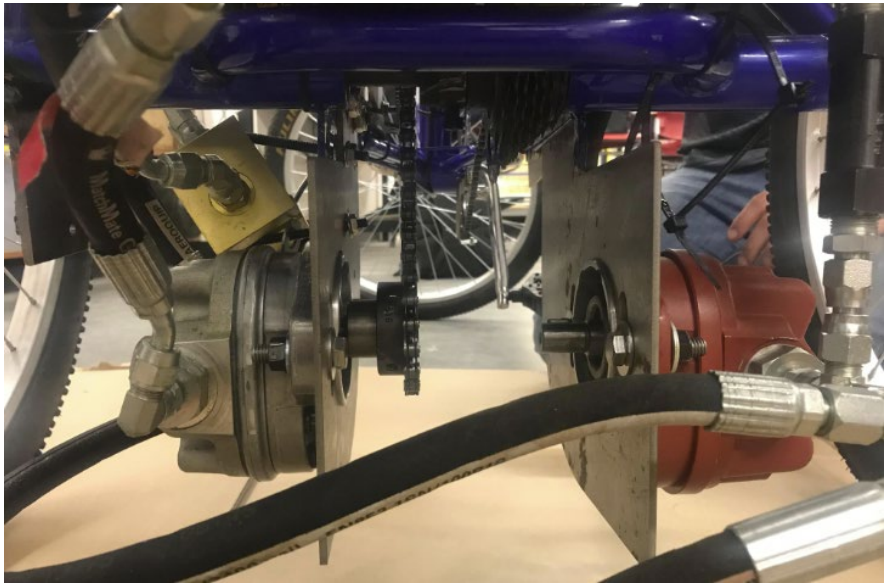
Vehicle Construction

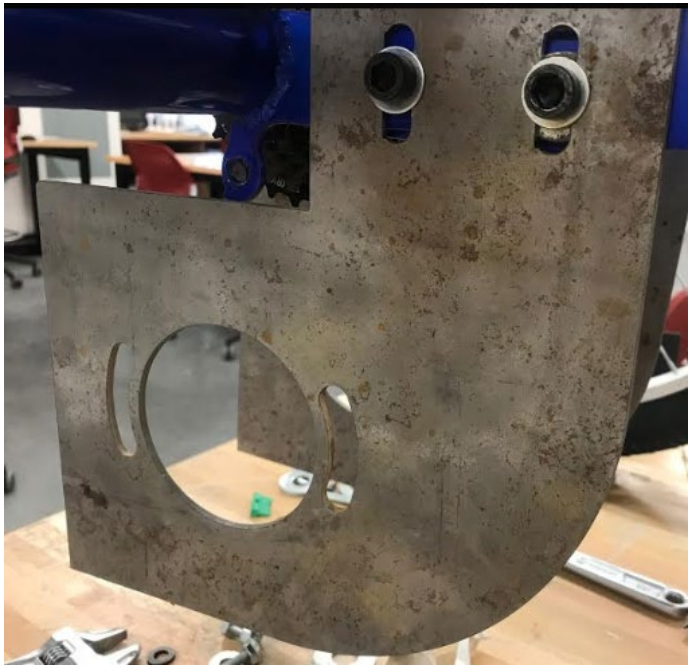
Reservoir

- Aluminum (lightweight)
- Easy to access
- Distributes weight on bike
- Supported using mounting tabs attached to bike frame

Motor and Pump

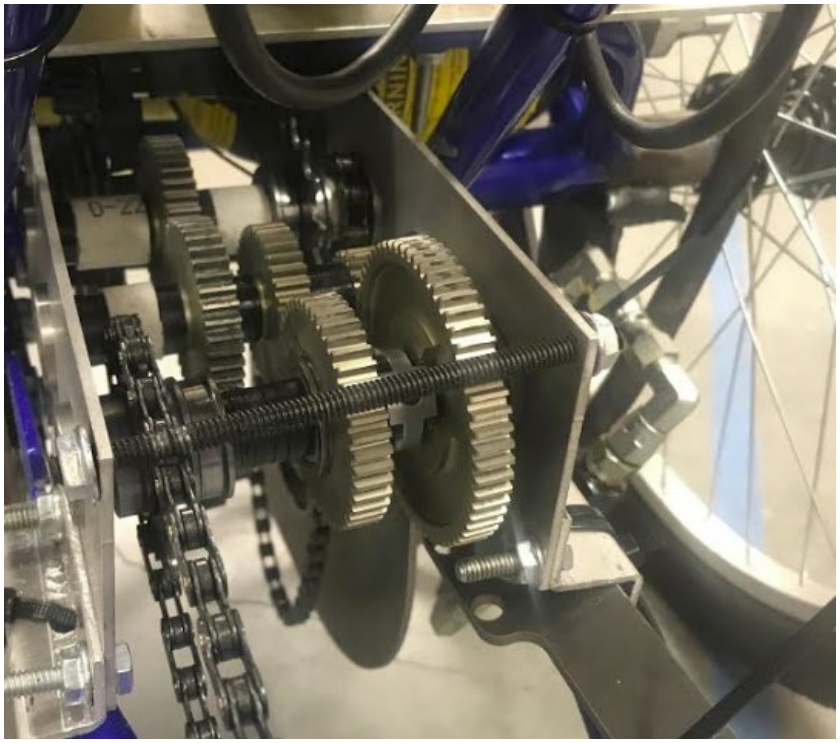
- 1/8” steel plating for mounting
- Allows for vertical adjustment of the pump and motor

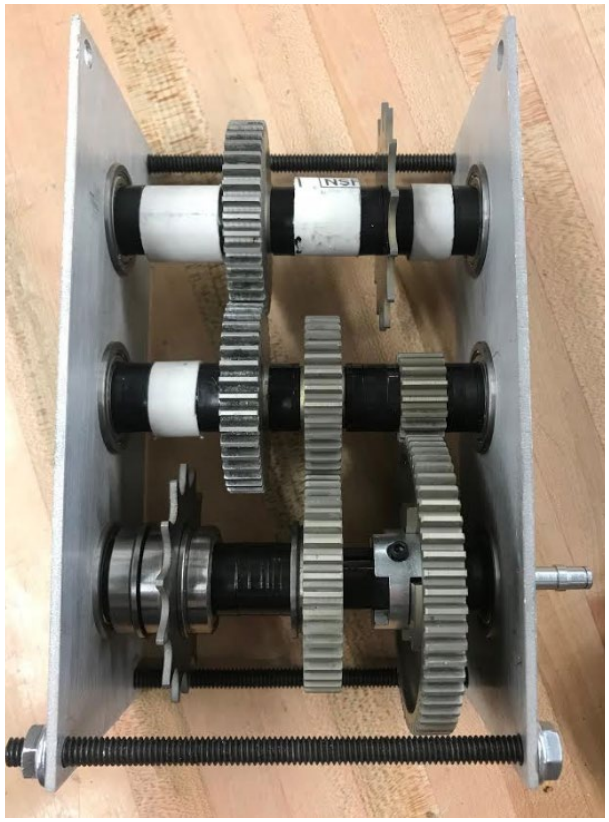




Gear Box

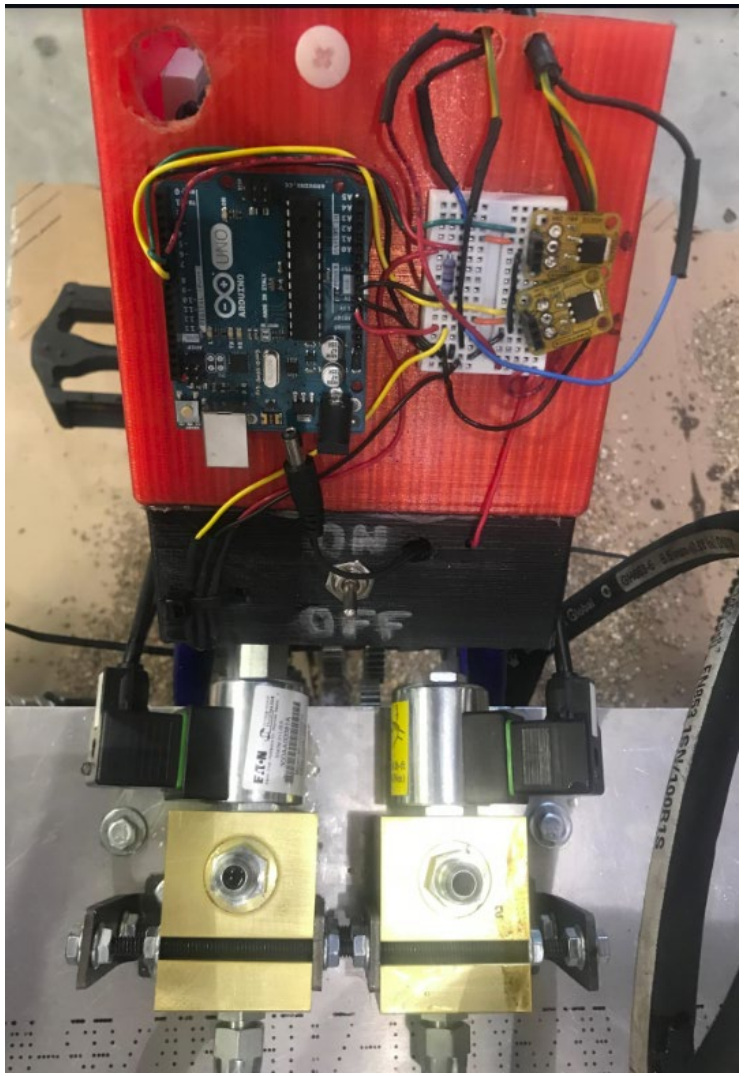
- Vex dog shifter
- Allows us to change gear for the endurance and sprint races
- 1/2” hex shaft
- High Gear - 1:8.6 ratio
- Low Gear – 1:4.6 ratio





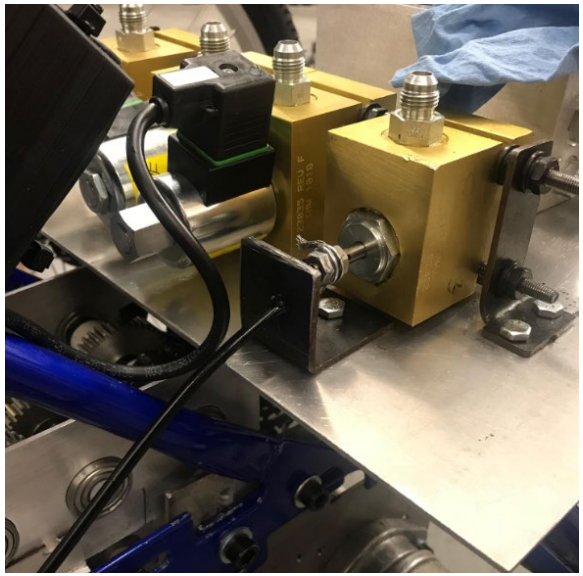
Regenerative Braking

- Arduino Uno
- NC and NO solenoid valves
- 12 volt battery with casing
- Switch-activated at handlebar



Hand Pumps and Accumulators

- 2 quart accumulators
- 2 hand pumps, one on each side of the bike
- Hand pumps mounted to steel brackets and welded to the bike's rear axle
- Accumulators activated using a pull valve attached to handlebar brake



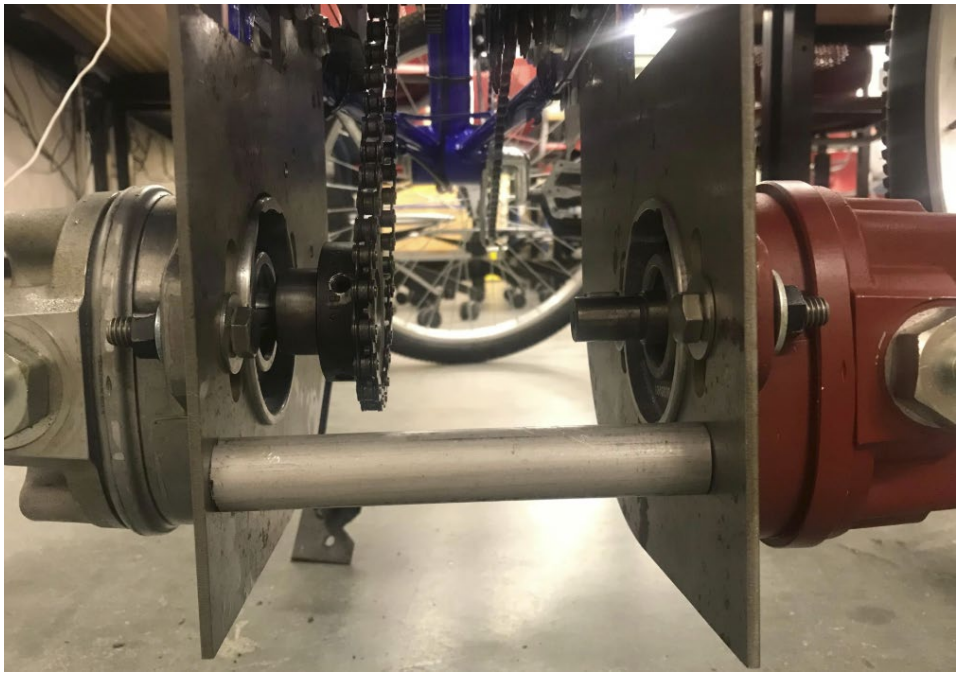
Vehicle Testing

- During vehicle testing we were running into the follow problems:
  - Leaks
  - In-proper plumbing
  - Lose chain
  - Flexing motor and pump plates

https://youtu.be/hgcAOTlPsvY

Improvements

- Replaced hydraulic hoses with tubing
- Added supports between pump and motor plates
- Switched gearbox side plates to steel
- Fixed lose chain by adjusting the pump mounting plate down



Closing Thoughts

- Time management and planning is key
- Vehicle testing is very important
- Learned how to apply knowledge gained from coursework to a real world project
- Learned how to incorporate many different constraints and criteria into a design

Special Thanks

Dr. Brian Steward

Aaron Darnell

Saxon Ryan

Norman Muzzy

All competition sponsors

Questions?