NFPA Fluid Power VEHICLE Challenge

NFPA Education and Technology Foundation

Midway Review & Update
Tennessee State University
Dr. Fasoro Abiodun
Dr. Habibi Mohammad
April 12th, 2023

TENNESSEE STATE UNIVERSITY

Agenda

- Team Introductions
- Project Goals and Objectives
- Design Progress
- Hardware Selected
- Calculations and Analysis
- Vehicle Build and Parts Integration
- Thank you Note
- Questions

NFPA Fluid Power Vehicle Challenge

MEET THE TEAM

Team Introductions

Juan Cabrera Rosario

- About
  - ✓ Junior student, Mechanical Engineering
  - ✓ Senator, TSU NSBE Chapter
  - ✓ Forest Park, Georgia
- Position
  - ✓ Team Lead
  - ✓ Design Lead
  - ✓ Hydraulics Lead
  - ✓ Communications Lead
- Hobbies
  - ✓ Watching movies and shows
  - ✓ Playing the french horn
  - ✓ Playing Video games and Listening to music

Team Introductions

Markel Belcher

- About
  - ✓ Junior student, Mechanical Engineering
  - ✓ Parliamentarian, TSU NSBE Chapter
  - ✓ Memphis, TN
- Position
  - ✓ Hydraulics Co-Lead
  - ✓ Communications Co-Lead
- Hobbies
  - ✓ Playing Video games
  - ✓ Playing and watching baseball
  - ✓ Journalling

Team Introductions

Ishmahl Armstrong

- About
  - ✓ Sophomore student, Applied and Industrial Technology
  - ✓ Member of the Aristocrat of Bands
  - ✓ Atlanta, GA
- Position
  - ✓ Rider
  - ✓ Design Co-Lead
- Hobbies
  - ✓ Musician
  - ✓ Photography
  - ✓ Watching Anime

Team Introductions

Christopher Buford II

- About
  - ✓ Graduate Student, Mechanical Engineering
  - ✓ Parliamentarian of TSUEAA board
  - ✓ Nashville, TN
- Position
  - ✓ Research assistant
  - ✓ CAD Designer
- Hobbies
  - ✓ Producing and recording music
  - ✓ Journaling and reading books
  - ✓ Exercising

Team Introductions

Havilah Akachukwu

- About
  - ✓ Junior Student, Mechanical Engineering
  - ✓ Member of The American society of Mechanical Engineers
  - ✓ Abuja, Nigeria
- Position
  - ✓ Documentation
  - ✓ Solid Works Specialist
- Hobbies
  - ✓ Reading – mostly novels and poetry
  - ✓ Journalling and Puzzles
  - ✓ Cooking – If it takes more than 3 hours, I'm out

Team Introductions

Dr. Abiodun Fasoro

- About
  - ✓ Assistant Professor, Mechanical Engineering
  - ✓ Ph.D. Mechanical Engineering, University of Texas at Arlington,
  - ✓ MBA, Capital University, Columbus.
  - ✓ M.Phil. Metallurgy and Materials Engineering, Univ. of Birmingham, England
  - ✓ B.S. Mechanical Engineering, Obafemi Awolowo University
  - ✓ Hometown is Texas
- Position
  - ✓ Faculty Advisor

Team Introductions

Dr. Mohammad Habibi

- About
  - ✓ Assistant Professor, Mechanical Engineering
  - ✓ Ph.D., CISE (Robotics & Computer Integrated Manufacturing), Tennessee State University
  - ✓ M.S., CISE (Systems Engineering), Tennessee State University
  - ✓ B.S., Electrical Engineering, Z. H. College of Engineering and Technology, Aligarh Muslim University,
  - ✓ Hometown is Nashville, TN
- Position
  - ✓ Faculty Advisor

PROJECT GOALS AND OBJECTIVES

Project Goals and Objectives

❖ The Competition's Goals and Objectives

First, a list of the Program objectives for the Competition as set by NFPA are:

- ✓ Stimulate education in fluid power components, circuits, and systems, incorporating them into a systems engineering experience.
- ✓ Provide students with experience in real-world engineering under a strict timeline of designing, simulating, ordering, building, testing, and demonstrating their designs.
- ✓ Stimulate innovative thinking for designing and testing potential new fluid power technologies or concepts integrated into a vehicle platform.
- ✓ Provide an industry recruitment opportunity for high-potential engineering seniors by engaging directly with practitioners in the fluid power industry.

Project Goals and Objectives

❖ The Team's Goals and Objectives

In addition to the competition goals, the team identified specific goals and objectives the team we would like to accomplish for the project:

- ✓ Vehicle should be able to qualify for all races
- ✓ Vehicle's must meet the weight requirement by not exceeding 200 lbs
- ✓ Vehicle must meet all safety requirements; damage to driver cannot occur.
- ✓ Participating students must finish the project having learned more about fluid power and the product manufacturing products

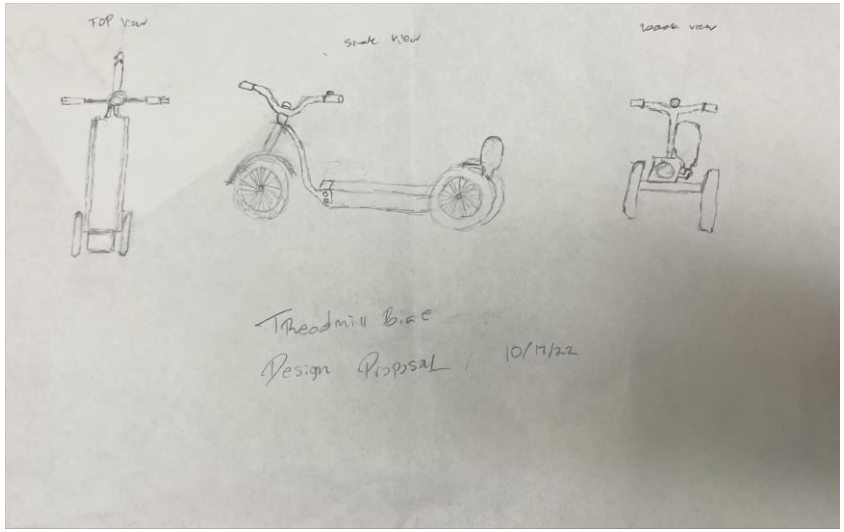
NFPA Fluid Power Vehicle Challenge

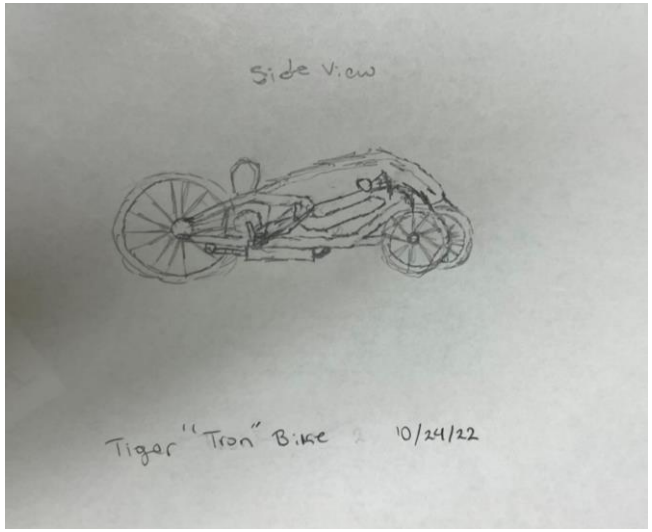
DESIGN PROGRESS

DESIGN PROGRESS

❖ Initial Sketch of Vehicle

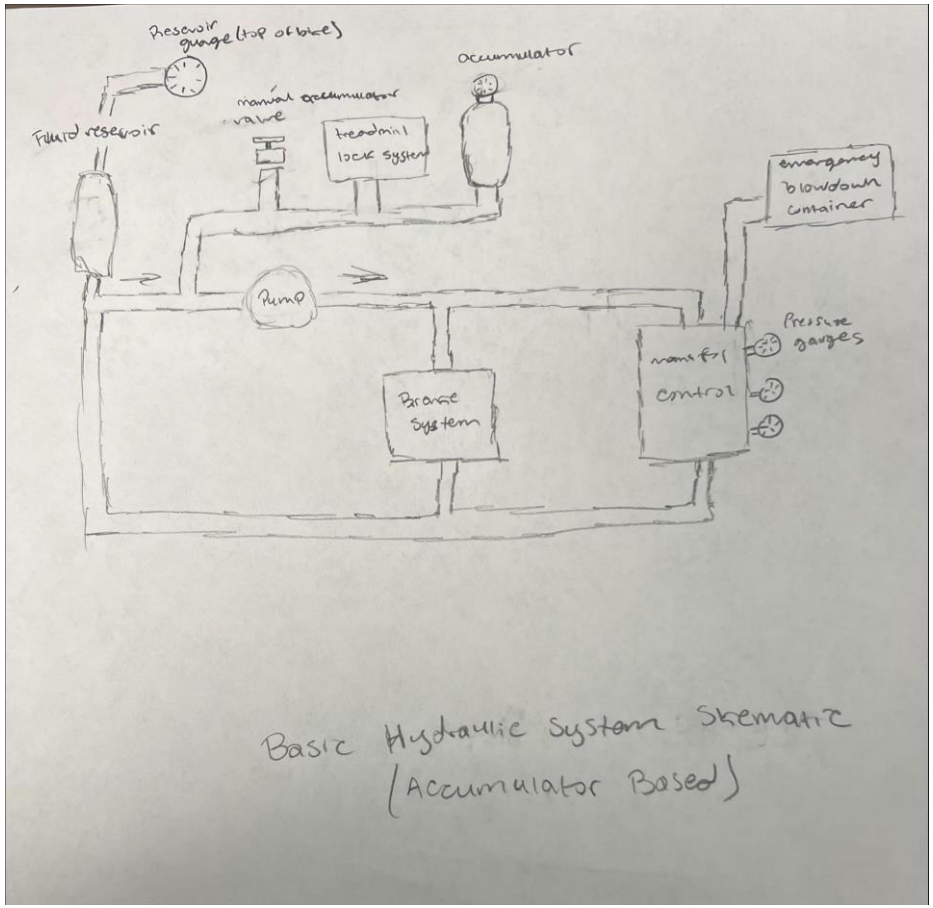
This was part of the initial design process. The team had meetings to discuss the design of vehicle. The design lead came up with various sketches for the design.

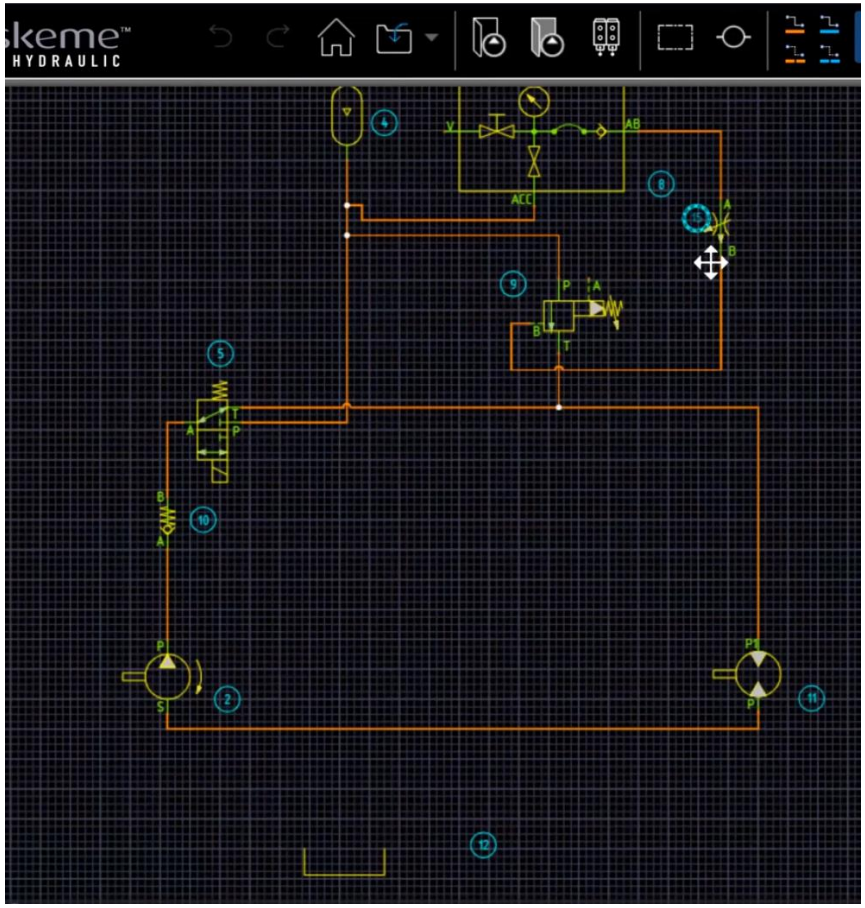




DESIGN PROGRESS

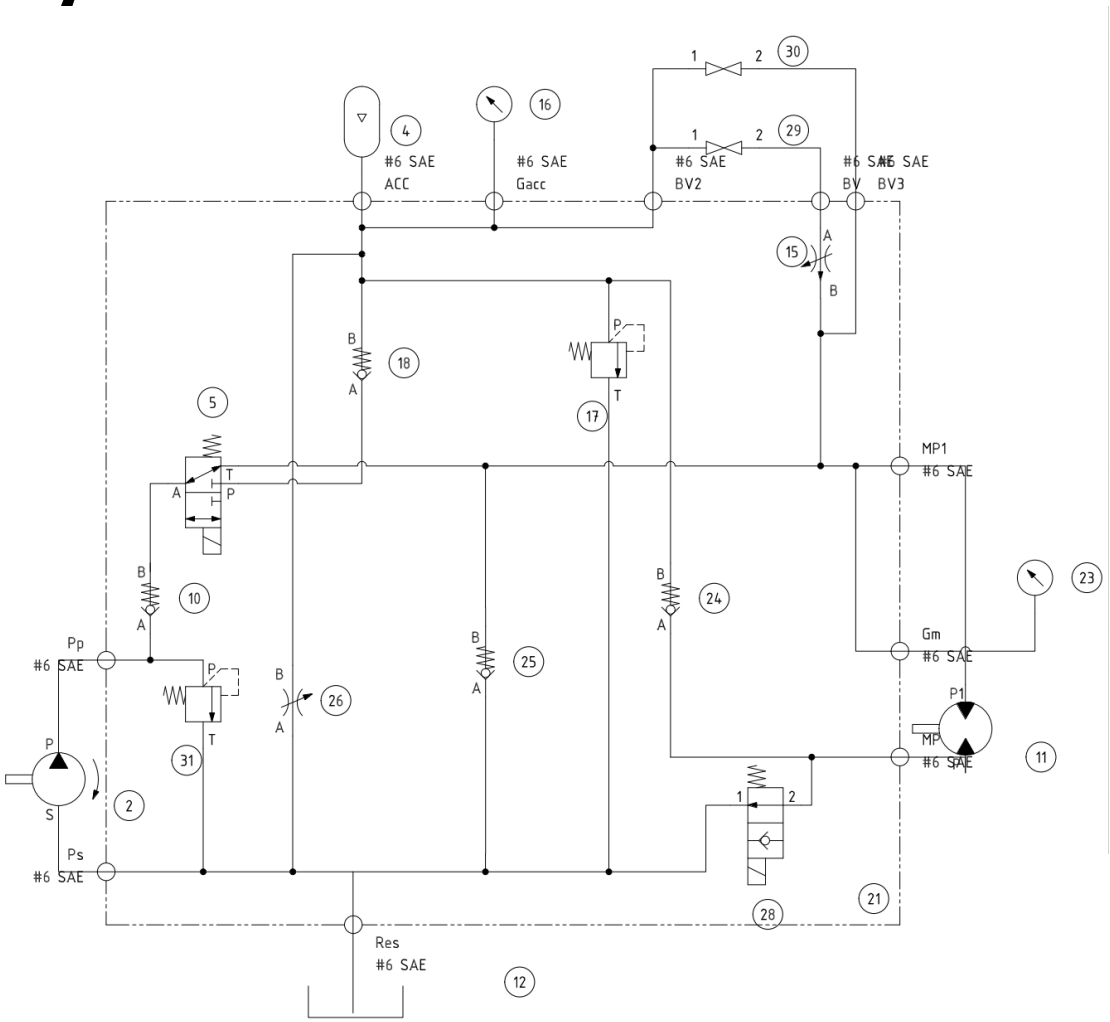
❖ **Initial Sketch of hydraulic circuit**





DESIGN PROGRESS

❖ Final Hydraulics Circuit

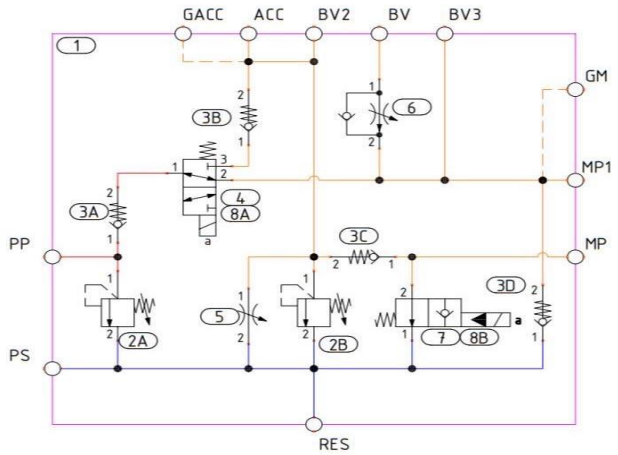


DESIGN PROGRESS

❖ Final Manifold Design

ITEM ID	PORT TYPE	PORT SIZE
ACC, BV, BV2, BV3, GACC, GM, MP, MP1, PP, PS, RES	SAE O-RING	#6 SAE

Item	Qty	Model Code	Description	Manufacturer
1	1	FV-14057-M1	Manifold body	Source Fluid Power
2	2	RV1-10-S-0-36	Relief Direct Acting	Eaton
3	4	CV08-NP-0.3-B-00	Check 1 to 2	Danfoss ICS
4	1	SV1-10-3-0-00	Solenoid 2 pos. 3 way	Eaton
5	1	NV1-8-S-0	Needle Valve, Screw Adj	Eaton
6	1	FAR1-10-S-0	Flow Control Compensated, Screw Adjust	Eaton
7	1	SV3-10-0-0-00	Solenoid 2 pos. 2 way	Eaton
8	2	300AA00081A	Coil 12VDC, DIN	Eaton



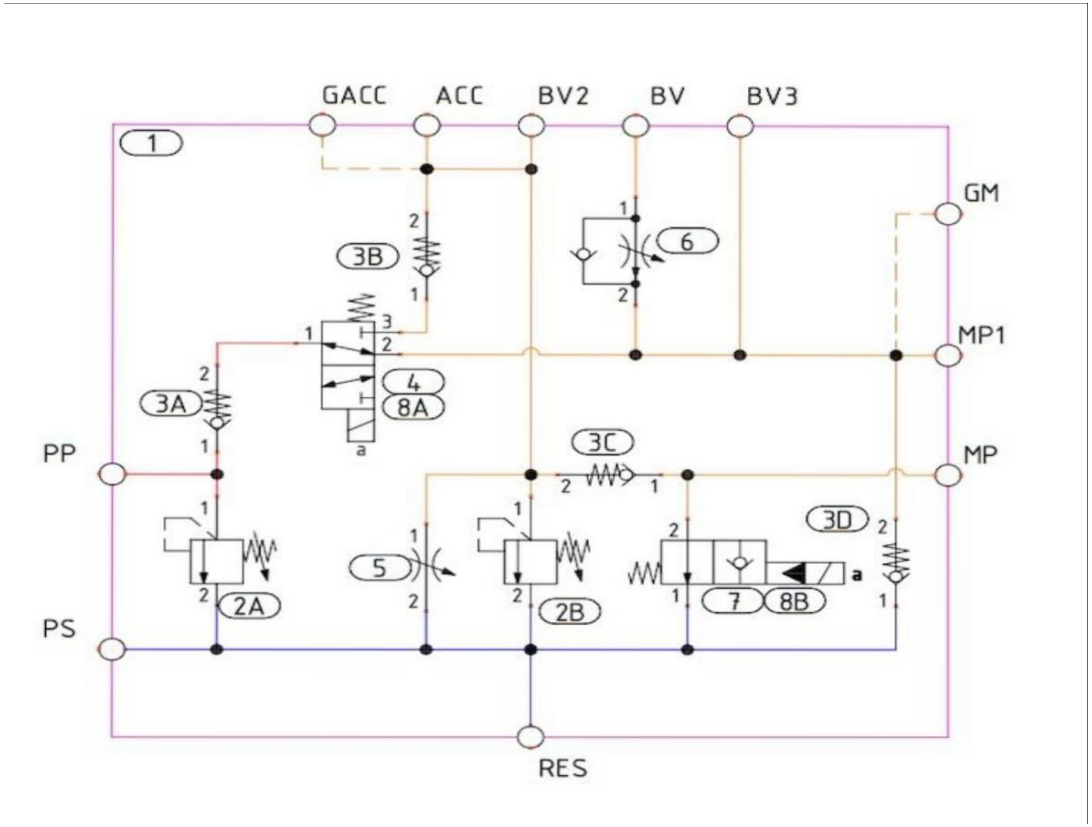
Notes:
-3000 PSI max

SUNSOURCE

Creation Date 12/19/2022	Drawn By J. McCarthy	Customer Name Tennessee State University
Material Aluminum	Print Checked By (Team)	Title NFPA-FPVC 22-23 manifold
Protective Finish None	Sheet Name Sheet 1 of 1	Part Number FV-14057-V1 schem
Size B — Dimensions are in inches. Do not scale drawing. Unless otherwise specified, apply standards per FV-1000-Spec1	Third Angle Projection	Proprietary and Confidential. SunSource claims proprietary rights on the information disclosed on this drawing. It is issued in confidence and may not be reproduced or used to manufacture anything shown hereon without direct written permission from SunSource to the user. — Rev A

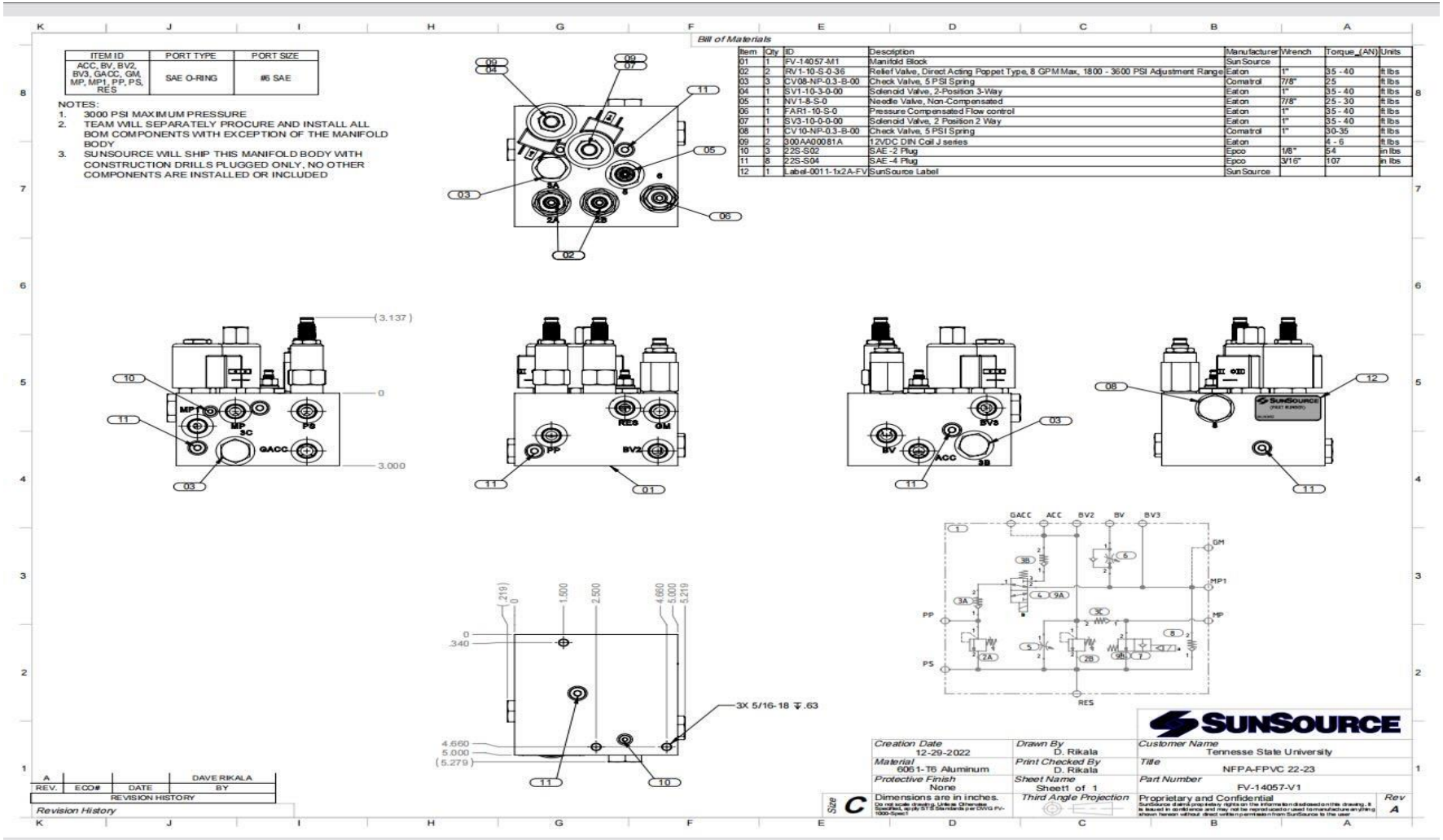
DESIGN PROGRESS

❖ **Final manifold design**



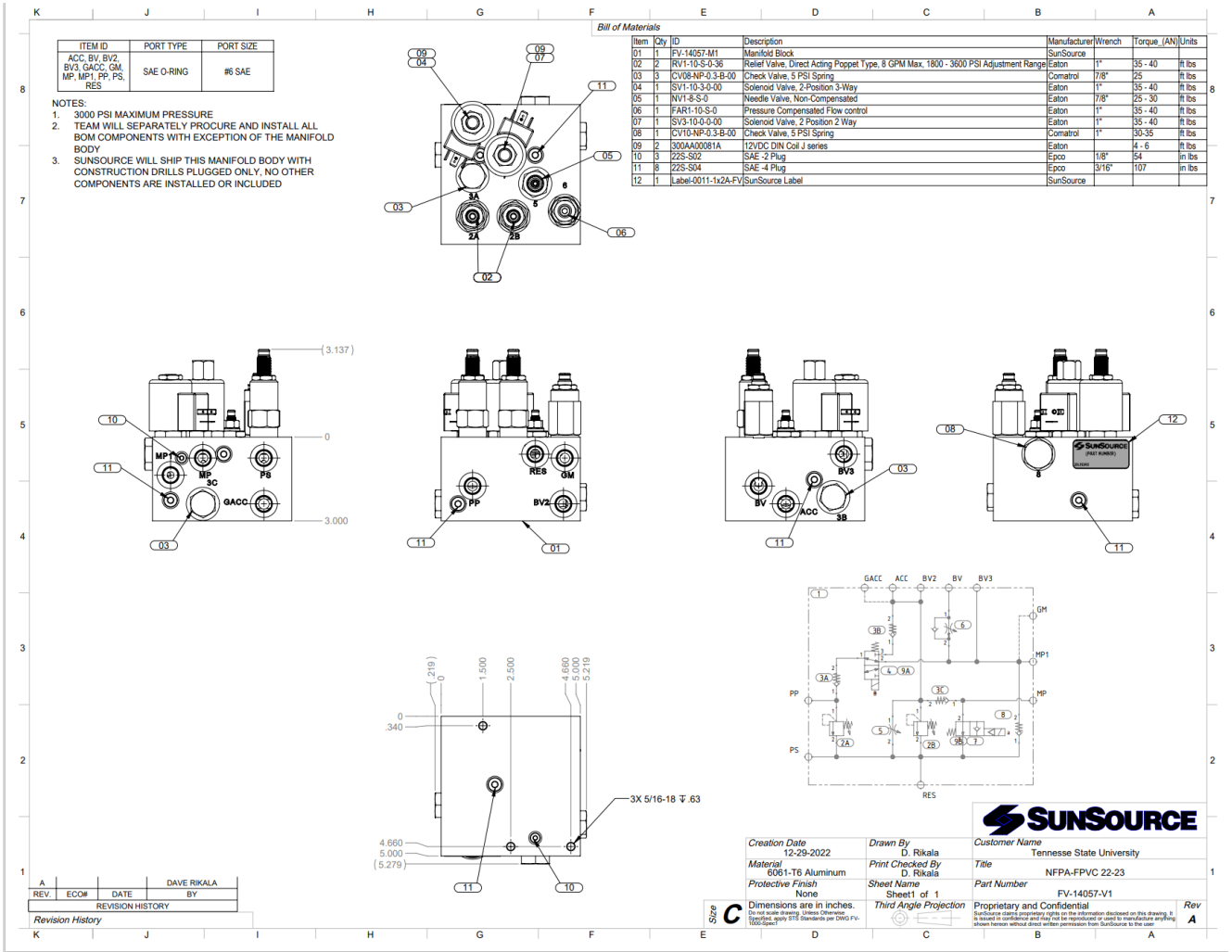
DESIGN PROGRESS

❖ Final manifold design



DESIGN PROGRESS

❖ Final Manifold Design



ITEM ID	PORT TYPE	PORT SIZE
ACC, BV, BV2, BV3, GACC, GM, MP, MP1, PP, PS, RES	SAE O-RING	#6 SAE

NOTES:
1. 3000 PSI MAXIMUM PRESSURE
2. TEAM WILL SEPARATELY PROCURE AND INSTALL ALL BOM COMPONENTS WITH EXCEPTION OF THE MANIFOLD BODY
3. SUNSOURCE WILL SHIP THIS MANIFOLD BODY WITH CONSTRUCTION DRILLS PLUGGED ONLY, NO OTHER COMPONENTS ARE INSTALLED OR INCLUDED

Bill of Materials

Item	Qty	ID	Description	Manufacturer	Wrench	Torque_(AN)	Units
01	1	FV-14057-M1	Manifold Block	SunSource			
02	2	RV1-10-S-0-36	Relief Valve, Direct Acting Poppet Type, 8 GPM Max, 1800 - 3600 PSI Adjustment Range	Eaton	1"	35 - 40	ft lbs
03	3	CV08-NP-0.3-B-00	Check Valve, 5 PSI Spring	Comatrol	7/8"	25	ft lbs
04	1	SV1-10-3-0-00	Solenoid Valve, 2-Position 3-Way	Eaton	1"	35 - 40	ft lbs
05	1	NV1-8-S-0	Needle Valve, Non-Compensated	Eaton	7/8"	25 - 30	ft lbs
06	1	FAR1-10-S-0	Pressure Compensated Flow control	Eaton	1"	35 - 40	ft lbs
07	1	SV3-10-0-0-00	Solenoid Valve, 2 Position 2 Way	Eaton	1"	35 - 40	ft lbs
08	1	CV10-NP-0.3-B-00	Check Valve, 5 PSI Spring	Comatrol	1"	30-35	ft lbs
09	2	300AA00081A	12VDC DIN Coil J series	Eaton		4 - 6	ft lbs
10	3	22S-S02	SAE -2 Plug	Epco	1/8"	54	in lbs
11	8	22S-S04	SAE -4 Plug	Epco	3/16"	107	in lbs
12	1	Label-0011-1x2A-FV	SunSource Label	SunSource			

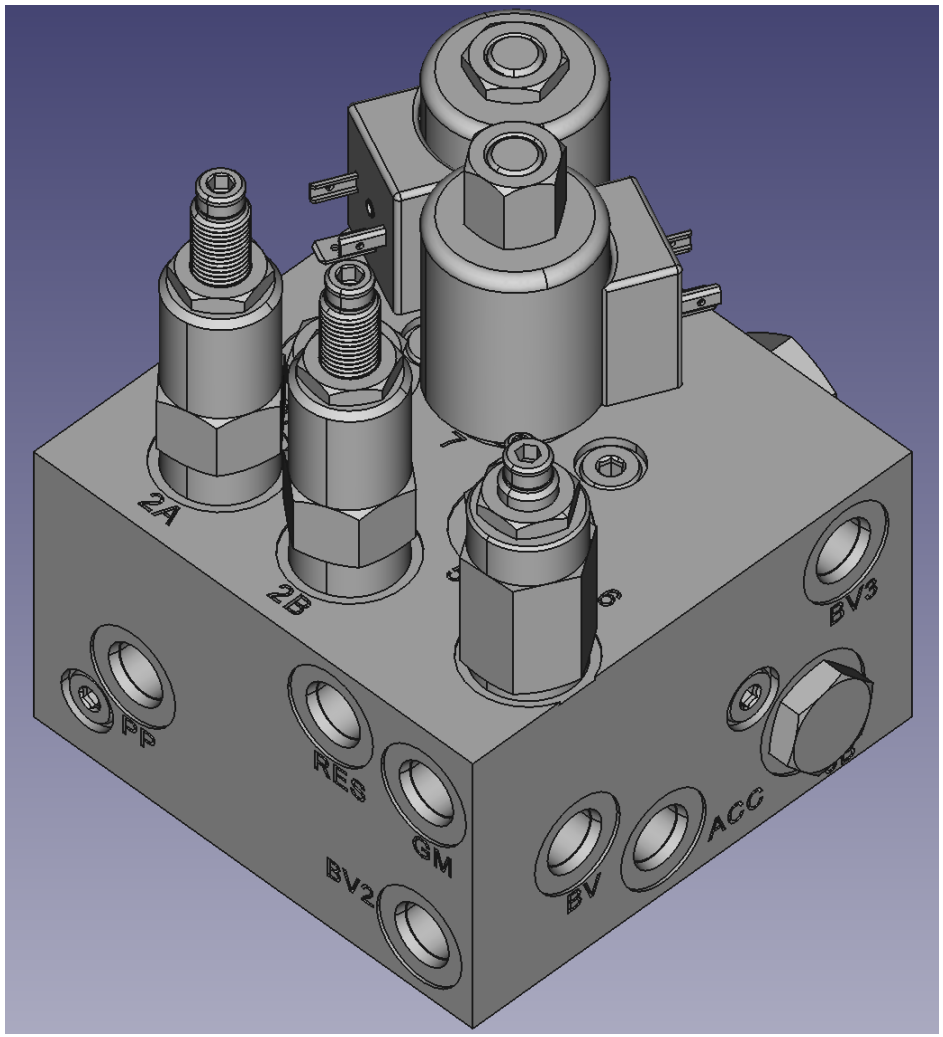
REV.	ECO#	DATE	BY
A			DAVE RIKALA

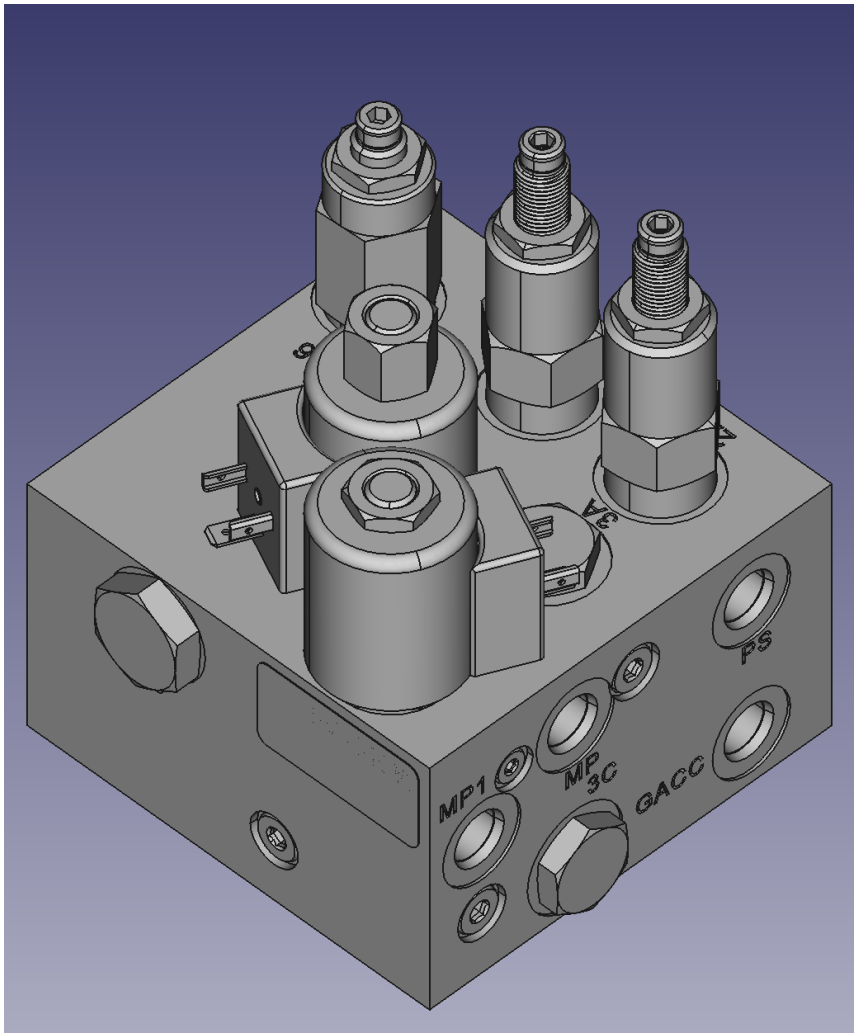
Revision History

Creation Date 12-29-2022	Drawn By D. Rikala	Customer Name Tennessee State University	
Material 6061-T6 Aluminum	Print Checked By D. Rikala	Title NFPA-FPVC 22-23	
Protective Finish None	Sheet Name Sheet1 of 1	Part Number FV-14057-V1	
Size C	Dimensions are in inches. Third Angle Projection	Proprietary and Confidential	Rev A

DESIGN PROGRESS

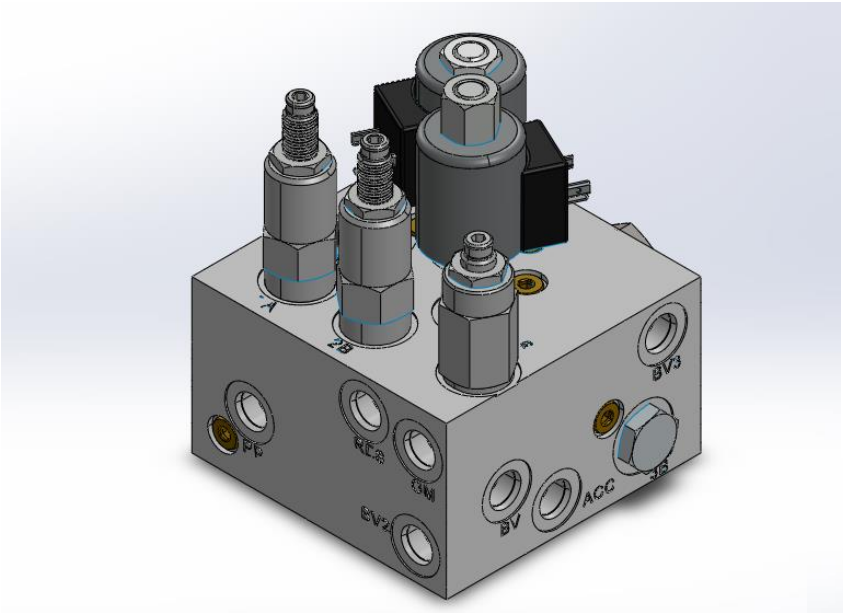
❖ **Final Manifold Design – 3D**

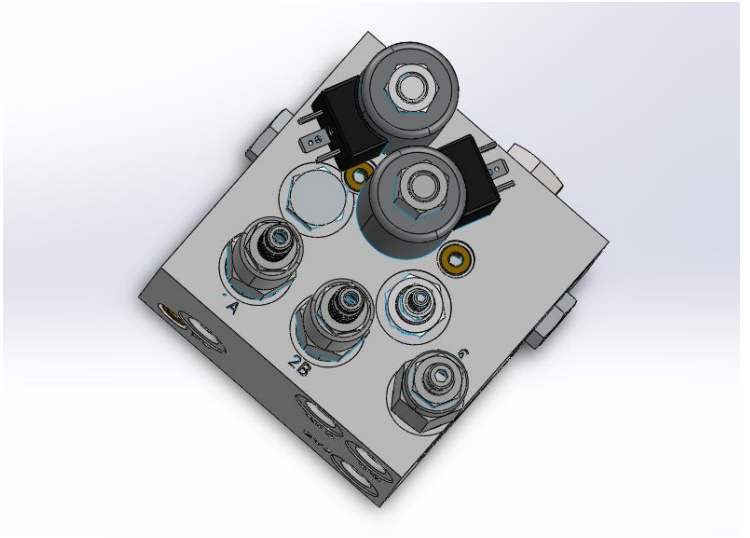


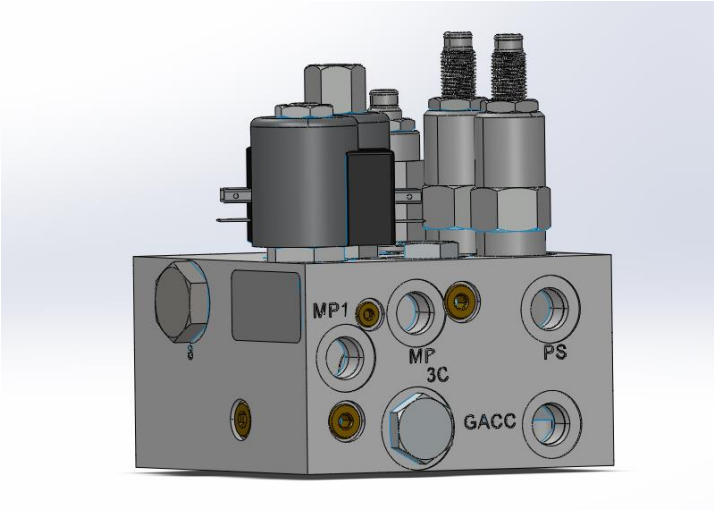


DESIGN PROGRESS

❖ **Final manifold design – 3D**







HARDWARE SELECTED

Hardware Selected

Hardware selected and purchased for vehicle

Vehicle Part/component	Hardware Selected	Part Number
Motor	A Bi-rotation gear motor with external drain, 0.513 CID, and Keyed Shaft .625"	121.20.096.00
Accumulator	1 Gallon Bladder Accumulator, A13100-3	
Check Valve	4 1-2, size 10, poppet style, catridge only check valve	CV10-NP-0.3-B-00
Coil	2 12VDC DIN, J type coil	300AA00081A
Electrical Connector	2 DIN, 12-24VDC w/ LED (for coils)	2291.3301
Flow Regulator	A size 10 Flow adjustable, pressure compensated flow regulator with reverse flow check	FAR1-10-S-0
Flow Restrictor valve	A size 8 screw style needle valve	NV1-8-S-0
Gauge	A 2-1/2" diameter Gauge, with 0-3000 PSI range, and a SAE -4 male adjustable stem.	CF-1P-210-A-SAE
Pump	A CW rotation Gear Pump with a 0.659 CID, and a Keyed Shaft .625"	111.20.243.00
Relief Valve	1 direct acting relief valve	RV1-10-S-0-36
Solenoid Valve	1 2 pos. 2 way Uni-poppet Normally Open solenoid valve	SV3-10-0-0-00
Solenoid Valve	1 2 pos. 3 way Spool 1-2/1-3 solenoid valve	SV1-10-3-0-00

Calculations and Analysis

Calculations

Gross Weight of Vehicle	
Accumulator	32 lbs.
Check Valve (x4)	0.09 lbs.
Electrical Connector (x2)	0.04375 lbs.
Flow Regulator	0.44 lbs.
Needle Valve (x2)	0.15 lbs.
Gear Motor	7 lbs.
Gear Pump	6 lbs.
2W/2P Poppet	0.87 lbs.
3W/2P Spool	0.93 lbs.
Ball Valve (x2)	1.55 lbs.
Bike	66 lbs.
Total	118.0875 lbs.

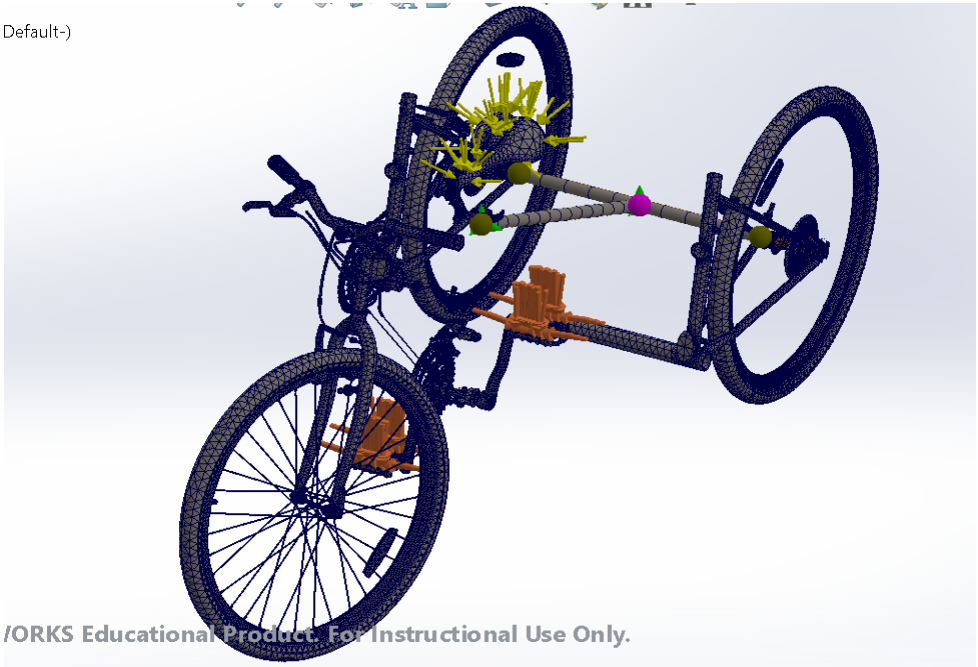
Estimated Weight of components: 52.0875 lbs.

Estimated Weight of vehicle with Rider: 286.0875lbs.

Analysis

❖ Static Analysis

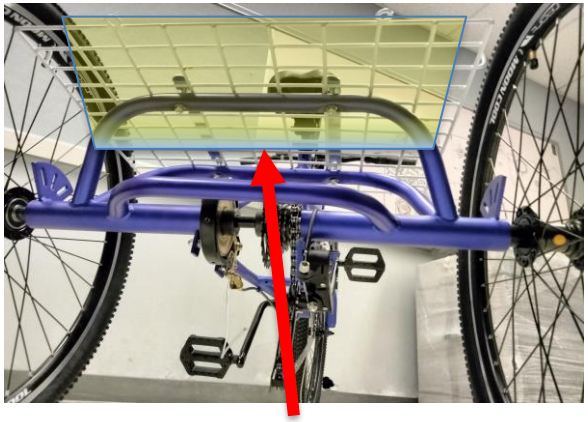
- Static Analysis of the rider on the bike.
  The analysis was initially performed using the estimated weigh of the rider on the bike. The aim is for areas of less and greater stress to be identifiable now and considerations to be taken when building the bicycle. Due to an error in either the assembly or parts design, our diagram was unable to Run.
- We plan to redesign the parts that caused the error and do another analysis.



Vehicle Build and Parts Integration

Assembled Bike

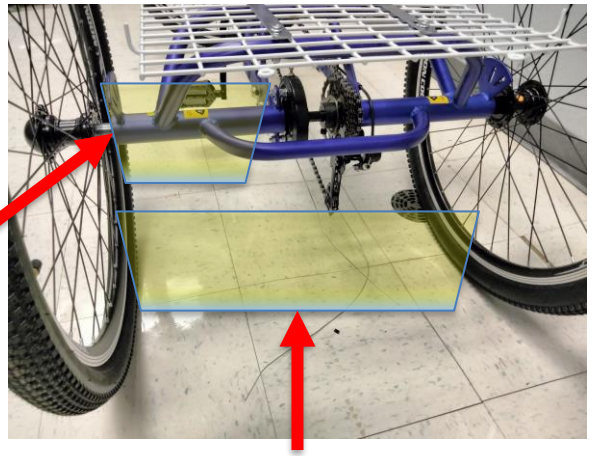
Component Locations



Load Center for Reservoir, Manifold, and Accumulator

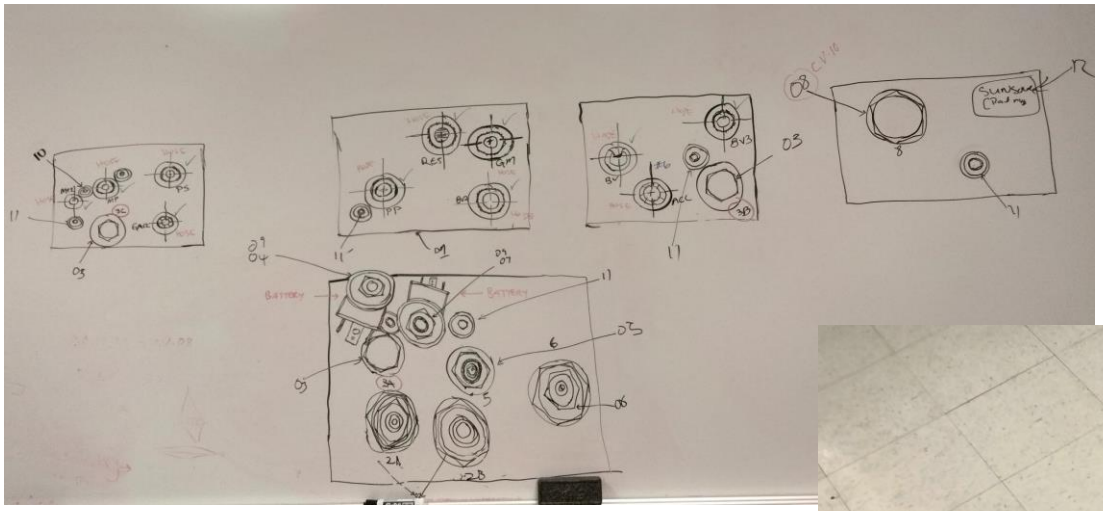
Pump Mount

Motor Mount



Clearance for Hoses

Proposed Integration



Work in Progress

Parts unavailable
Couldn't procure in time

Sprockets, Hoses, connectors and Controller

THANK YOU!!

A special thanks to our Mentor, Austen Nielsen, Mr. Jeff McCarthy, Mr. Ernest Parker, Mr. Josh Scarbrough, Mrs. Mary Pluta, Ms. Stephanie Scaccianoce and all the people who helped make our first time in the competition smoother than we expected.

We are extremely grateful.

Thank you!!!.

NFPA Fluid Power Vehicle Challenge

QUESTIONS?