

TEAM HYDRA

Hydraulic Rover Team

Our Team

Kyle Keath

MET

Steering, Ergonomics, Budget

David Bischoff

MET

Drivetrain, Assembly, FEA

Scott Ora

MET

Frame, Suspension, Driver

Son Tran

MET

Steering, Hardware

Daniel Turcotte

MET

Suspension, Wheels

Gregory Struble

MFGET

Frame, Ergonomics

Dalton Hendren

MFGET

Drivetrain, Budget

What Drives Us

Vision

2018 NASA Human Exploration Rover Challenge Champions!

Mission

To take the skills we have learned at Pittsburg State University and further develop them by designing a one-of-a-kind human powered rover through Teamwork, Innovation, and Precision.

Values

Teamwork

Respect

Integrity

Simplicity

Innovation

Problem Statement

WIN the 2018 NASA Human Exploration Challenge

- Design a Human Powered Hydraulic Rover
- Fund Project
- Build Rover
- Compete!
- Win!

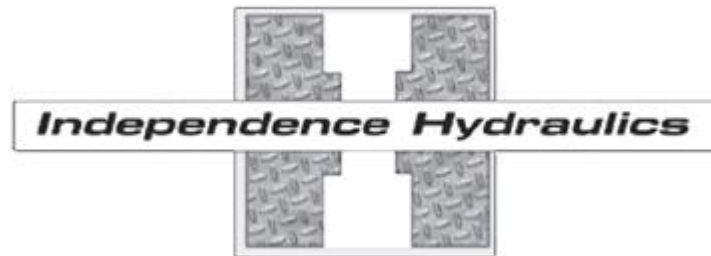


Fundraising

Need \$3000

- Pitt Power Crowdfunding
- Private Donations/Sponsorships

Budget	Donations	Deficit	Amount Spent
\$2935.00	\$3068.00	0	3068.00



Budget

- Travel/Lodging/Food - \$1200
- Parts - \$1600
- Team Polos/Vehicle Logos - \$200
- Total ~ \$3000



Please See Appendix

Stakeholders and Donors

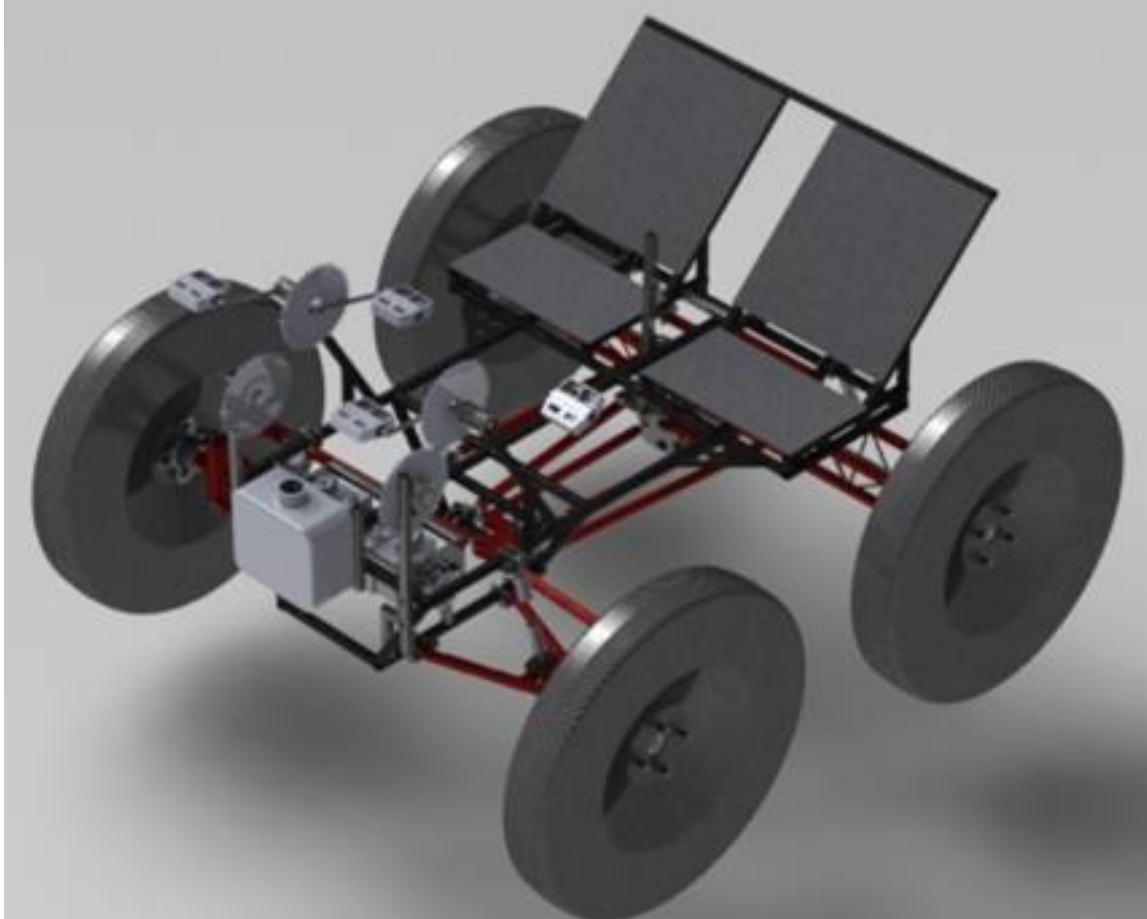
- Pittsburg State University
- State of Kansas Space Grant
- Pitt Power Crowdfund
- Ben Peters & ETCO Specialty Products
- Friends and Family

Customer Criteria

- Human Powered
- Hydraulic Powertrain
- Student Manufactured Wheels
- 15 Inch Ground Clearance
- 15 Foot Turning Radius
- 5' x 5' x 5' Volume Constraint

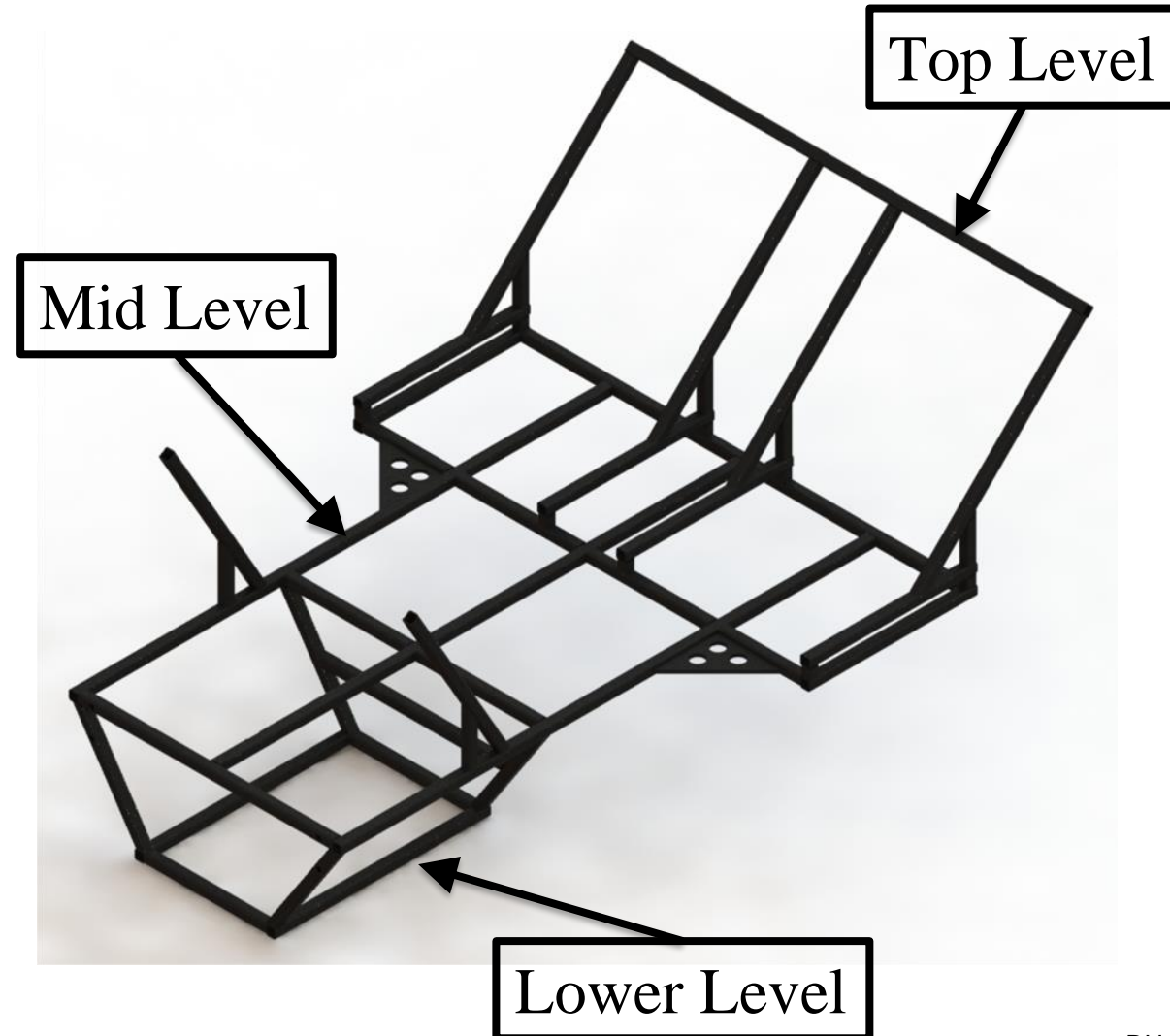
See Appendix for Complete Design Table

Full Assembly

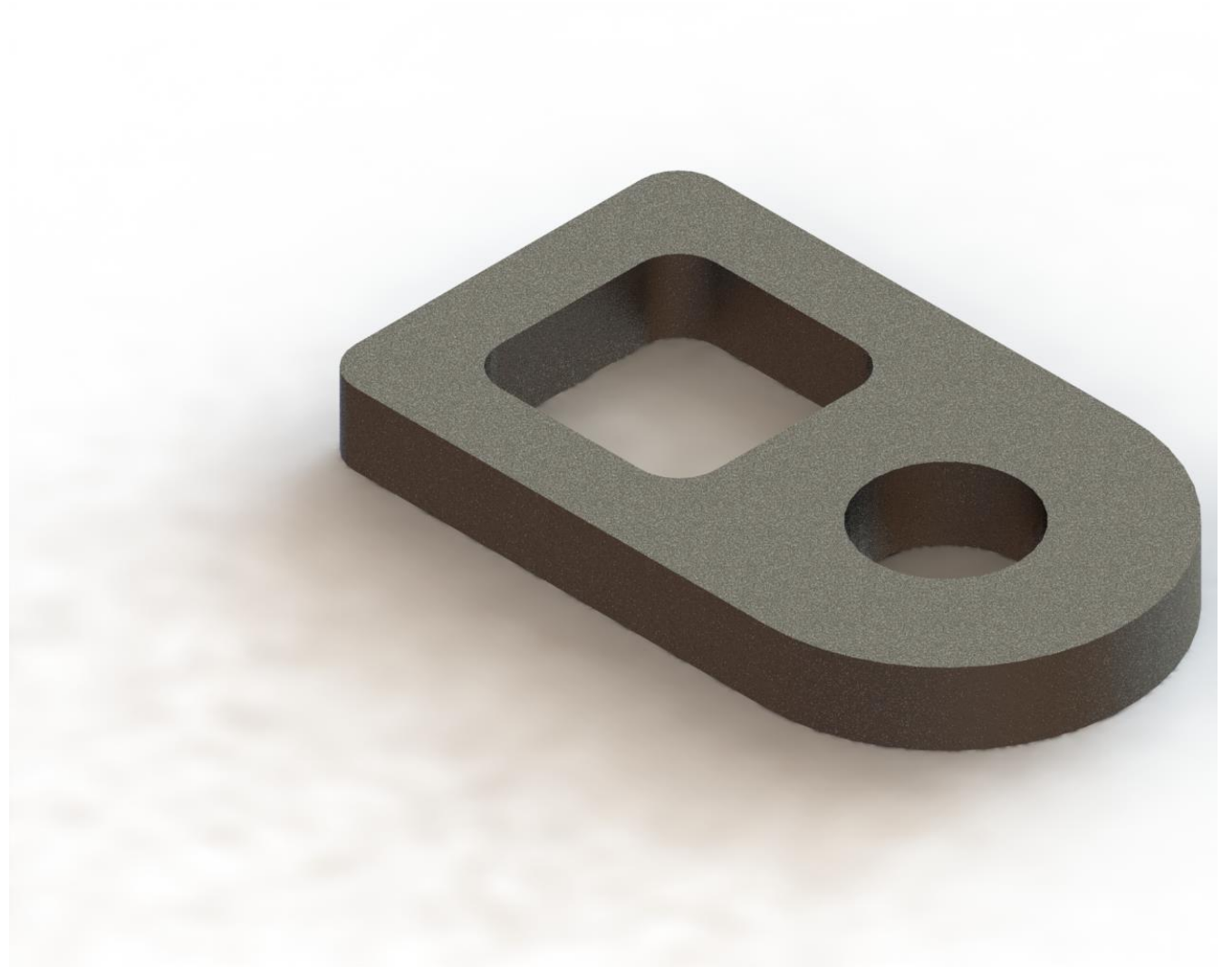


Frame

- Cut All Members on Chop Saw
- Welded All Members
- Constructing the frame in three layers
 - Top
 - Mid
 - Lower

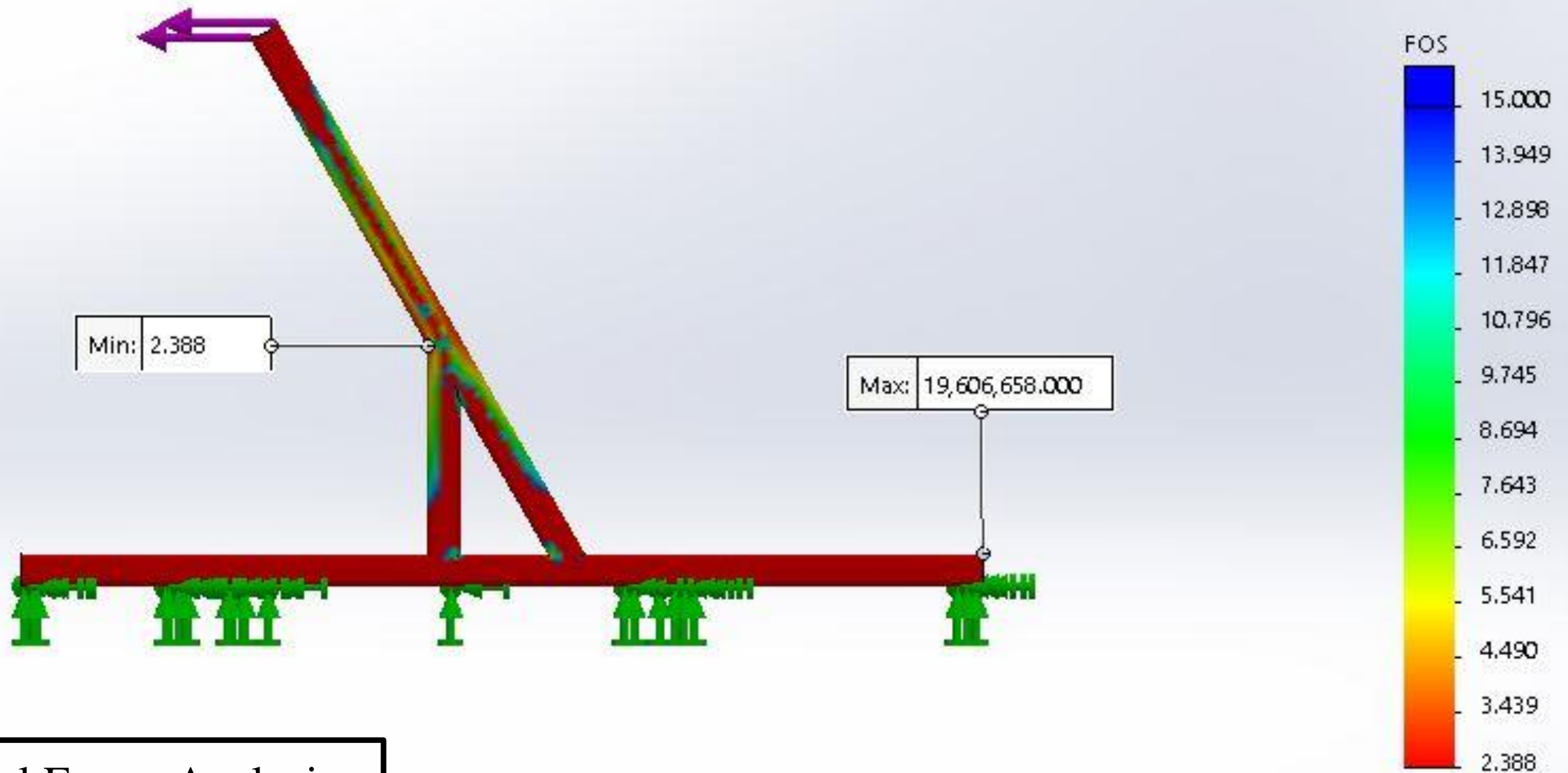


Dog Ears



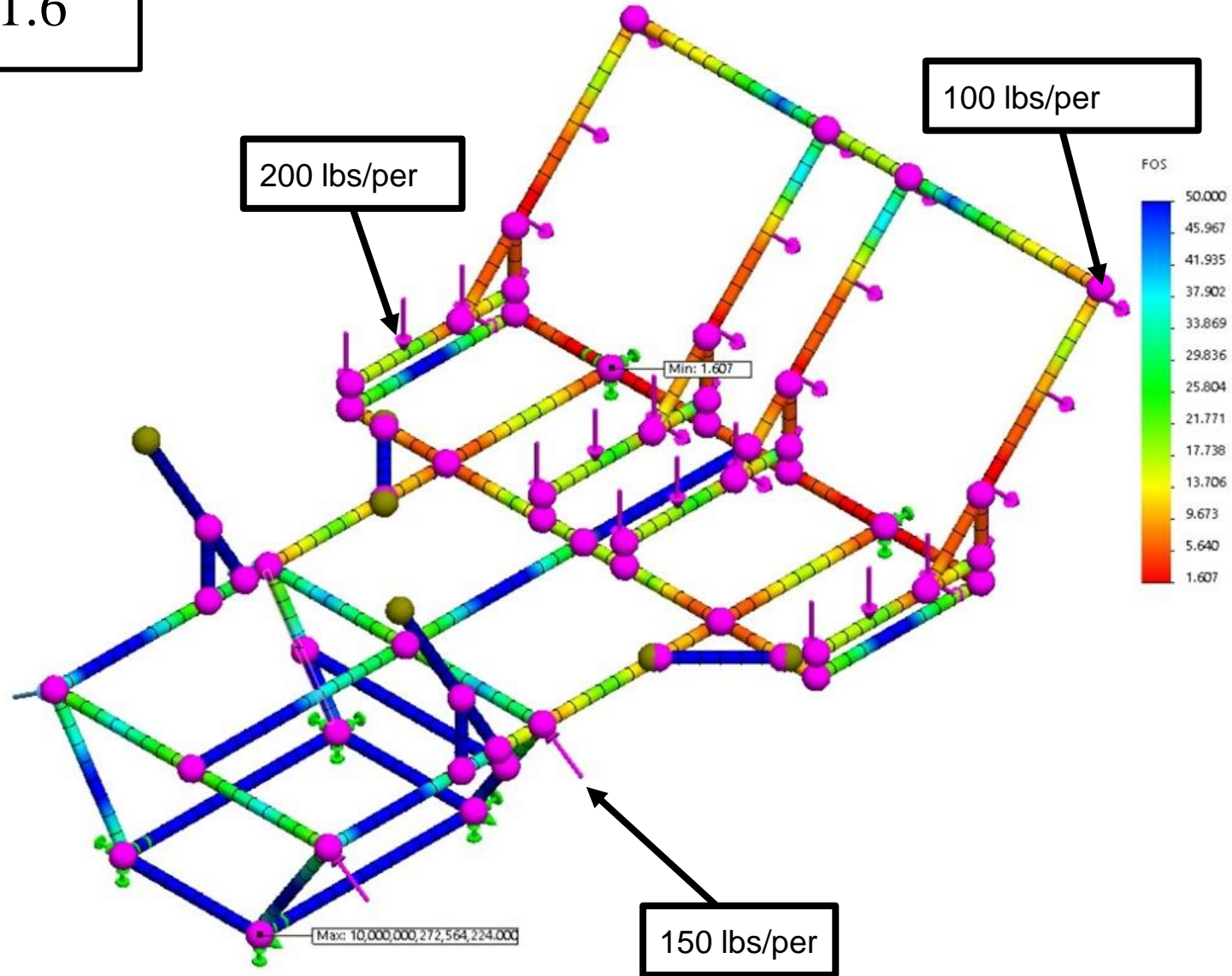
Frame



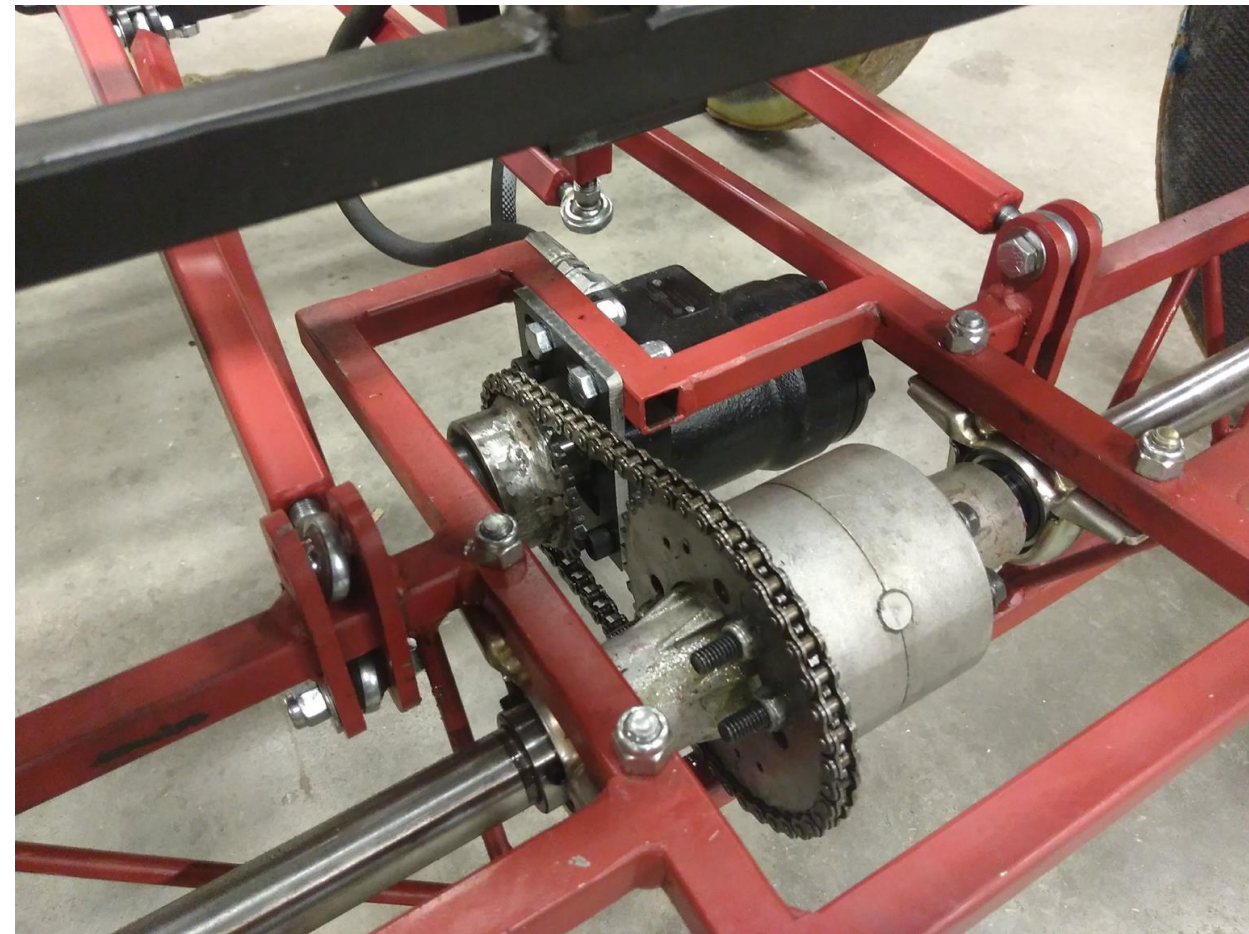


Partial Frame Analysis
Load: 200 lbs

Min Factor of Safety: 1.6



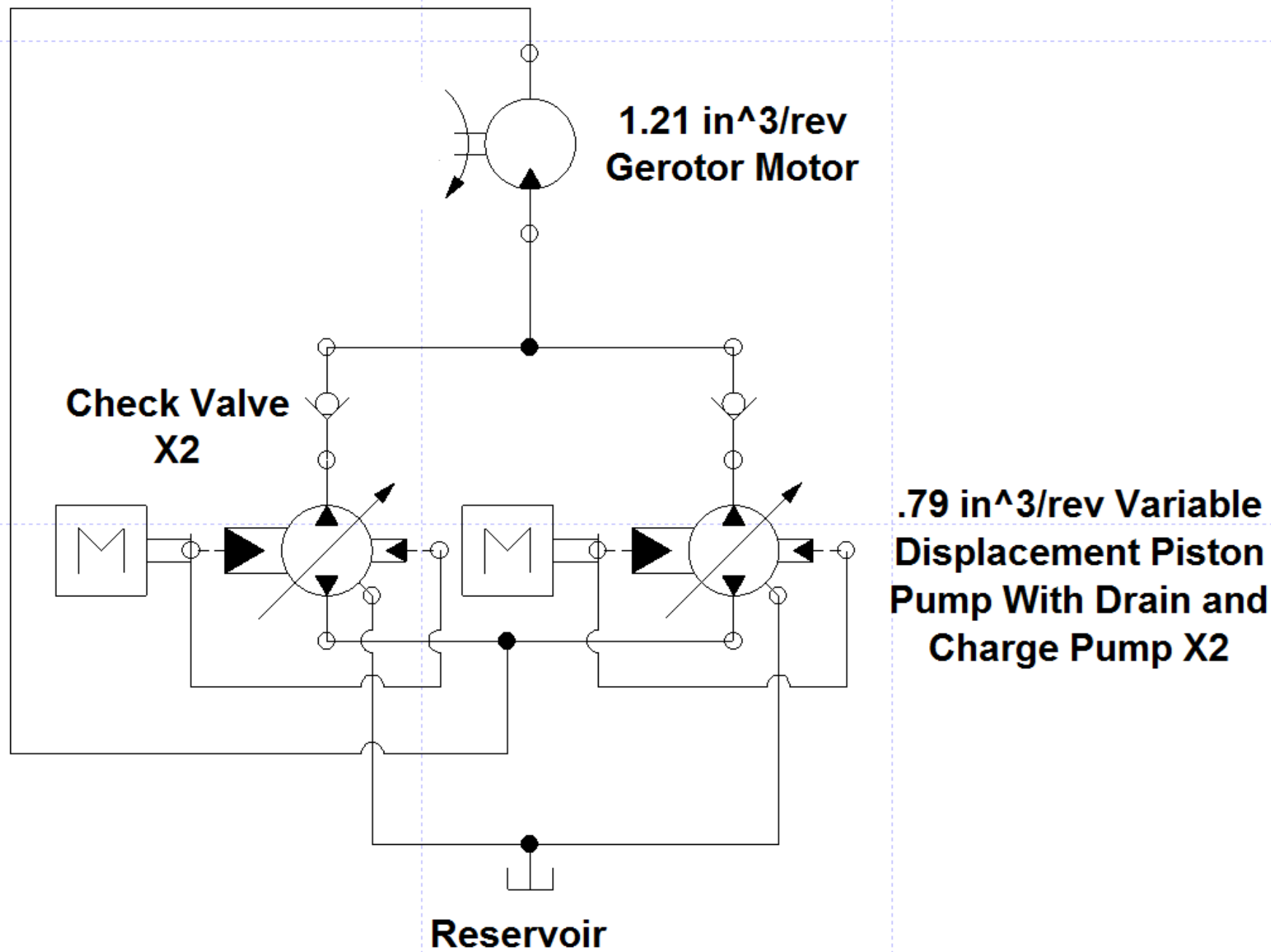
Drive Layout

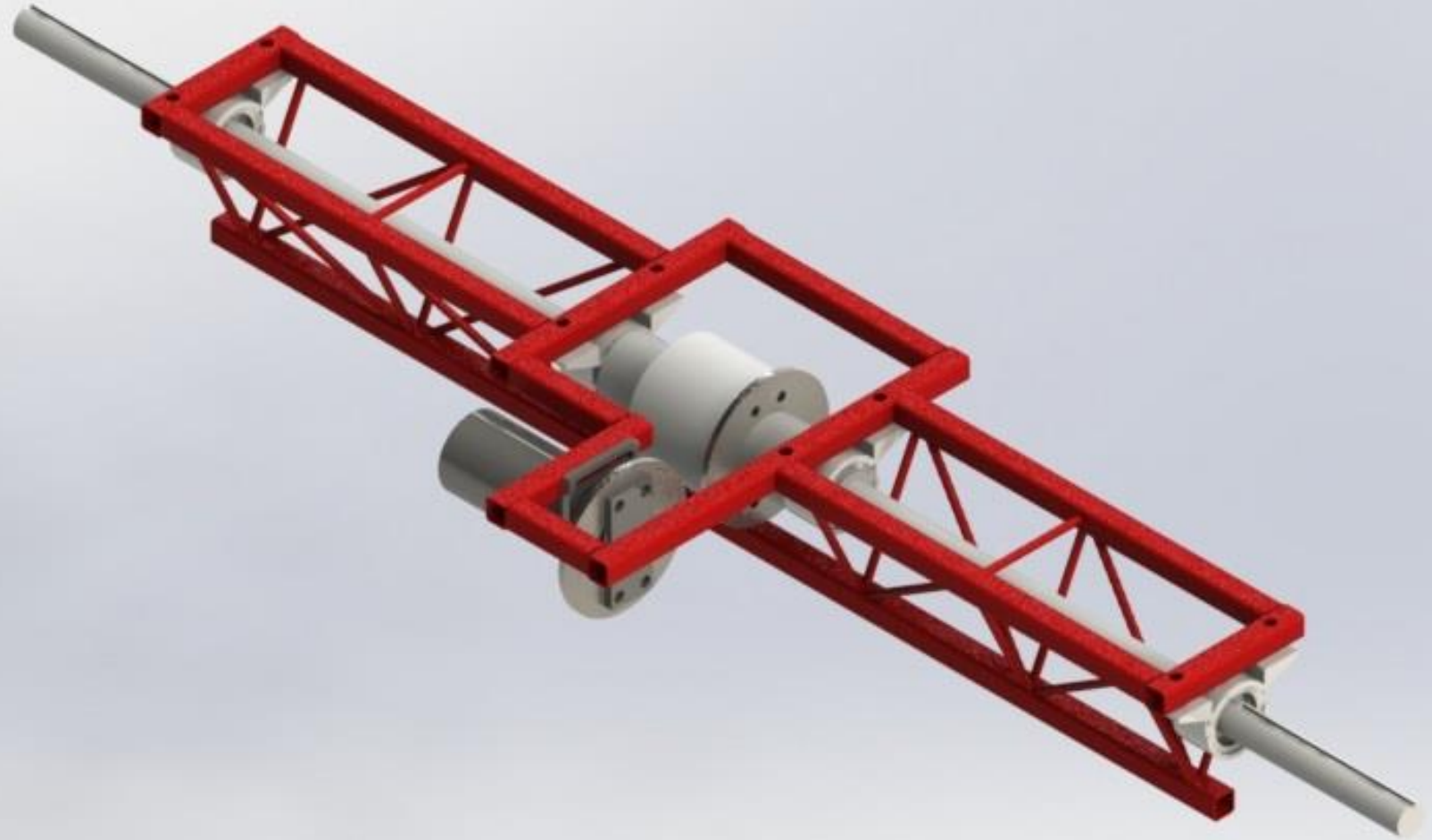
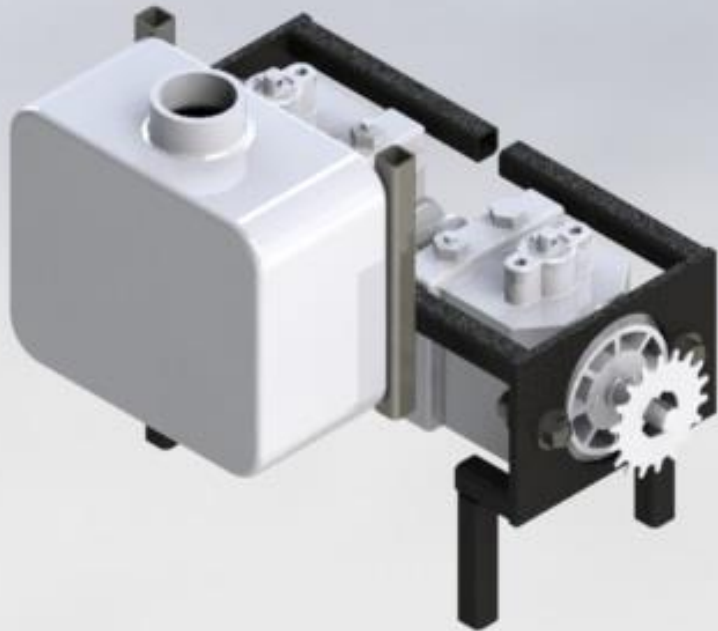


Drive Layout

Front Sprocket Ratio: 1:5.14
Rear Sprocket Ratio: 3:5
Overall Gear Ratio: approx 1:1





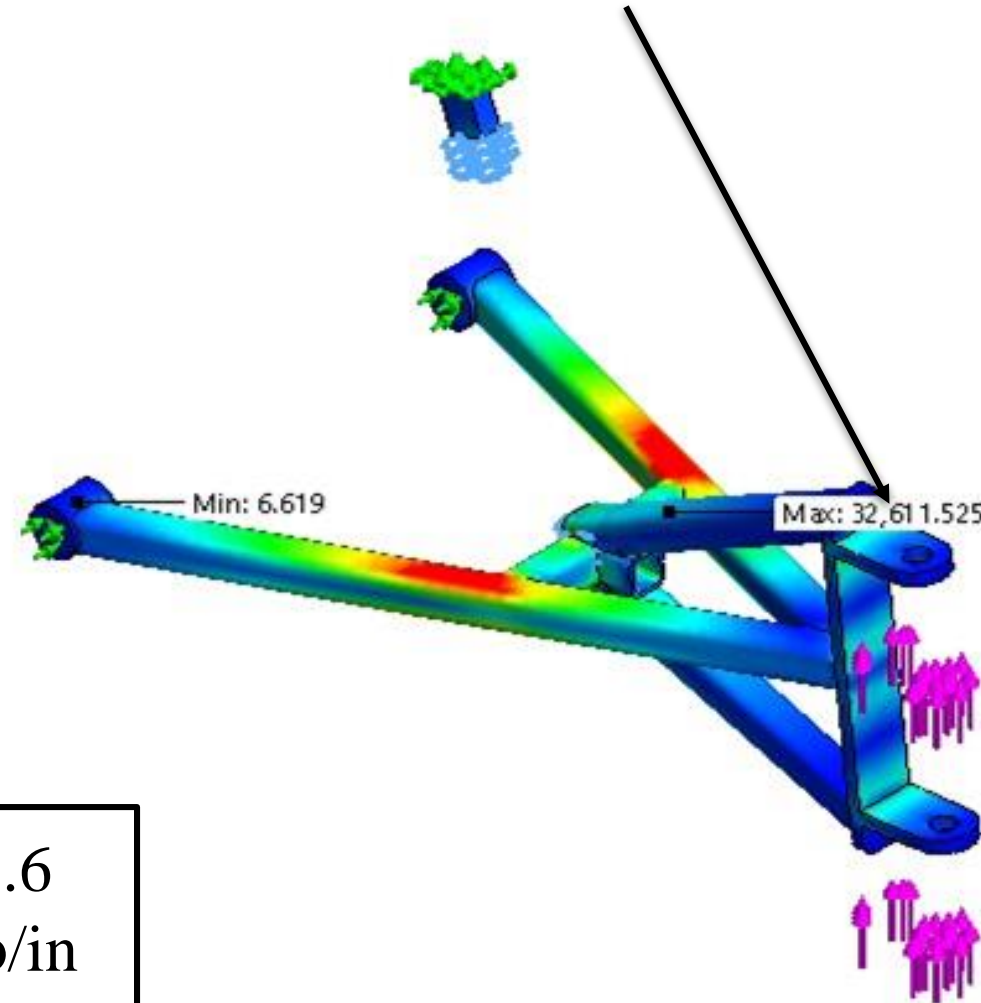


- Target Motor Speed 60 RPM
 - 4.3 mph
- Actual Motor Speed 78 RPM
 - 5.6 mph

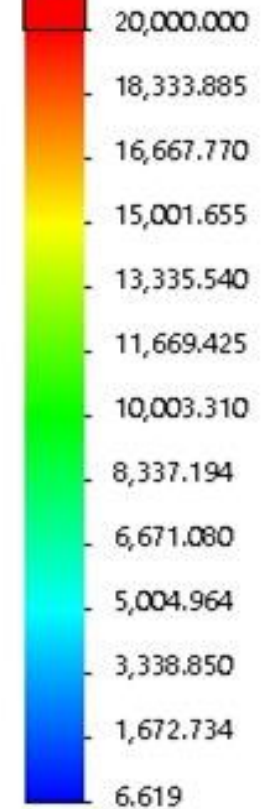
Front Suspension



Max von Mises (psi) 32,611.525



von Mises (psi)

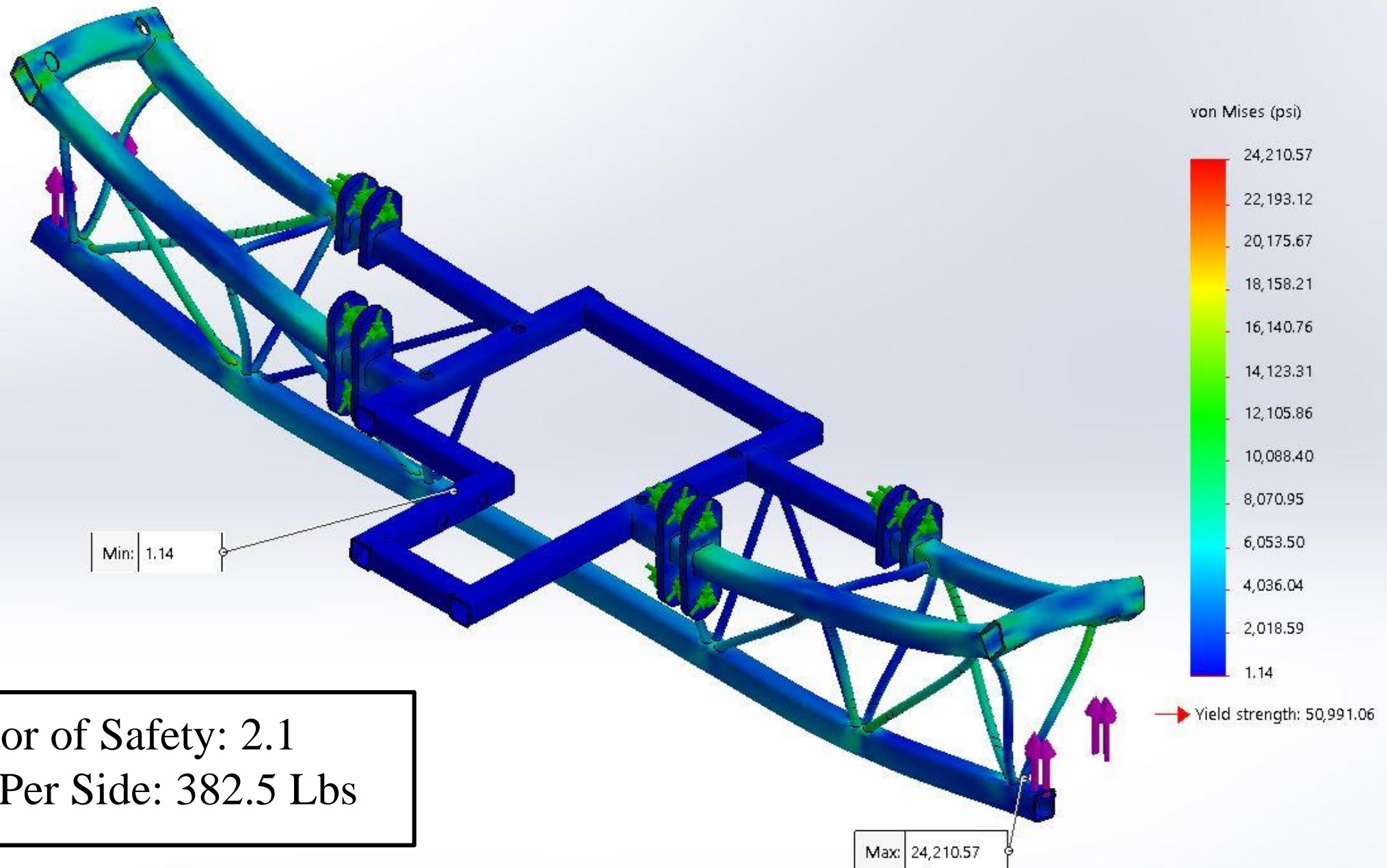


→ Yield strength: 50,991.064

Min Factor of Safety: 1.6
Spring Stiffness: 750 lb/in
Total Loading: 300 Lbs

Rear Suspension





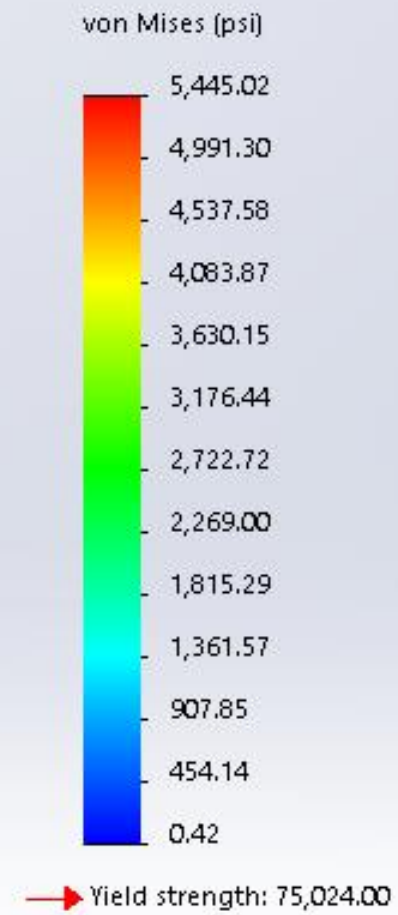
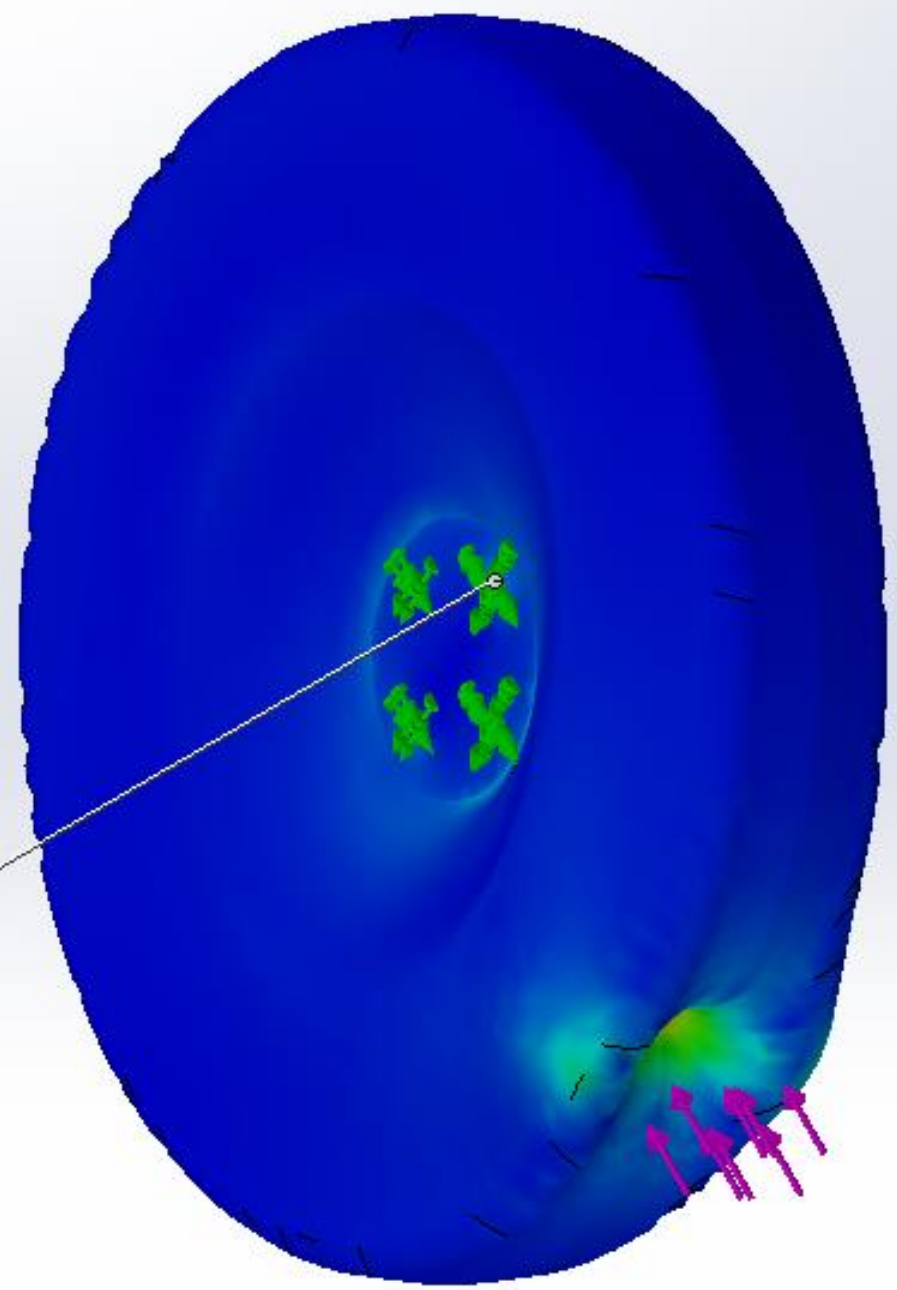
Min Factor of Safety: 2.1
Loading Per Side: 382.5 Lbs

Wheels

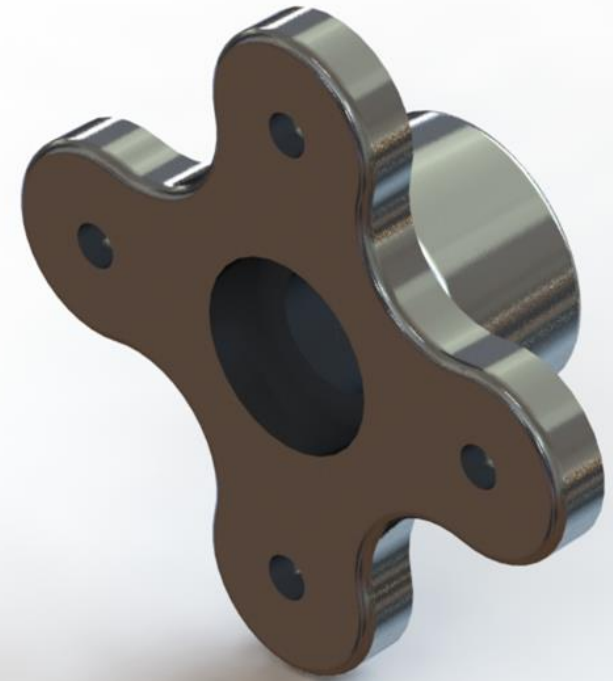


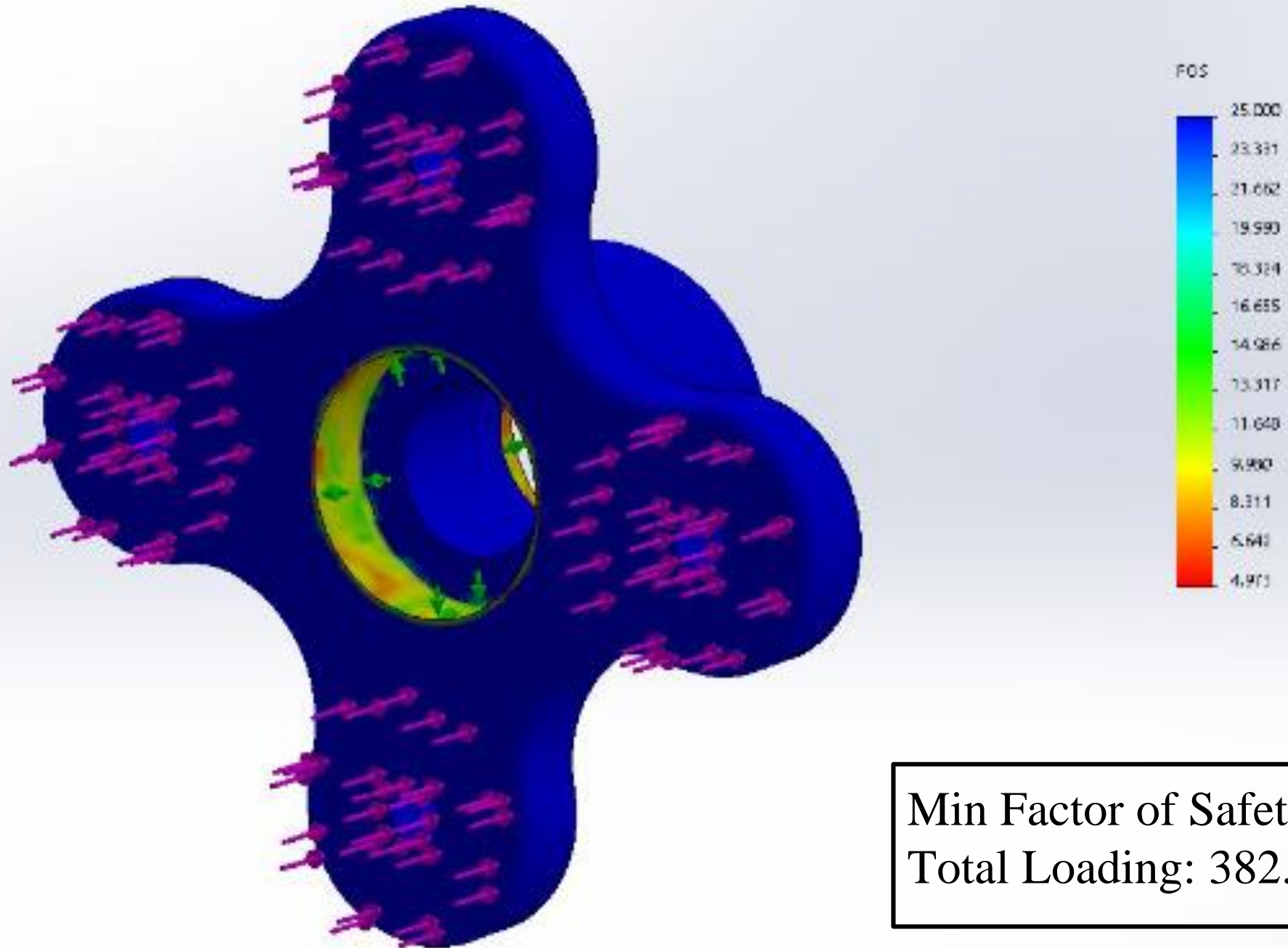
Loading: 382.5 Lbs.
Manual FOS: 13.7
Initial Solidworks FOS:
1.05

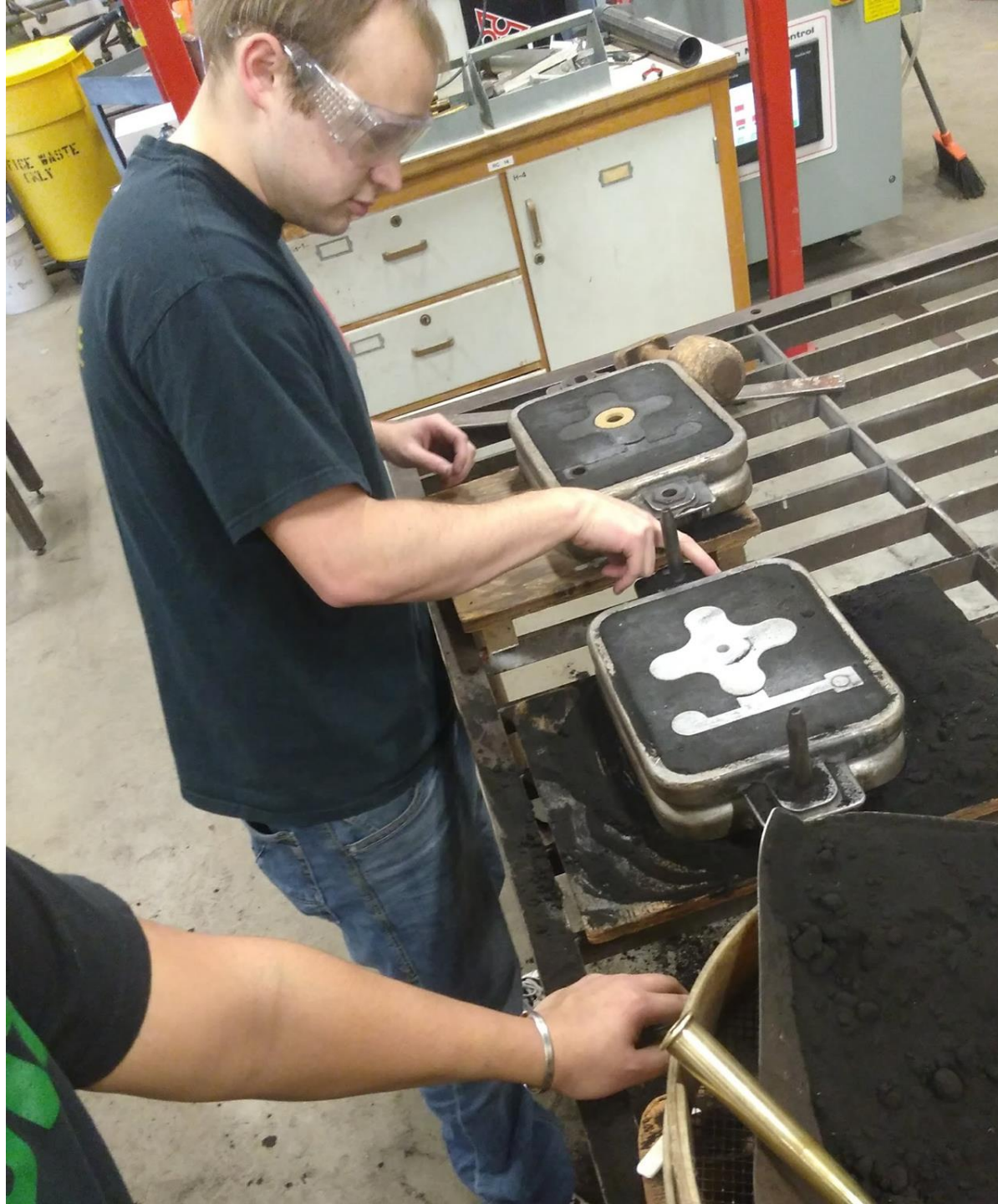
Max: 5,445.02



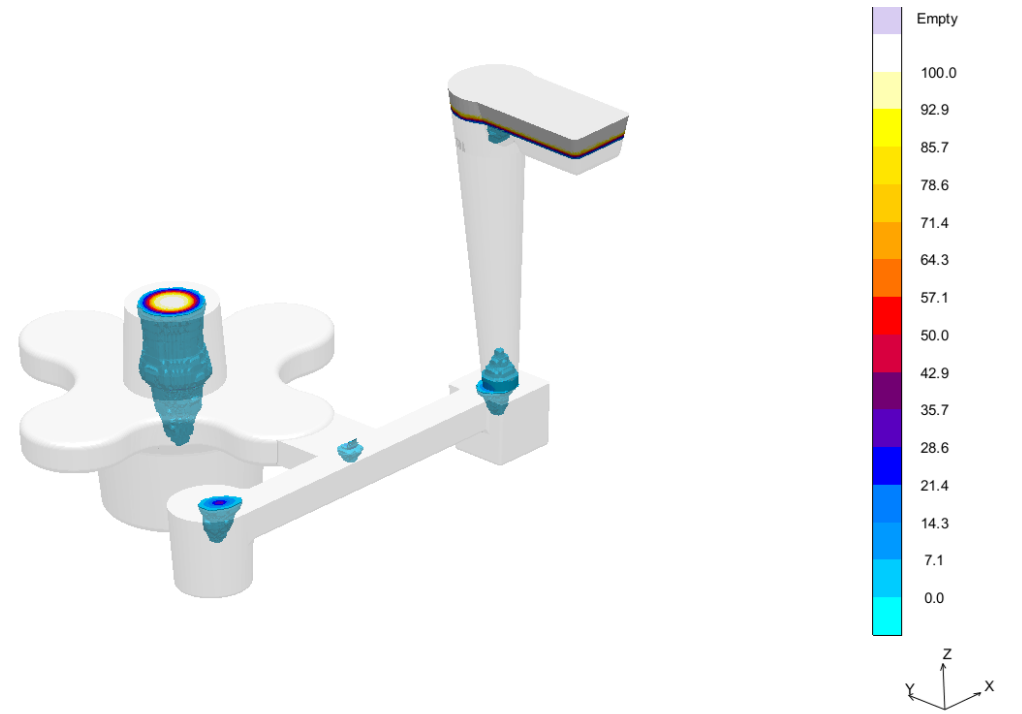
Solution Description (Wheel Hubs)











Steering System



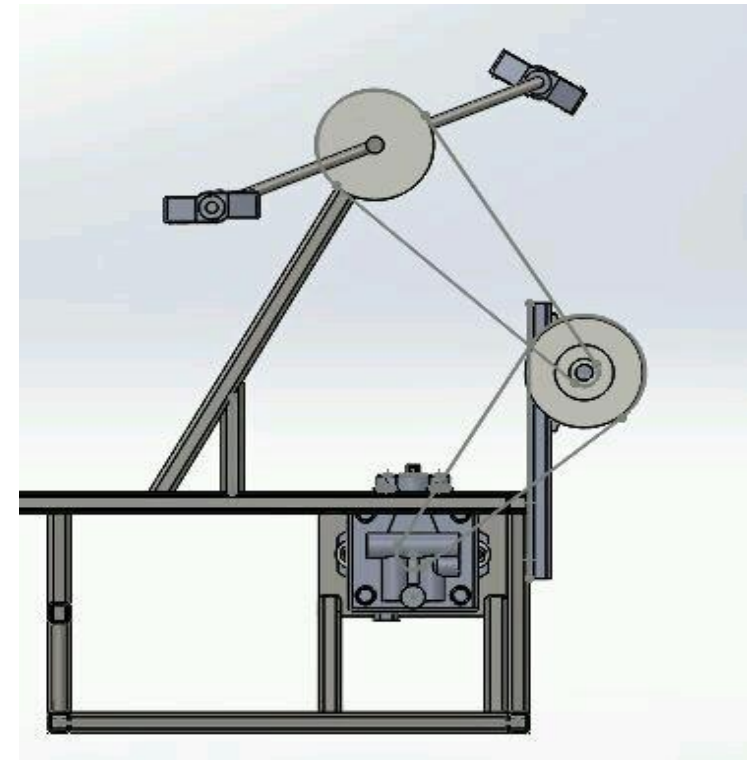
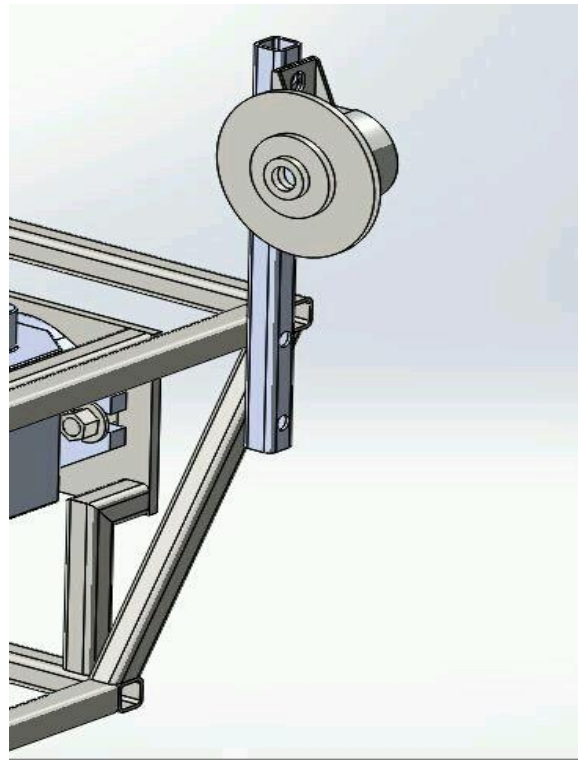
Production Issues (Additional Sprocket)

Problem:

Low Hydraulic Efficiency (250 RPM)

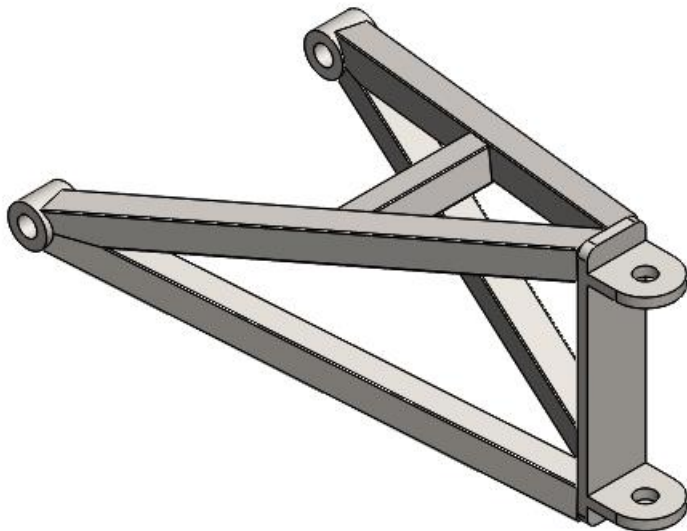
Solution:

Increased Pump Speed to 514 RPM



Production Issues (A-arm Design)

Problem:
Complex Joinery



Solution:
Simplified Geometry



Production Issue (Knuckle Redesign)

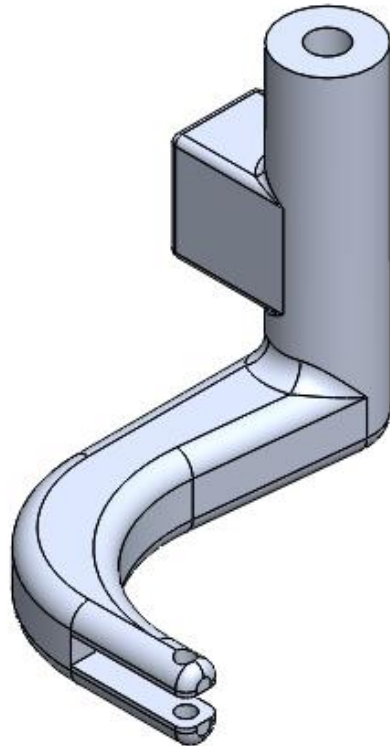
Problem:

Complex Casting Process

Draft Angles

Thick Sections

356 Aluminum

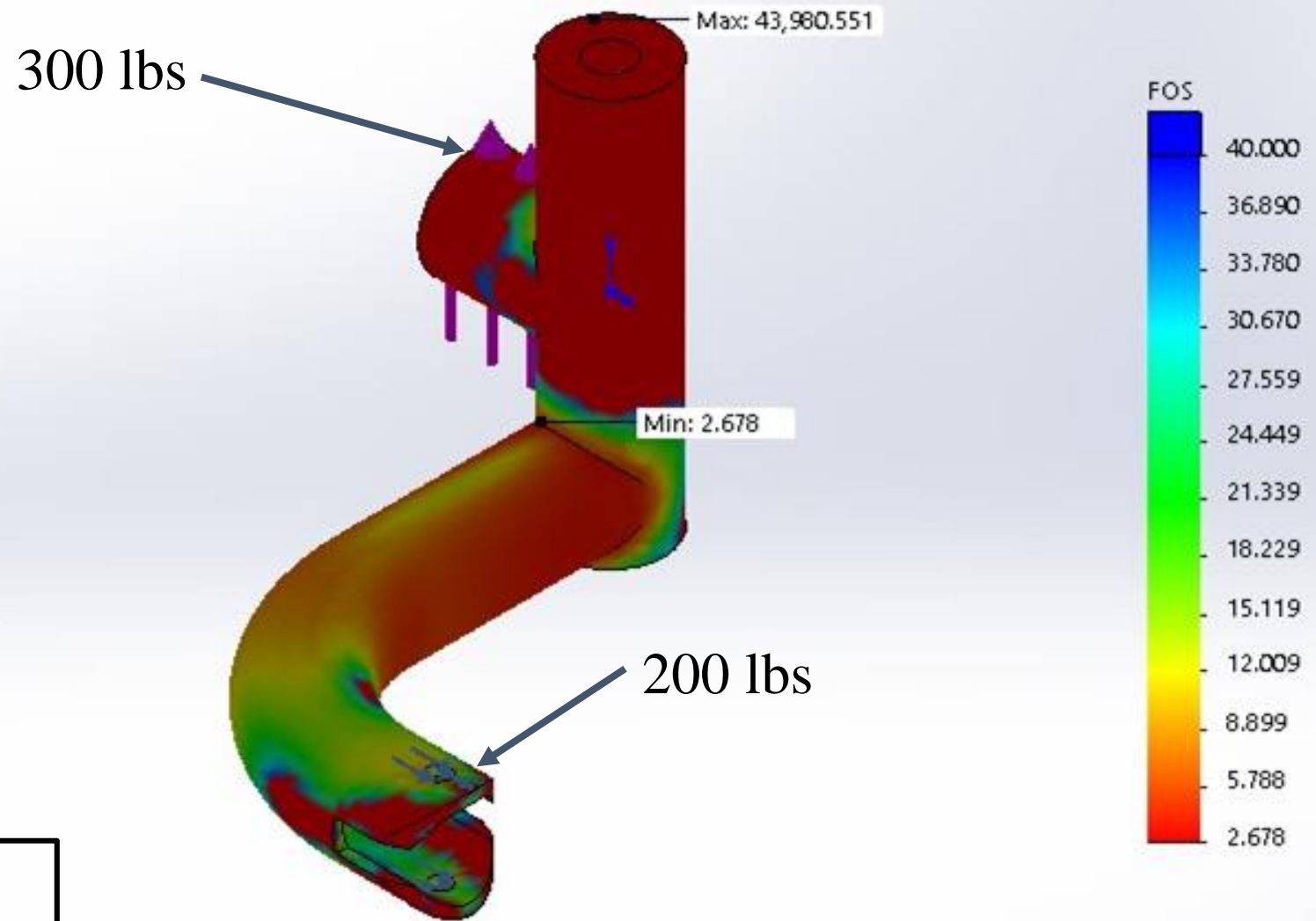


Solution:

Used Available Materials

Mild Carbon Steel



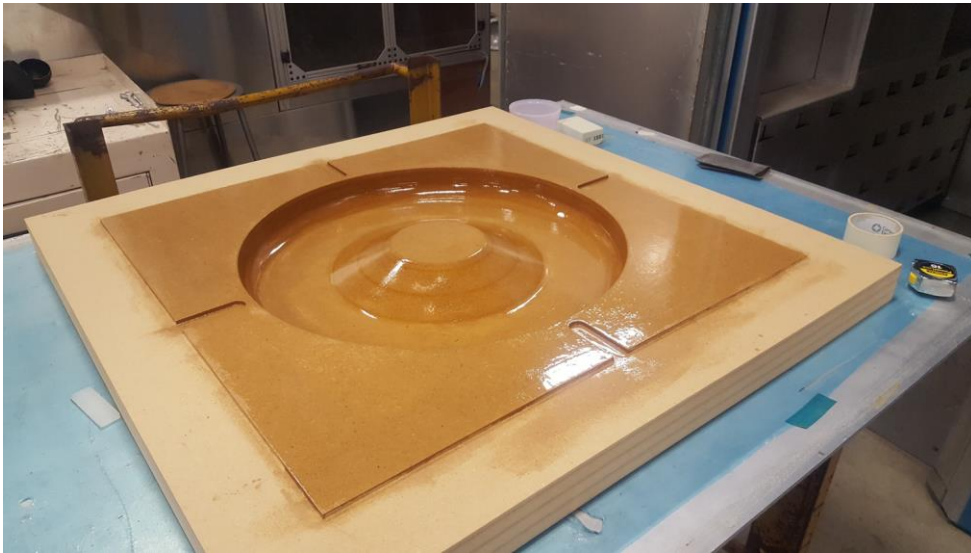


Min Factor of Safety: 2.7

Production Issues (Wheels)

Problem:

Mold Release



Solution:

Material Change

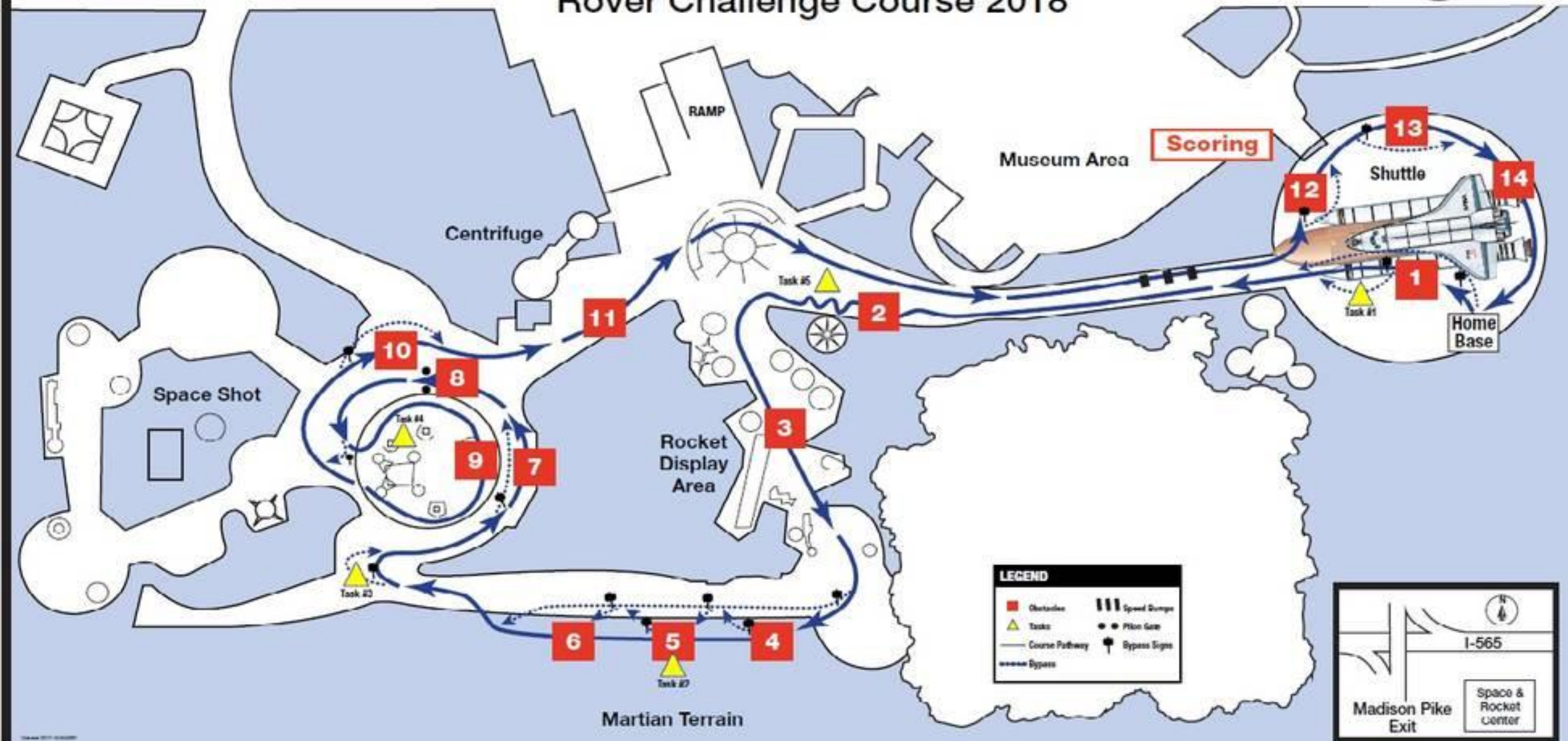


Race Day!



U.S. Space & Rocket Center

Rover Challenge Course 2018



Weigh in and Volume Check

- Weight: 205 lbs
 - 11% Higher than Simulated
- Fits in the 5'x5'x5'



Hydraulic Problem Encountered



Solutions to Problems

- Change Pumps
- 3M Adhesive for Tread
- Gearbox



Final Results

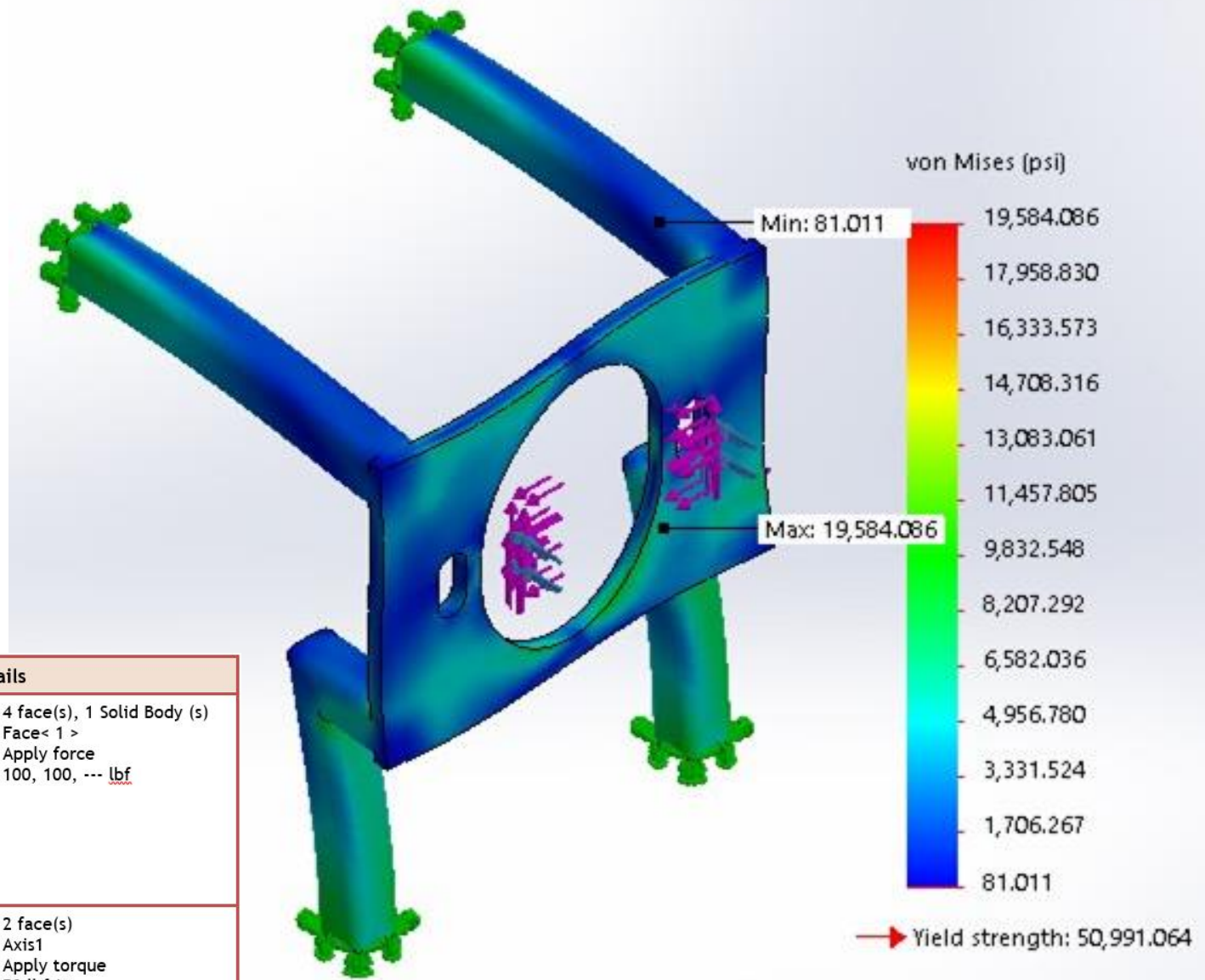
- Place: 39 out of 60
- Total Time: 11:06
- Points Scored: 11

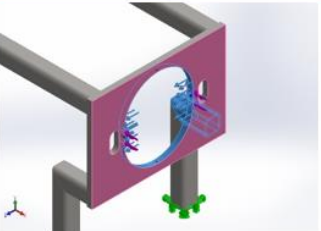
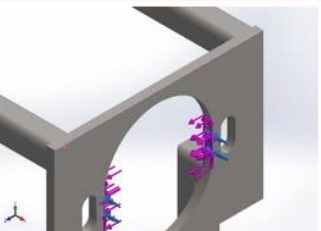
Questions?

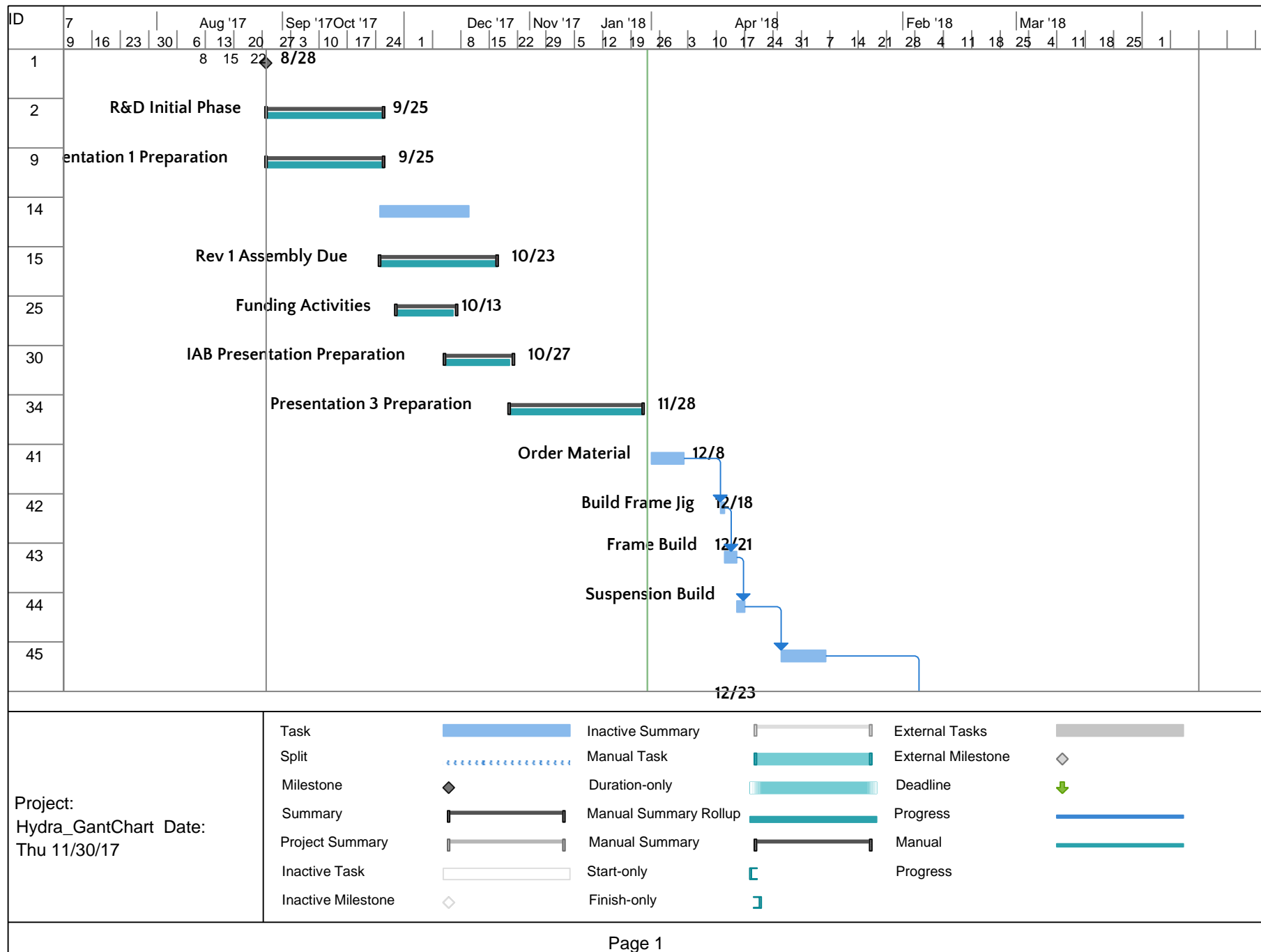
Design Input Table					
D/I (Design Input)	N/I (Nominal Input)	Tolerance	Rationale	Category	Importance
Hold Two Passengers	1 Male and 1 Female	N/A	Nasa Requirement*	CREW RULES	10
Dust Shields	120 in.^2 each wheel	Min	Receive Full Points in Category (1 point)	ERR**	10
National or Institution Flag	Present: Removable for Deployment	N/A	Receive Full Points in Category (1 point)	ERR	10
Solar Powered Instrument	Present: Solar Cell, On/Off Switch, Indicator Light	N/A	Task 3 Requirement	ERR	8
Ability to take Pictures	Present: Camera with Filter	N/A	Task 2,3,4 Requirement	ERR	10
Ground Clearance to Riders	15in.	Min	Nasa Requirement	MRR***	10
Width of Assembled Rover	</= 60in	Max	Nasa Requirement	MRR	10
Fit within Specified Volume Constraint	5' x 5' x 5'	Max	Receive Full Points in Category (4 points)	MRR	10
Assembly / Rider Ready Time	<2min.	Max	Receive Full Points in Category (2 point)	MRR	10
Vehicle Weight	</=170lb.	Max 210lb.	Receive Points in Category (1 to 3 points)	MRR	5
Seat Restraints	One lap strap for Each Driver	N/A	Nasa Requirement	SAFETY	10
Low Center of Gravity	Navigate 30 Degree Slopes Front to Back and Side to Side Without Tipping	Min Angle	Nasa Requirement	SAFETY	10
Personal Protective Equipment (PPE)	Helmet, Gloves, Long Pants, Long Sleeve Shirt and Tennis Shoes with Taped Laces	N/A	Nasa Requirements	SAFETY	7
Safe Design	No sharp edges	N/A	Nasa Requirements	SAFETY	10
Climb Inclined Hill	20 Degree Incline with 4' Height	Min Angle	Obstacle 4	TASK/OBSTACLE	5

Track Completion Time	6 Minutes.	Max 7 Minutes.	Qualify for Award Considerations	TASK/OBSTACLE	10
Overall Factor of Safety	1.5	Min	General Recommendations From EngineeringToolbox.com	TEAM REQUIREMENT	10
Paint	Frame	Min 90%	Presentation	TEAM REQUIREMENT	2
Hydraulic Powered	Present	N/A	Design Challenge	TEAM REQUIREMENT	10
Wheel Weight	7 lbs.	Max 8 lbs.	Advisor Suggestion	TEAM REQUIREMENT	7
Wheel Diameter	27 in.	Max 27 in.	Group Consensus	TEAM REQUIREMENT	8
Human Powered	No stored Energy	N/A	Nasa Requirements	Vehicle Rules	10
Turning Radius	15 ft.	Max	Navigate Min Radius Turn on Course	Vehicle Rules	10
Design Wheels	Student Manufactured	N/A	Nasa Requirements	Vehicle Rules	10
*Not Eligible to Compete if Requirement Not Met (NASA 2018 GUIDEBOOK)					
**Excursion Readiness Review (ERR)					
***Mission Readiness Review (MRR)					

Expenses						
Category	Sub-division	Item	Description	Unit Cost	# Units	Total
Travel/Lodging/food		Travel/Lodging/food	Amount based on previous years costs			\$ 1,200.00
Materials	Body					
		Frame	3/4" Square Tube .065" thick	\$ 0.83	120	\$ 99.60
	Powertrain					
		Pump	Swash Plate	\$ 220.00	2	\$ 440.00
		Motor	Variable Displacement	\$ 140.00	1	\$ 140.00
		Hoses, Connections, Oil	3/16" 500psi assembly	\$ 5.50	15	\$ 82.50
		Axel	4' 10" solid, 1" Thick	\$ 150.00	1	\$ 150.00
	Suspension					\$ -
		Heim joint		\$ 8.00	16	\$ 128.00
		A-Arms	3/4" Square Tube .065" thick	\$0.83	20	\$ 16.60
		Shocks	Spring shock absorber	\$ 22.00	4	\$ 88.00
	Wheels					\$ -
		Resin	Plastics department	\$ 20.00	4	\$ 80.00
		Tread Mold	Plastic material	\$ 30.00	1	\$ 30.00
	Steering					\$ -
		Links	3/4" Square Tube .065" thick	\$0.83	20	\$ 16.60
		Pins	3/8" Steel	\$ 1.00	10	\$ 10.00
		Steering Bar	3/4" Square Tube .065" thick	\$ 0.83	2	\$ 1.66
		Connecting Hub	Aluminum Casting	\$ 0.60	10	\$ 6.00
		Steering Plate	Aluminum Casting	\$ 0.60	3	\$ 1.80
	Seats, Straps, and pedals					\$ -
		Frame	3/4" Square Tube .065" thick	\$ 0.83	10	\$ 8.30
		Fabric	Polly Mesh	\$ 5.00	10	\$ 50.00
		Safety Straps	Go-Kart seat-belt assembly	\$ 25.00	2	\$ 50.00
		Pedal Assembly	Steel bike pedal assembly	\$ 25.00	2	\$ 50.00
	Tools					\$ -
		Scoop	Cast Aluminum	\$ 0.60	2	\$ 1.20
		Flag pole	Cast Aluminum	\$ 0.60	5	\$ 3.00
		Flag	Pitt State	\$ 10.00	1	\$ 10.00
	Support Materials					\$ -
		Ply Wood	3/4" sheet	\$ 20.00	1	\$ 20.00
		Wood	2" x 4" x 8'	\$ 30.00	1	\$ 30.00
		screws	3" Deck, box of 250	\$ 40.00	1	\$ 40.00
	Materials Subtotal					\$ 1,553.26
Team Polos/Logos		Team Polos/Logos	Pitt State colors with team name and sponsor logos			\$ 200.00
Total						\$ 2,953.26



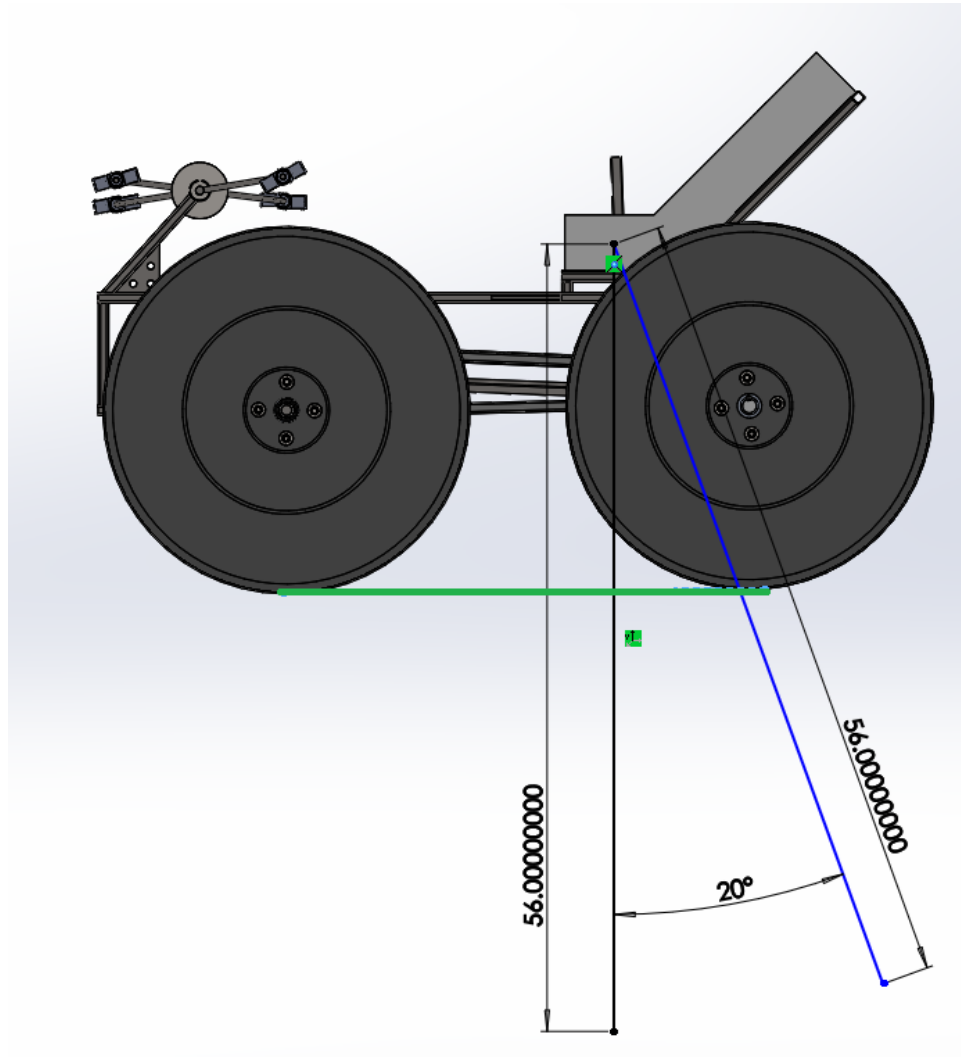
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Force-1		Entities: 4 face(s), 1 Solid Body (s) Reference: Face< 1 > Type: Apply force Values: 100, 100, --- lbf
Torque-1		Entities: 2 face(s) Reference: Axis1 Type: Apply torque Value: 50 lbf.in



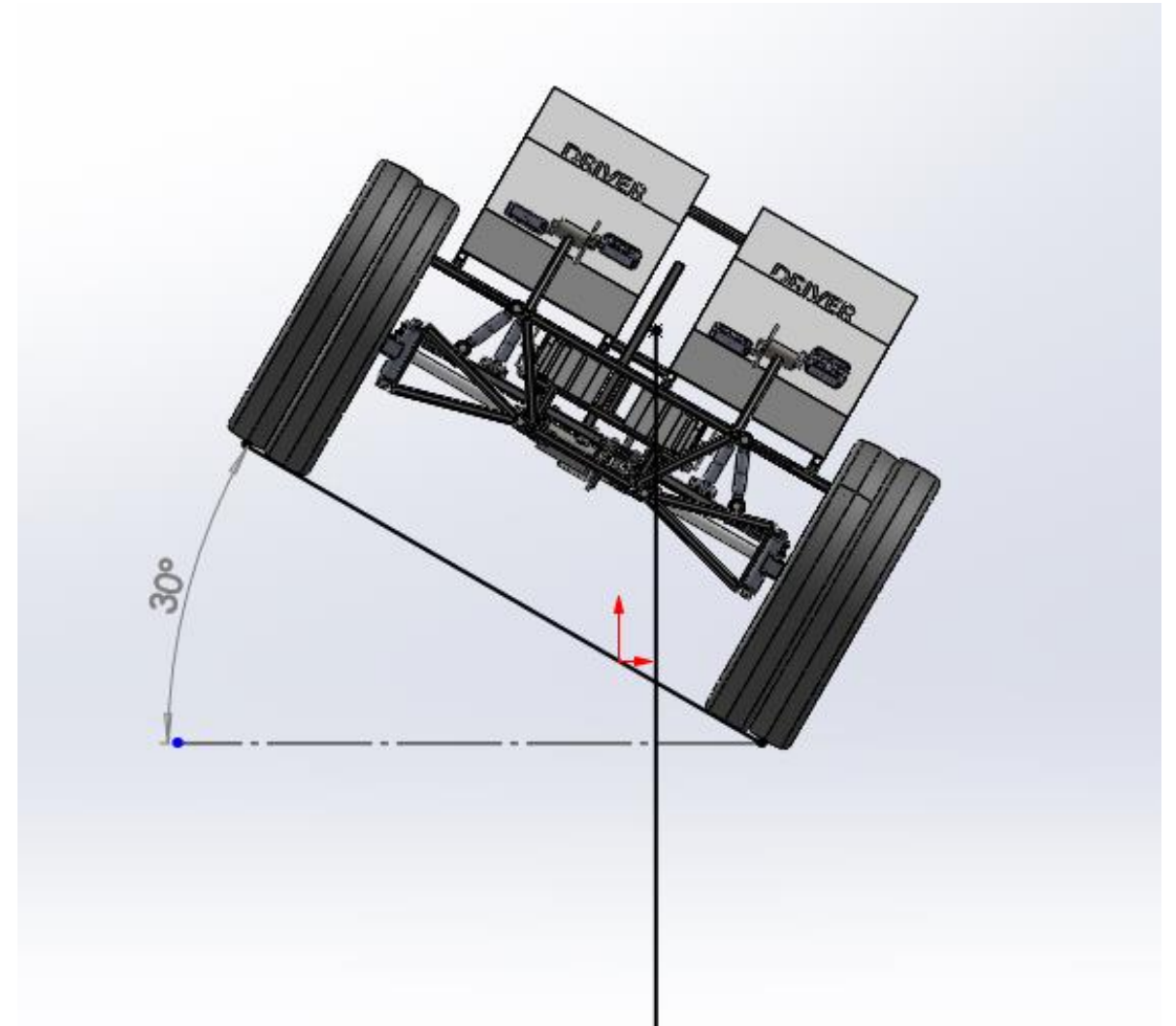
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46																							Steering Build 2/9																			
47																							Mounting gears & Hydraulics 2/16																			
48																							Hub 2/5																			
49																							2/16																			
50																							Photo Of Completed Rover Due At NASA 3/9																			
51																							NASA Human Exploration Rover Challenge																			
								Task				Inactive Summary												External Tasks																		
								Split				Manual Task												External Milestone																		
Project: Hydra_GantChart Date: Thu 11/30/17								Milestone				Duration-only												Deadline																		
								Summary				Manual Summary												Progress																		
								Project				Rollup Manual												Manual																		
								Summary				Summary												Progress																		
								Inactive Task				Start-only																														
								Inactive Milestone				Finish-only																														
Page 2																																										

Stability Test

@ Pitch = 20deg



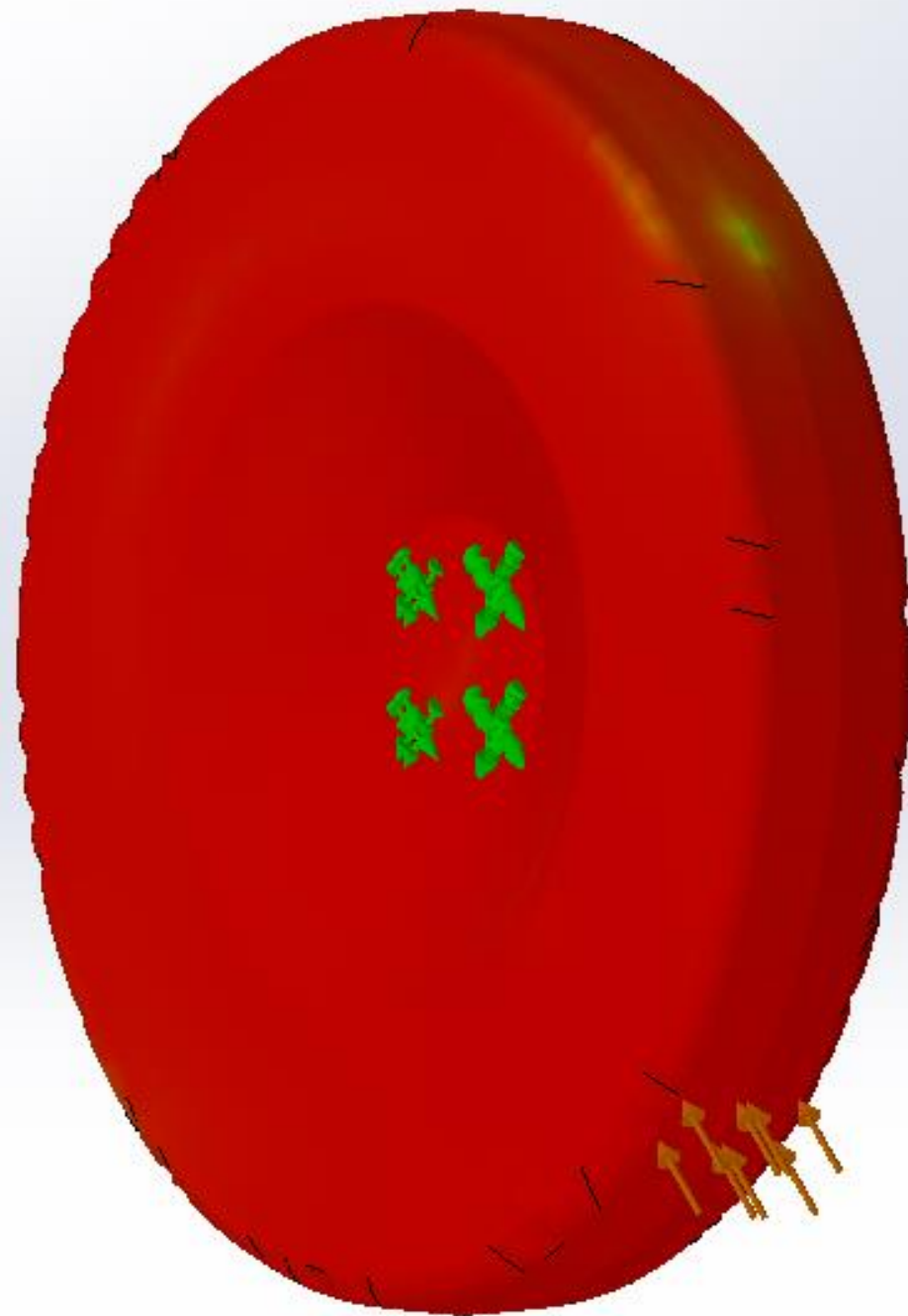
@ Roll = 30deg











FOS

