2016-2017 SAE Baja Design/Manufacturing Project

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Azmi Awari	(MECET, Design Emphasis)
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Introduction to SAE (Society of Automotive Engineers) Baja Competition-2017

- Four day long competition (May 25th to 28th)
- Hosted by Pittsburg State University
- Multidepartment project (MECET, Automotive Technology)

Components of the Event

- Inspection
- Dynamic Event
- Endurance Test
- Design Finals

Problem Statement

- Car that can function pass SAE inspection
- Strategic car that perform well during the competition
- Meet the budget requirement

Material For The Tubing

Material: ASTM A36 Steel	Yield Strength: Min. 36,000 psi Tensile Strength: 58,000 – 80,000 psi

The reason behind using this material?

Frame

Consideration for manufacturing phase:

- SAE Guideline
- Design compatibility

Manufacture Tools

CHOP SAW

STEEL BURR

BURR REMOVAL

Manufacturing Tools

BURR REMOVAL AND SCUFFING

MILLING MACHINE

Created By Mohannad Gazzaz

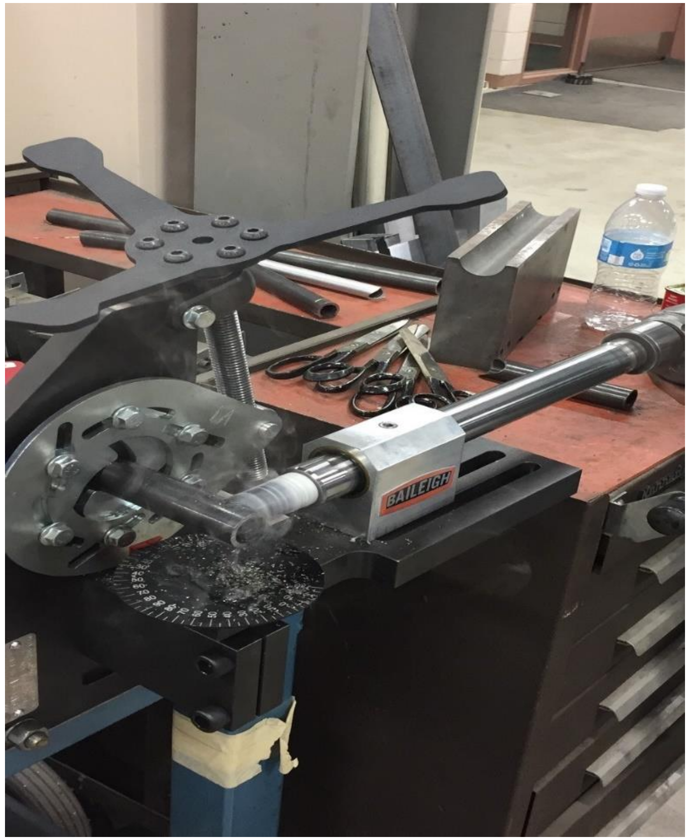
Manufacturing Tools

BENDING MACHINE

WELDING MACHINE

Created By Mohannad Gazzaz

Manufacturing Tools



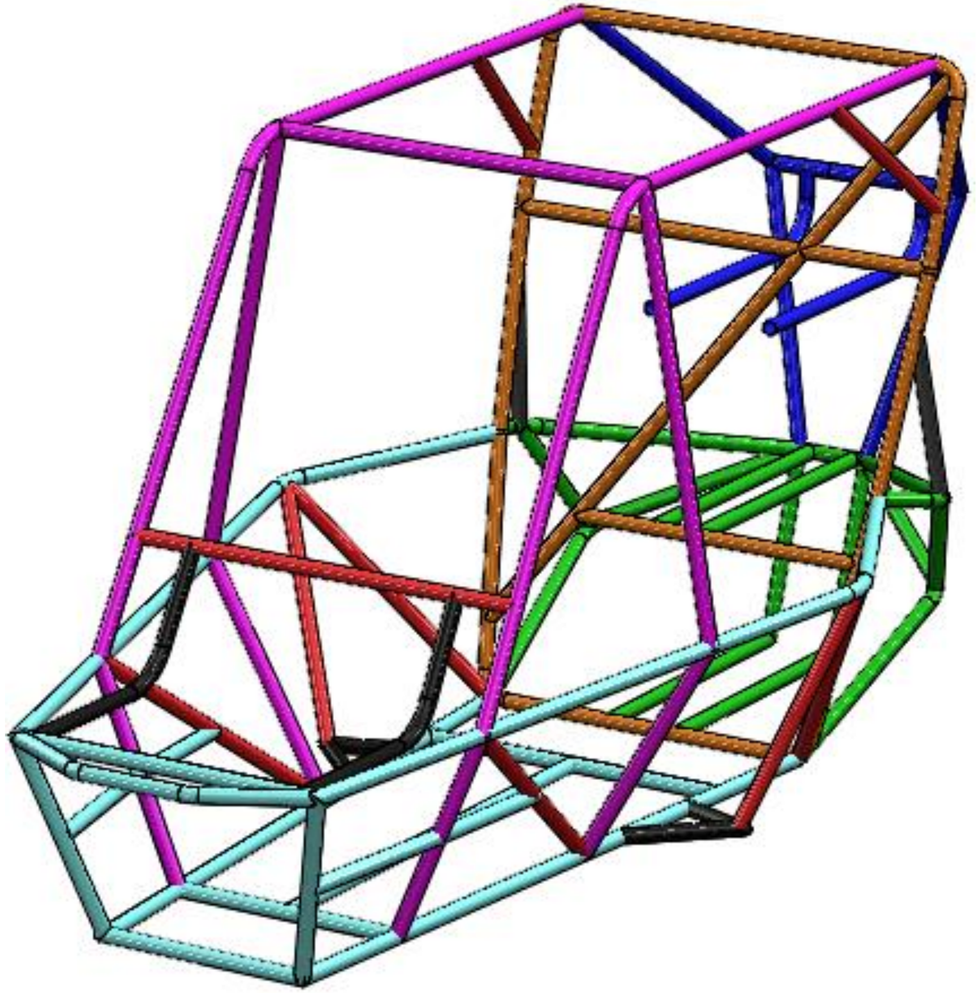
TUPING COPING

WATER JET

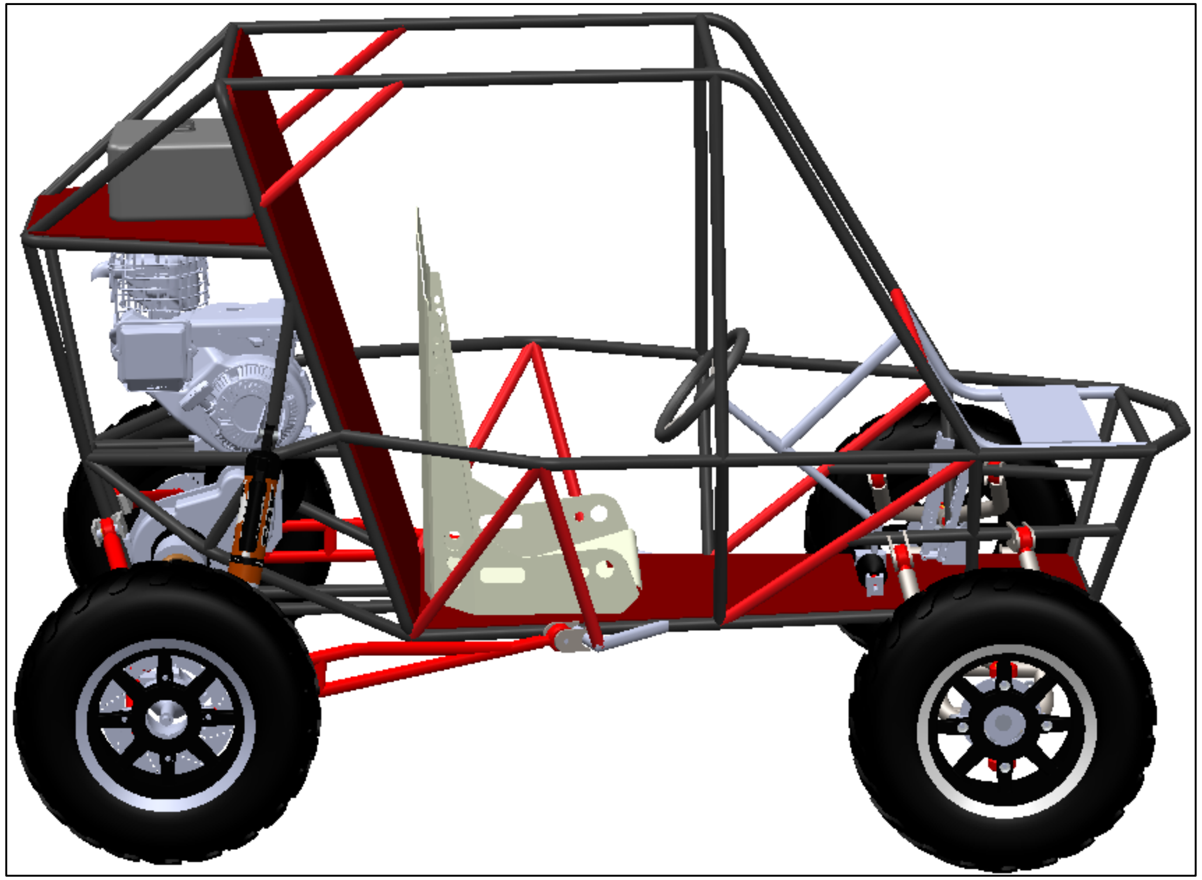
Frame Length, Height, and Width

Objective	Outcome
Maximum of 108 inches in length	91 inches
Height is based on the driver	60 inches
Maximum of 64 inches in width	59 inches

Frame Height and Width



Frame Length:



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SAE Baja Suspension

- Overview
  - Definition

    Suspension is the term given to the system of shock absorbers and linkages that connects between a vehicle and its wheels.
  - Purpose:
    - to keep the wheel in contact with the road surface as much as possible
    - to protect the vehicle itself from damage
    - to keep the driver as isolated possible from bumps and vibrations

Front Suspension

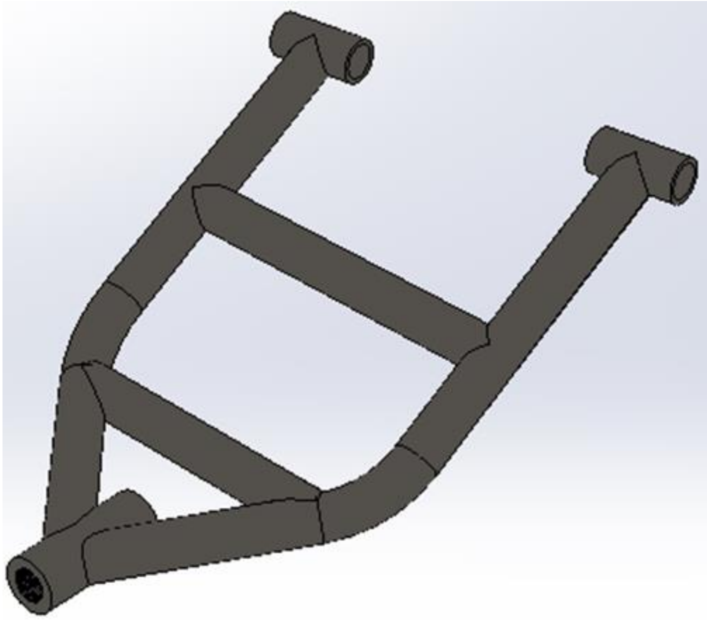
- Objectives

Objective	Outcomes
8 inches' suspension travel (minimum)	✓Complete
No more than 64-inch distance between front wheels (maximum)	✓Complete
15 inches' front clearance (maximum)	✓Complete
Compatible dimensions for A-arms design	✓Complete
Design and fabricate new suspension system	✓Complete

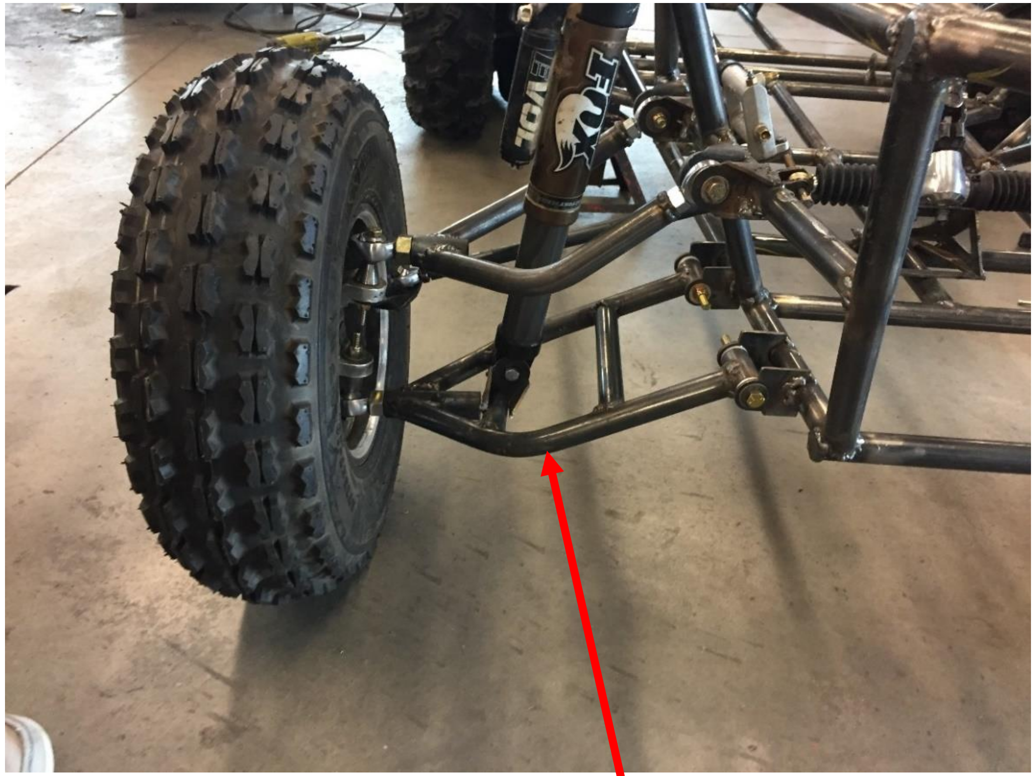
Front Suspension

- Design phase of the front suspension
  - A-arm suspension
  - Mounting tabs or brackets
  - Nylon solid stock inserts
  - Steel heim joint inserts
  - Knuckle spacer
- Material:
  - ASTM A36 Steel Pipes
  - Nylon

Front Suspension Outcomes

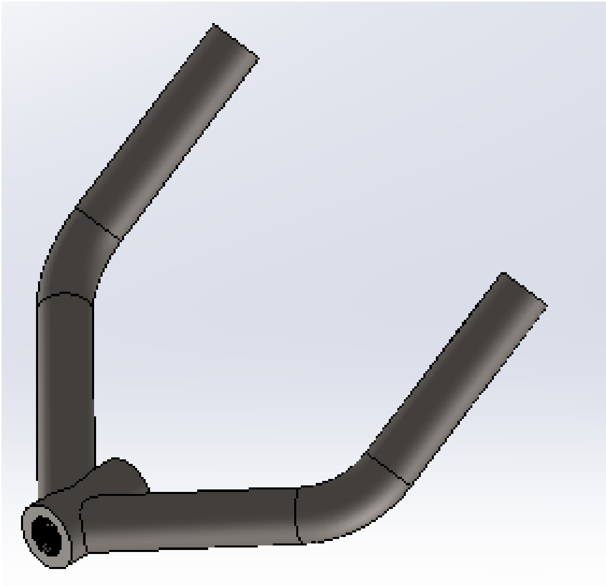


Lower A-arm on SolidWorks

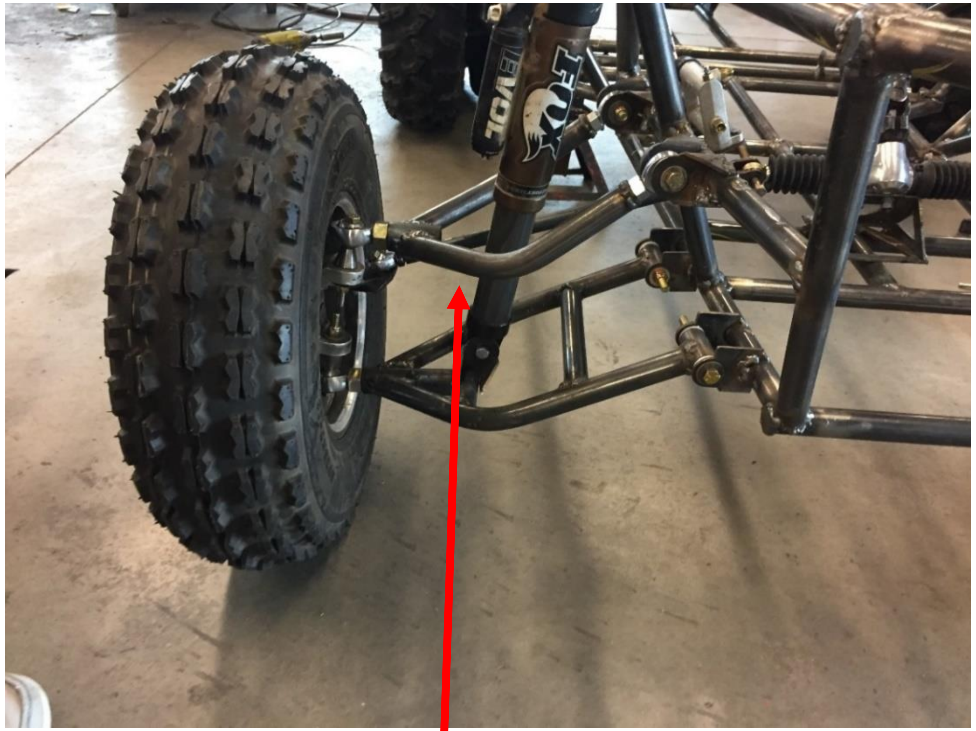


Lower A-arm

Front Suspension Outcomes

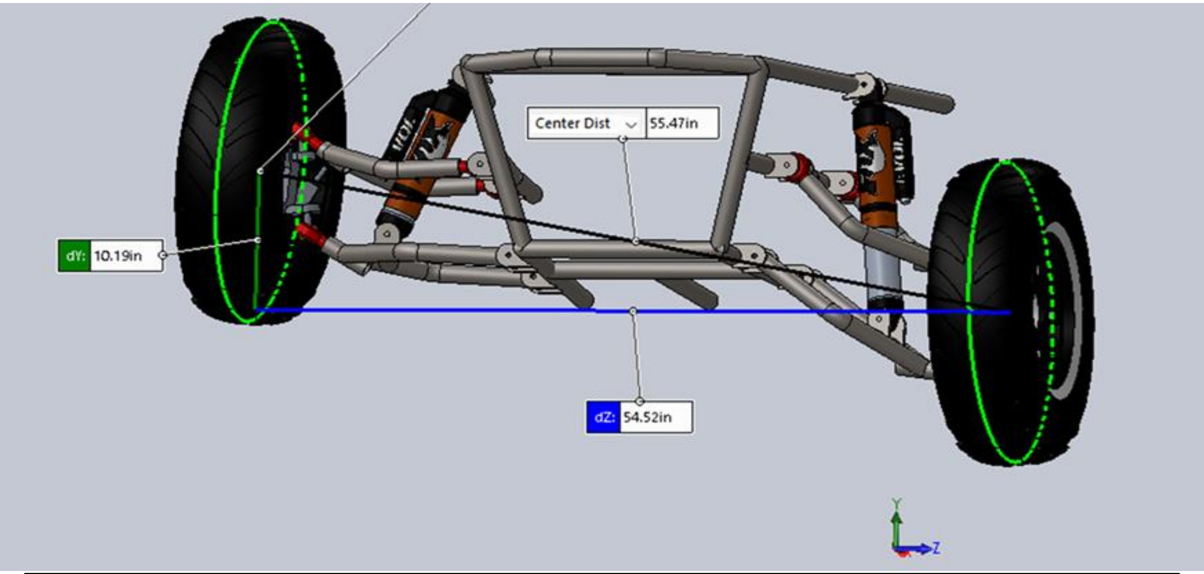


Upper A-arm on SolidWorks



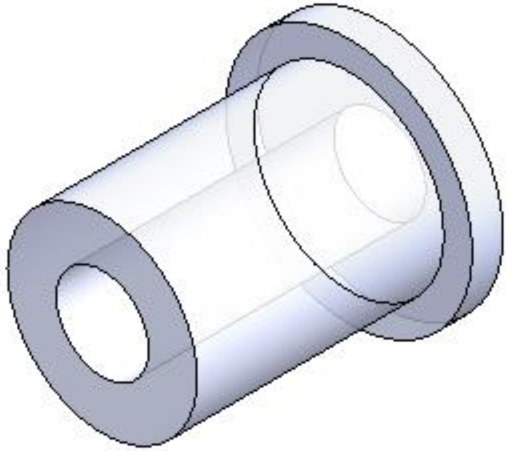
Lower A-arm

Front Suspension Outcomes



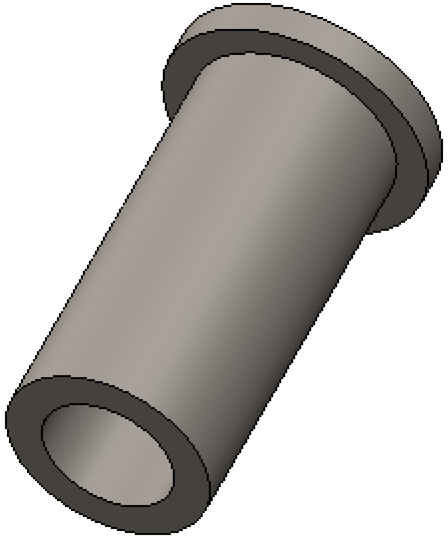
a) Suspension travel is almost 9 inches (8 inches min.)
b) Distance between front wheel is 59 inches (64 inches max.)
c) Front suspension clearance is 15 inches (max.)

Front Suspension Outcomes



Nylon solid stock inserts
on SolidWorks

Front Suspension Outcomes

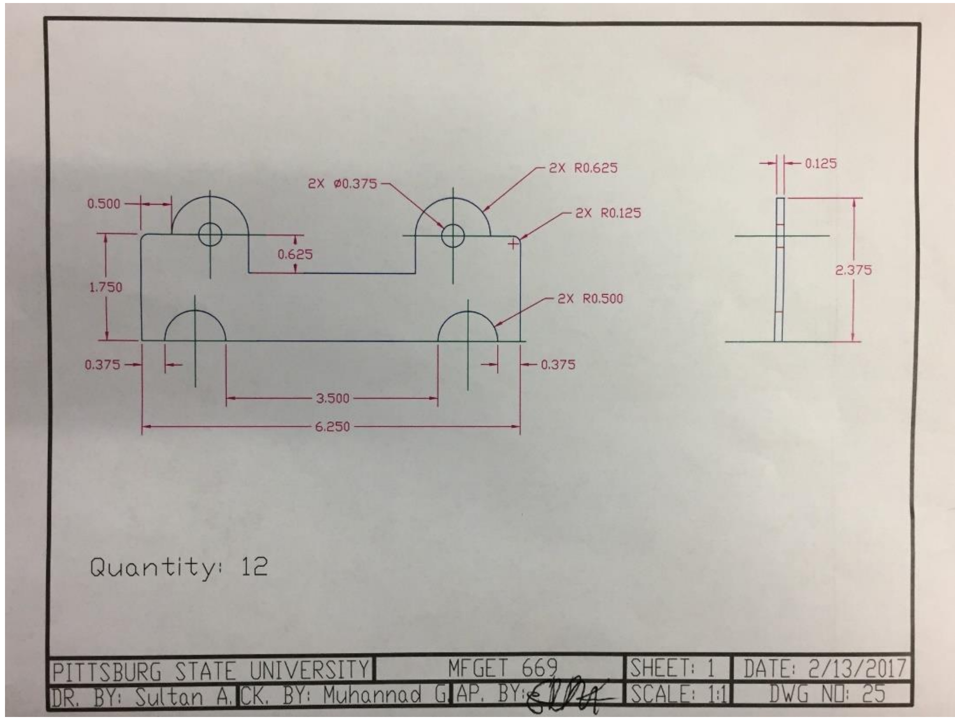


Steel heim joint inserts on SolidWorks

Steel insert

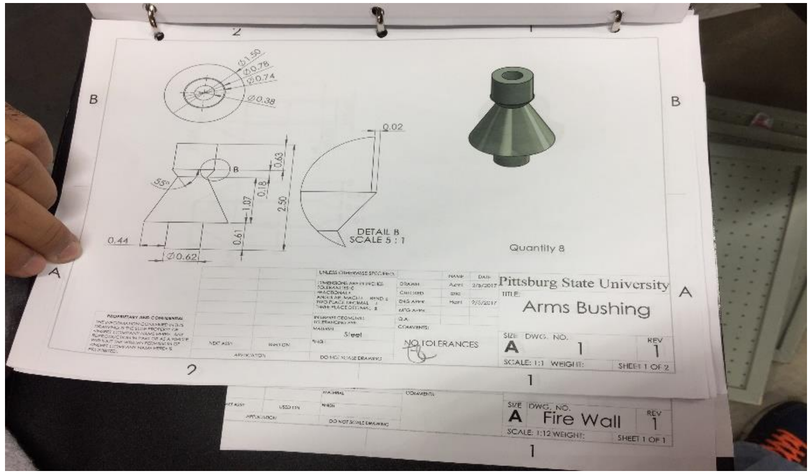
Created By Sultan Alshammari

Front Suspension Outcomes

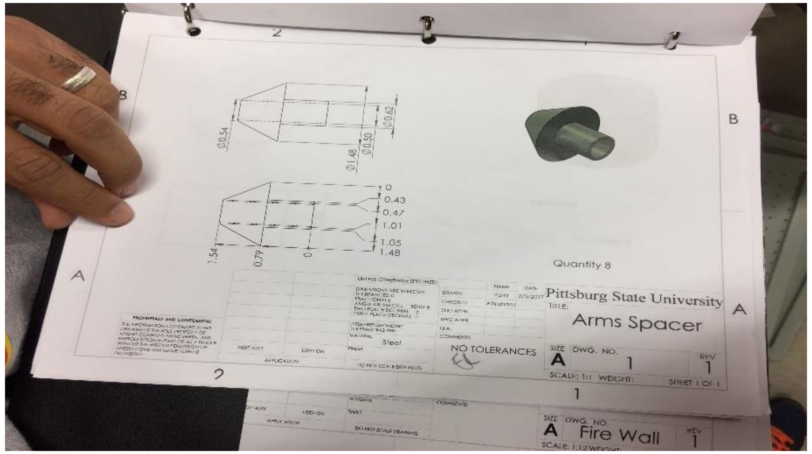


Mounting tabs or brackets (water jet)

Front Suspension Outcomes



Knuckle spacer_ designed by Azmi Awari



Knuckle head spacer_ designed by Azmi Awari

Knuckle spacer

Created By Sultan Alshammari

Rear Suspension

Three Links Arms:

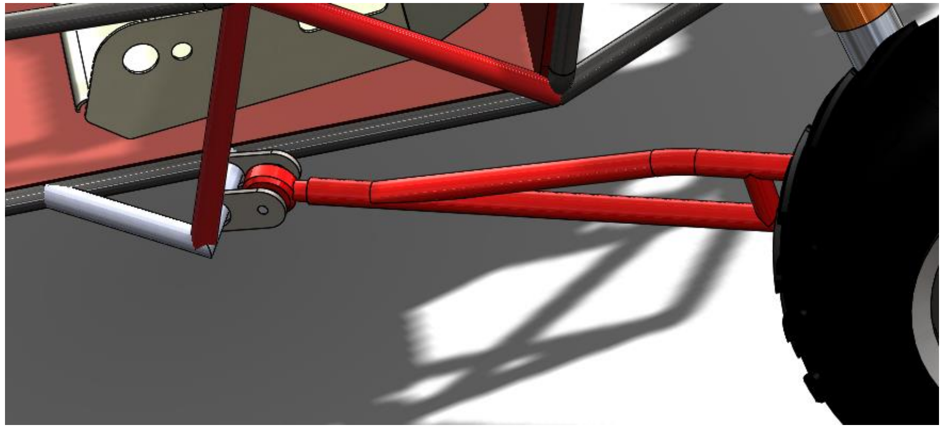
- Purpose?
- What is the goals?

Rear Suspension

- How to link it to the frame?

The angle shape at the middle of the frame will

be Used to link the trailing arm.



Rear Suspension

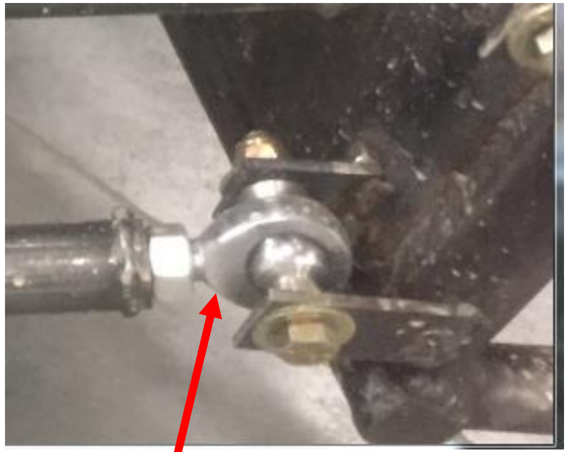
- Manufacture process:

Purchase Parts:

- 2off road Tires
- 2 Knuckles
- 2 Shafts
- 2 Fox Racing shocks
- 2 Hubs
- 10 Heim joints

Fox shock

Knuckle



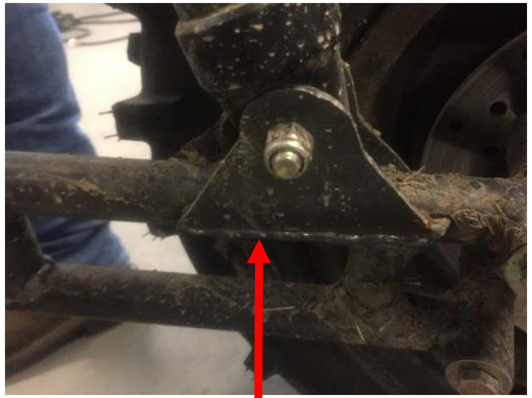
Heim joints

Rear Suspension

- Manufacture process:

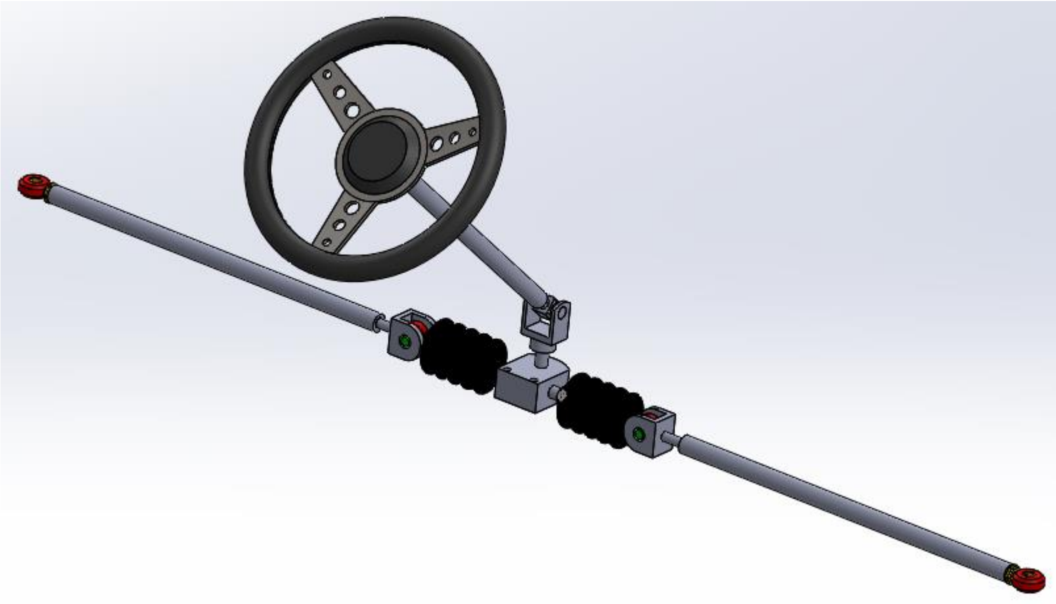
Parts made in the shop:

- 2 Trailing Arms(24”)
  (ASTM A36 Steel)
- 4 Shock mount Brackets
  (ASTM A36 Steel)
- 4 Support arms (17”)
  (ASTM A36 Steel)
- 10 Heim inserts
  (ASTM A36 Steel)



Steering System

- Purpose
  - To control the direction of the vehicle direction by turning the front wheels.



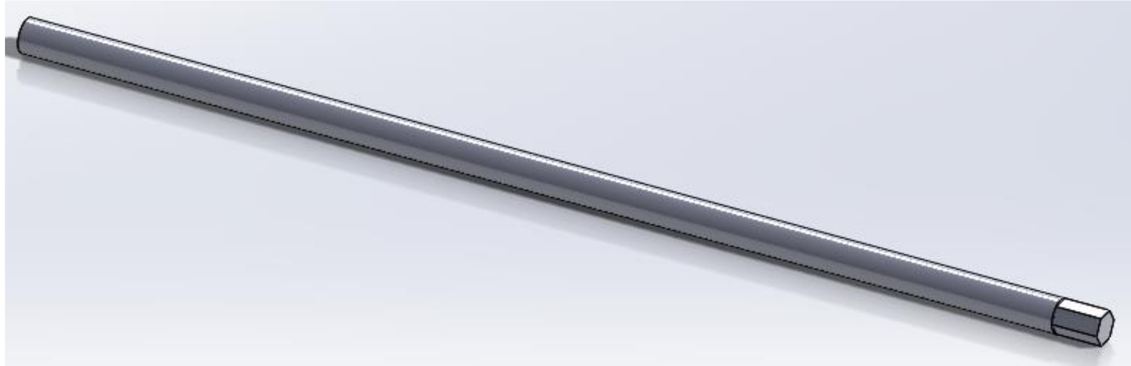
Steering System

- Component Parts

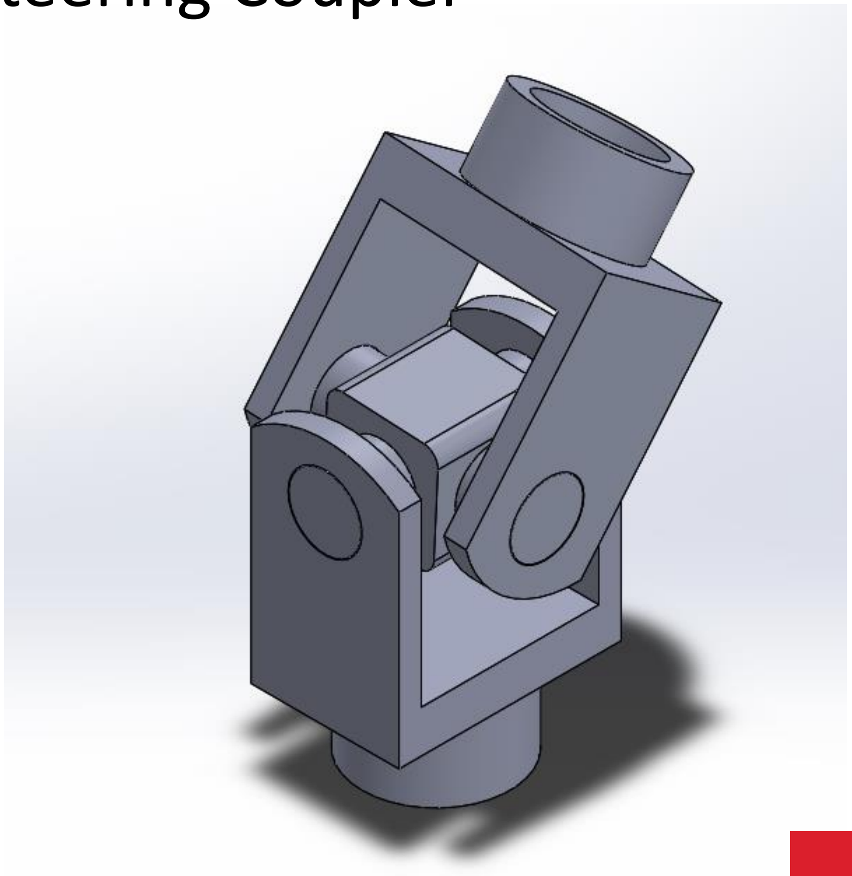
  - Steering Wheel Handel

Steering System

- Steering Shafts



- Steering Coupler



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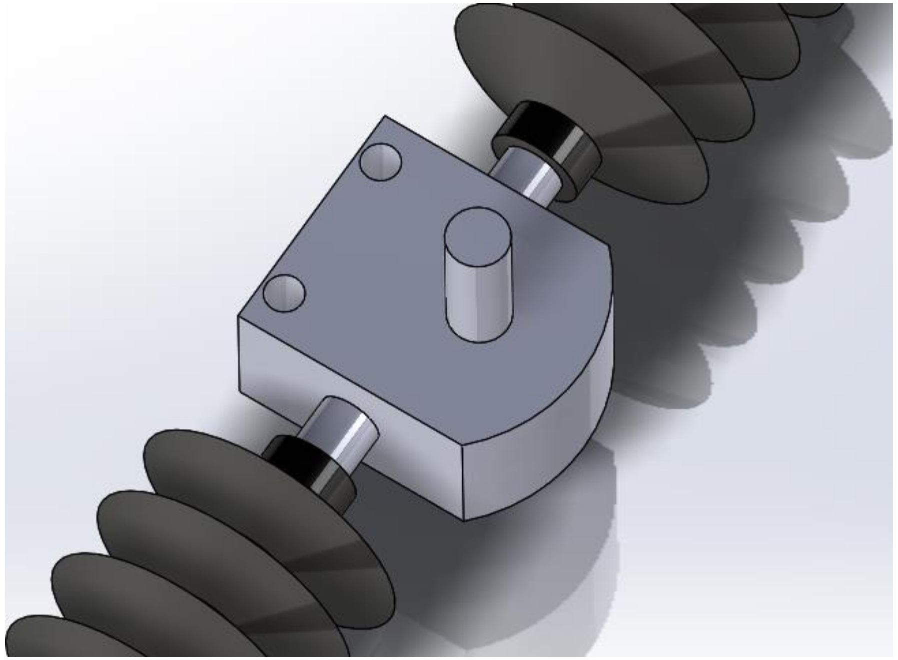
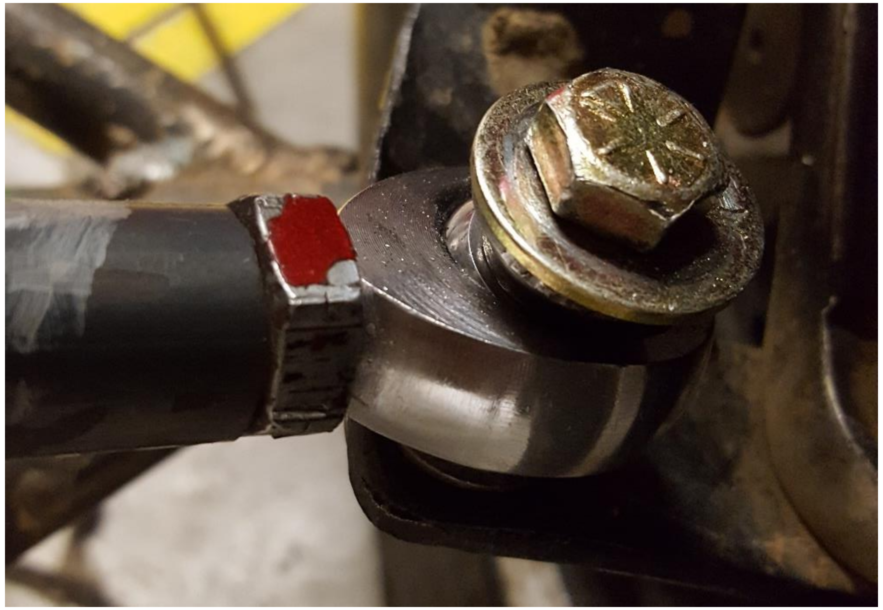
Steering System

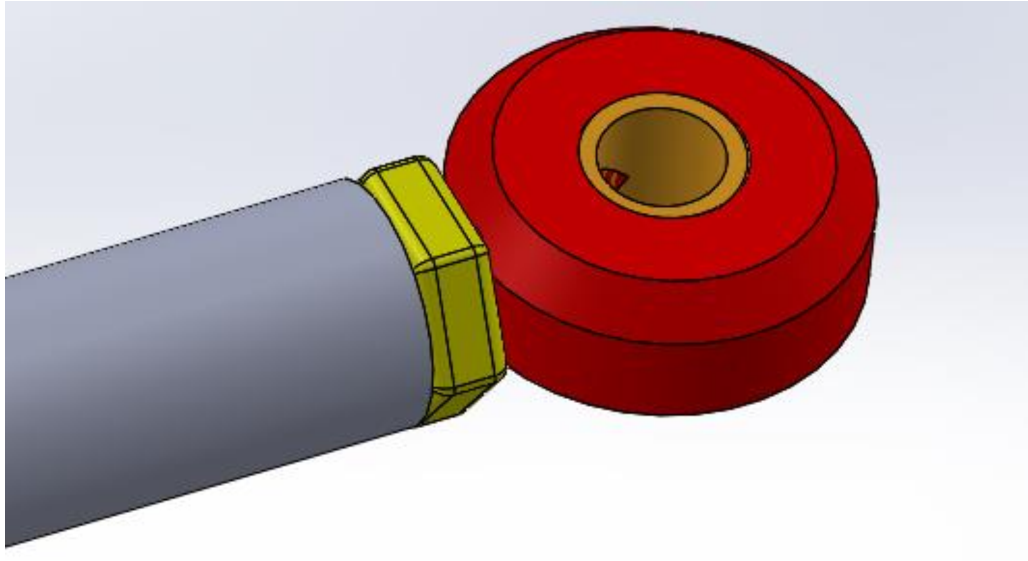
- Rack and pinion & steering boot



Steering System

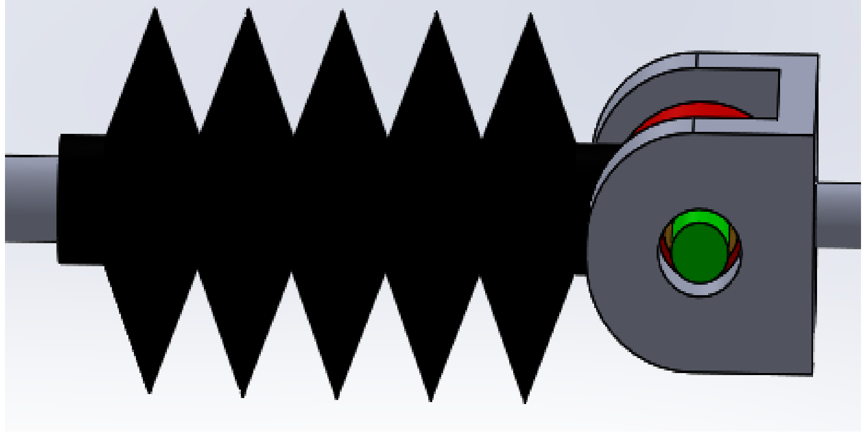
- Heim Joints

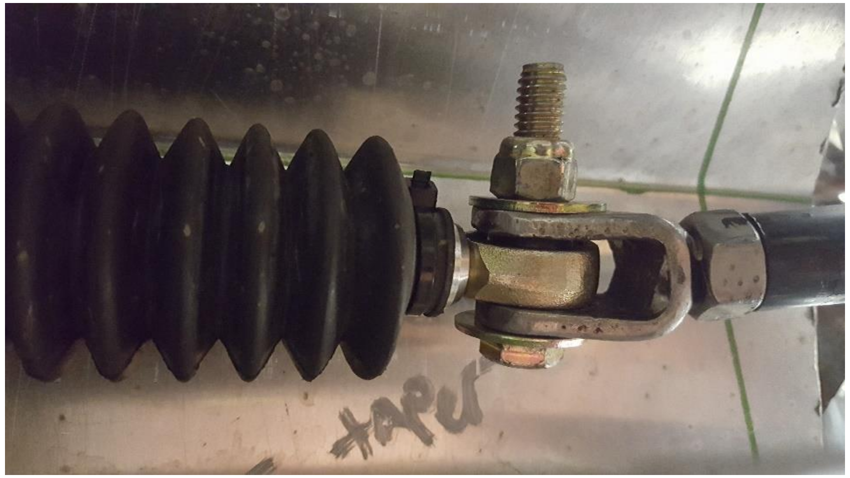




Steering System

- Heim Joints





Steering System

- The Safety in the steering system

  - Good component quality.

  - Wheel alignment.

    1- To make the directions of the car more accurate.

    2- Avoiding the losing the control of the car.

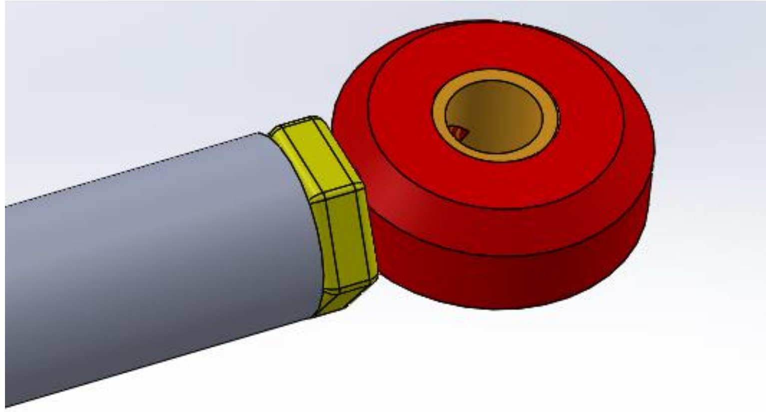
Steering System

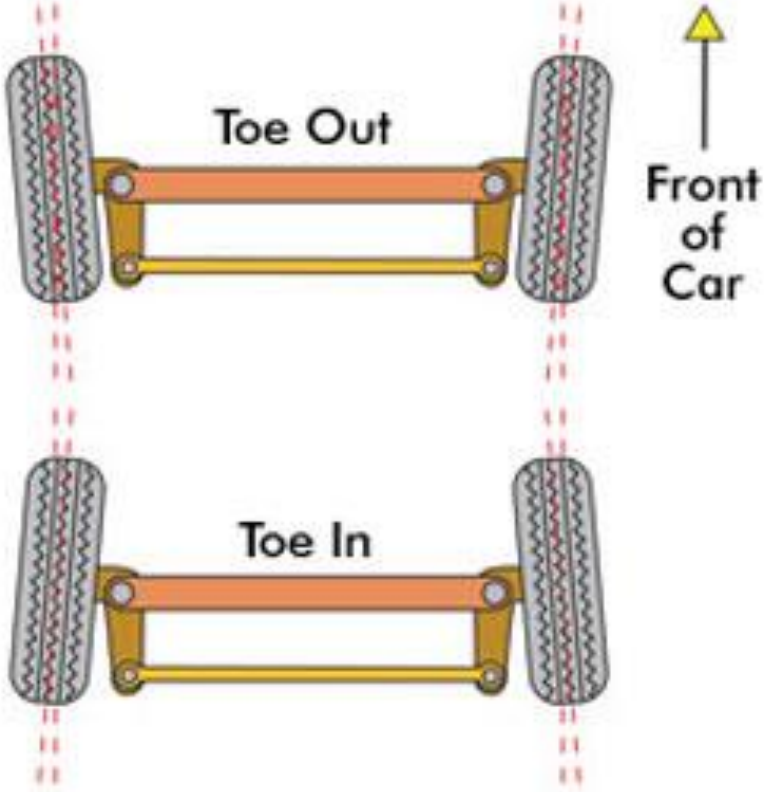
- Wheel alignment.

  Adjusting the angle of the Wheels.

  Toe out

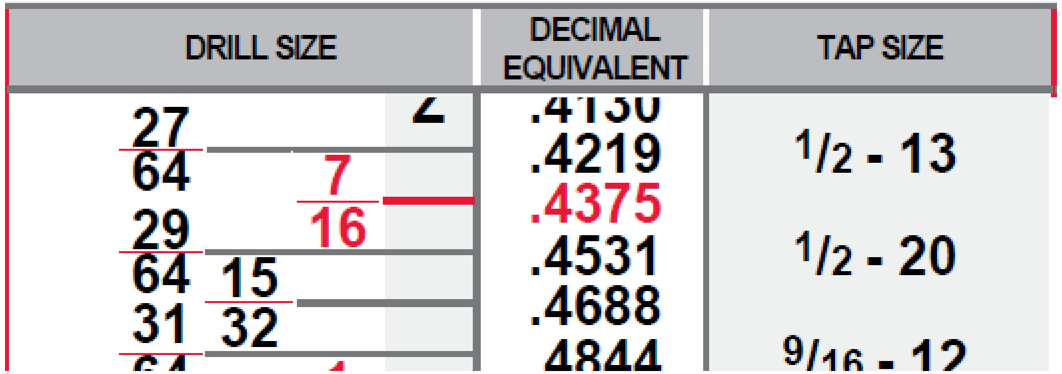
  Toe in

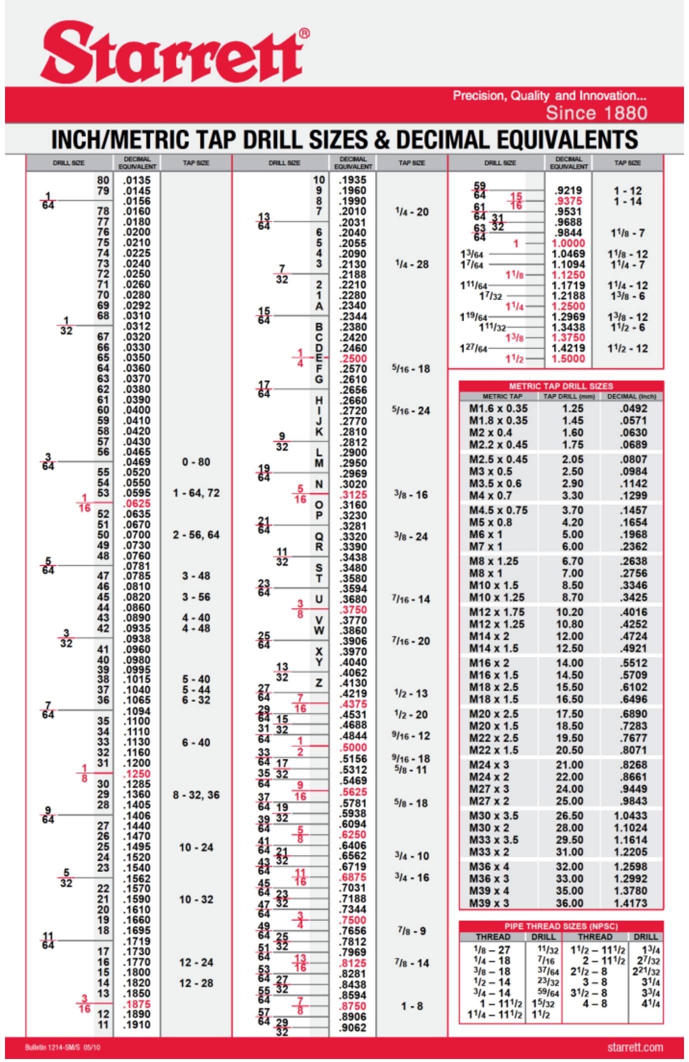




Steering System

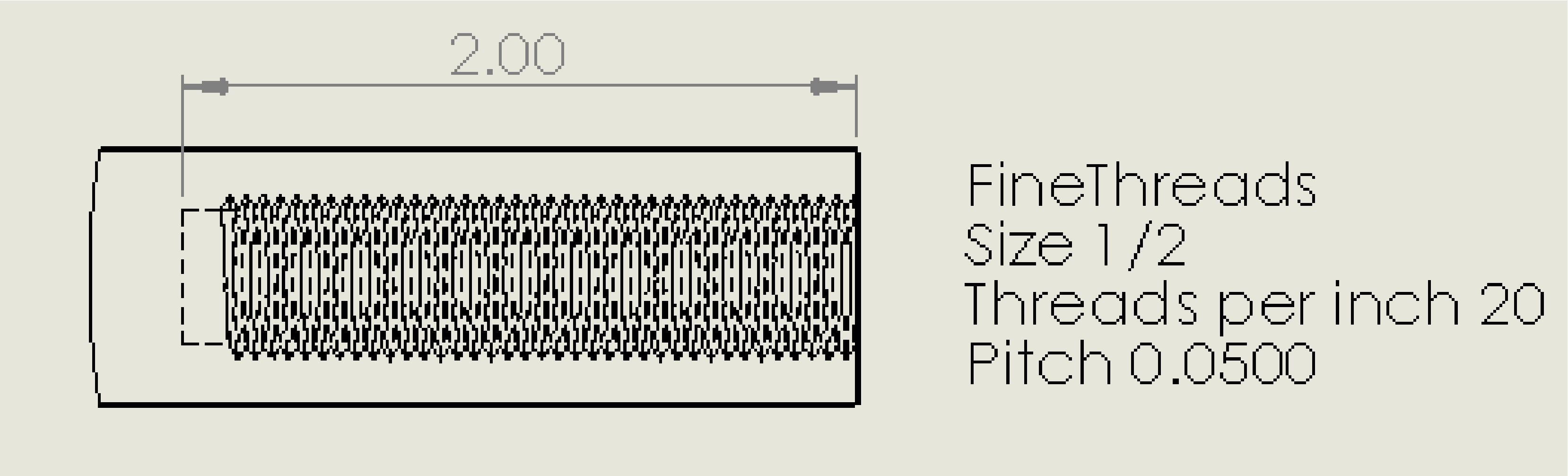
- Manufacture





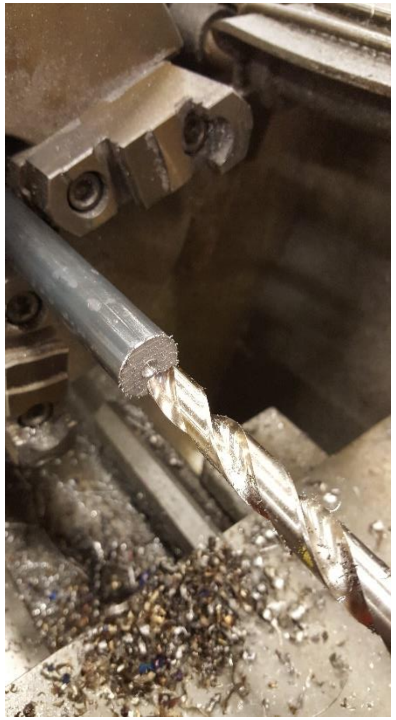
Steering System

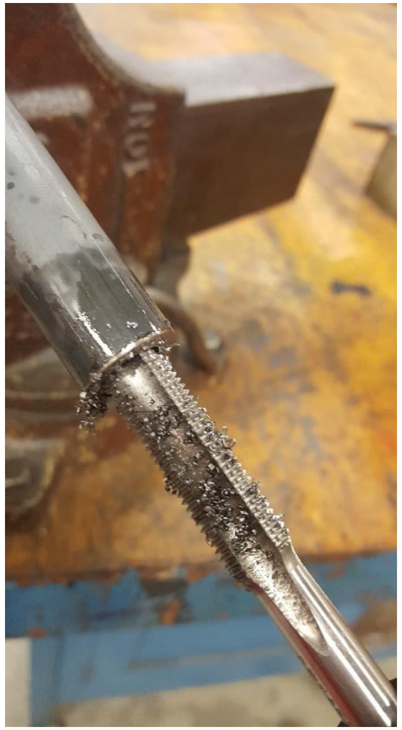
- Drawing



Steering System

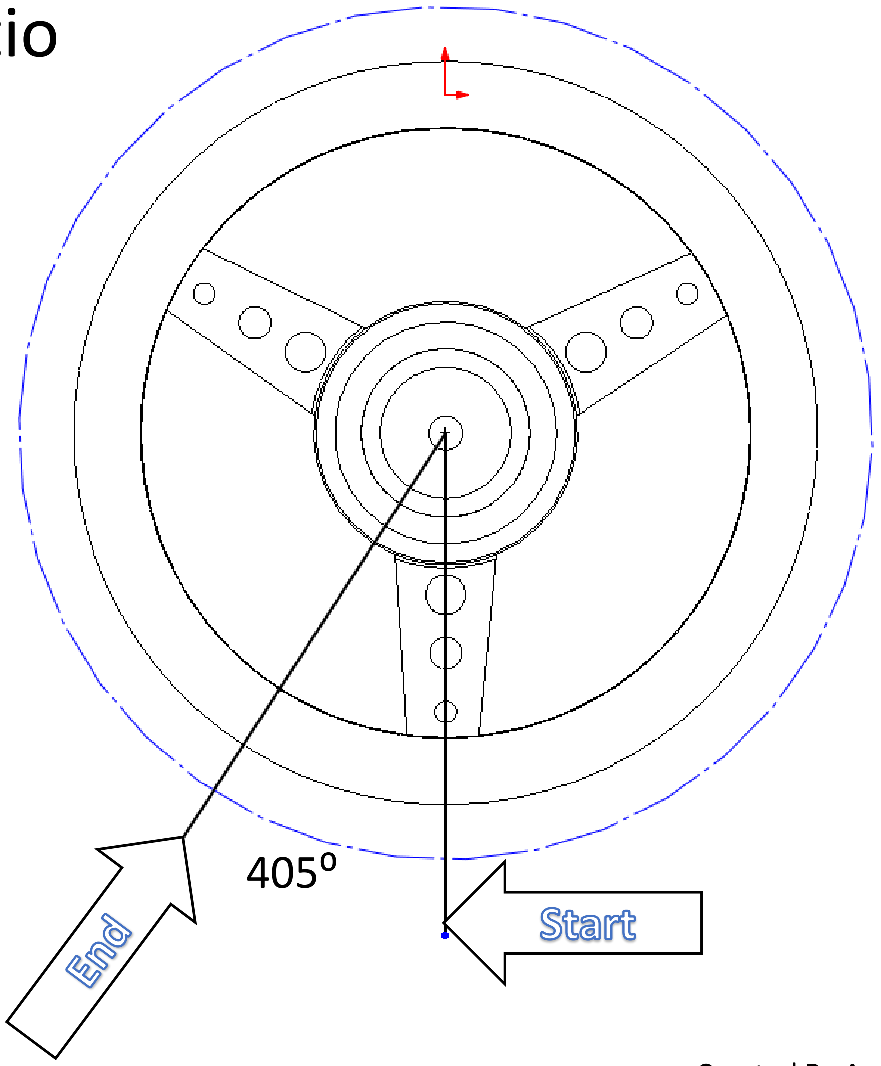
- Manufacture

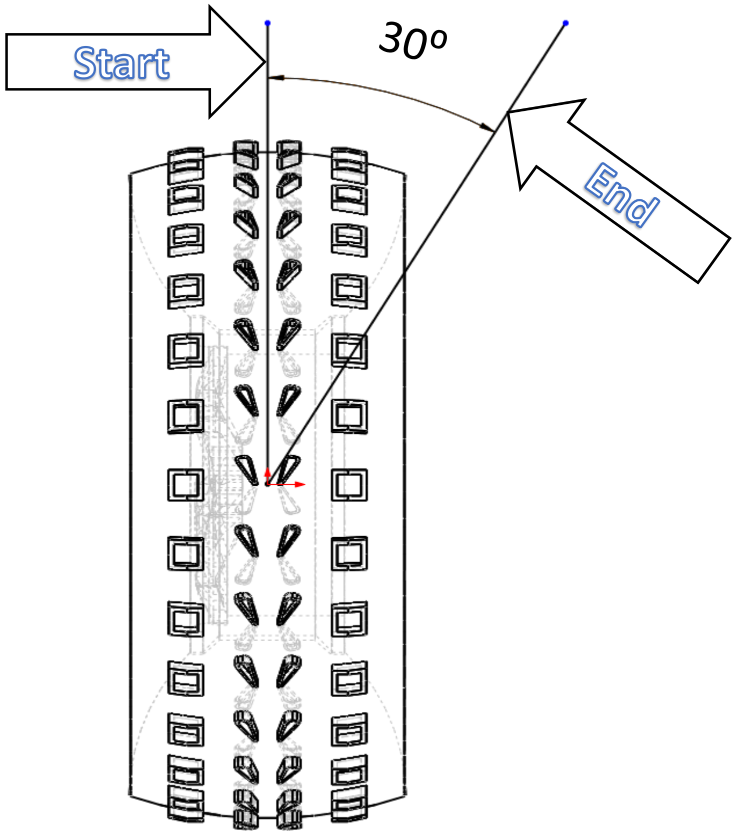




Steering System

- Ratio





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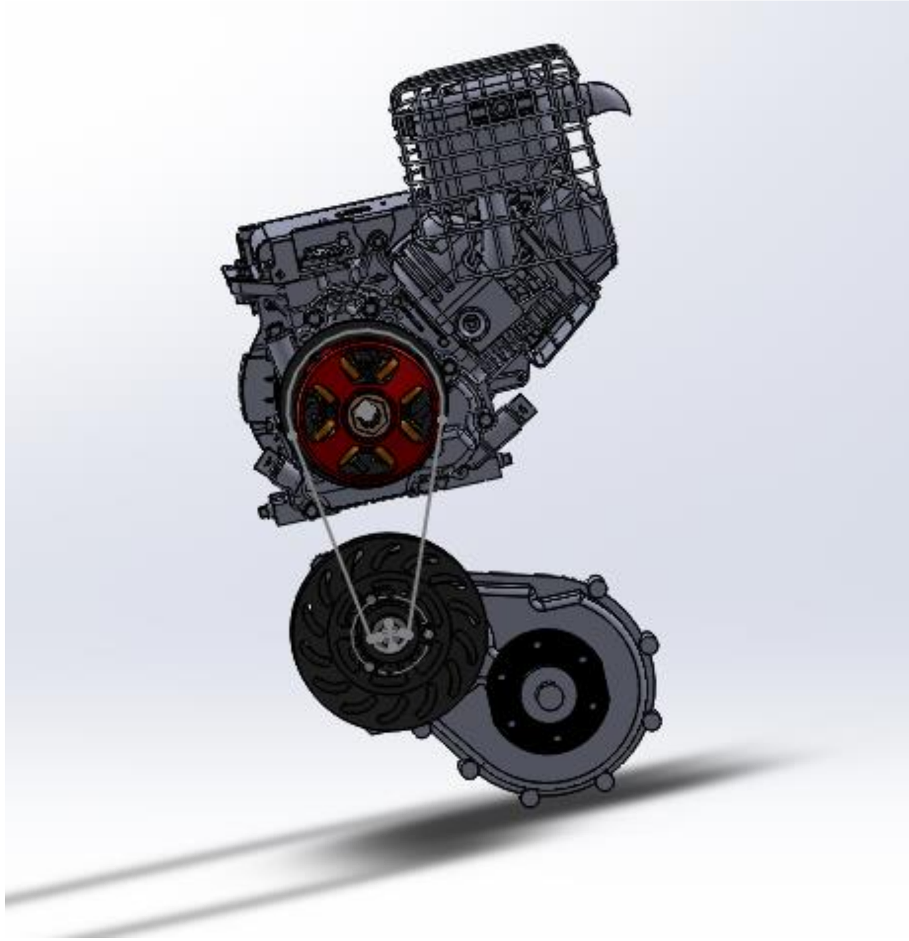
Powertrain: Design & Manufacturing Process

- Strategic (Torque vs Speed)
- Availability of products
- Cost



Powertrain Dynamic Test: Torque Requirements 1

- Uphill Climb

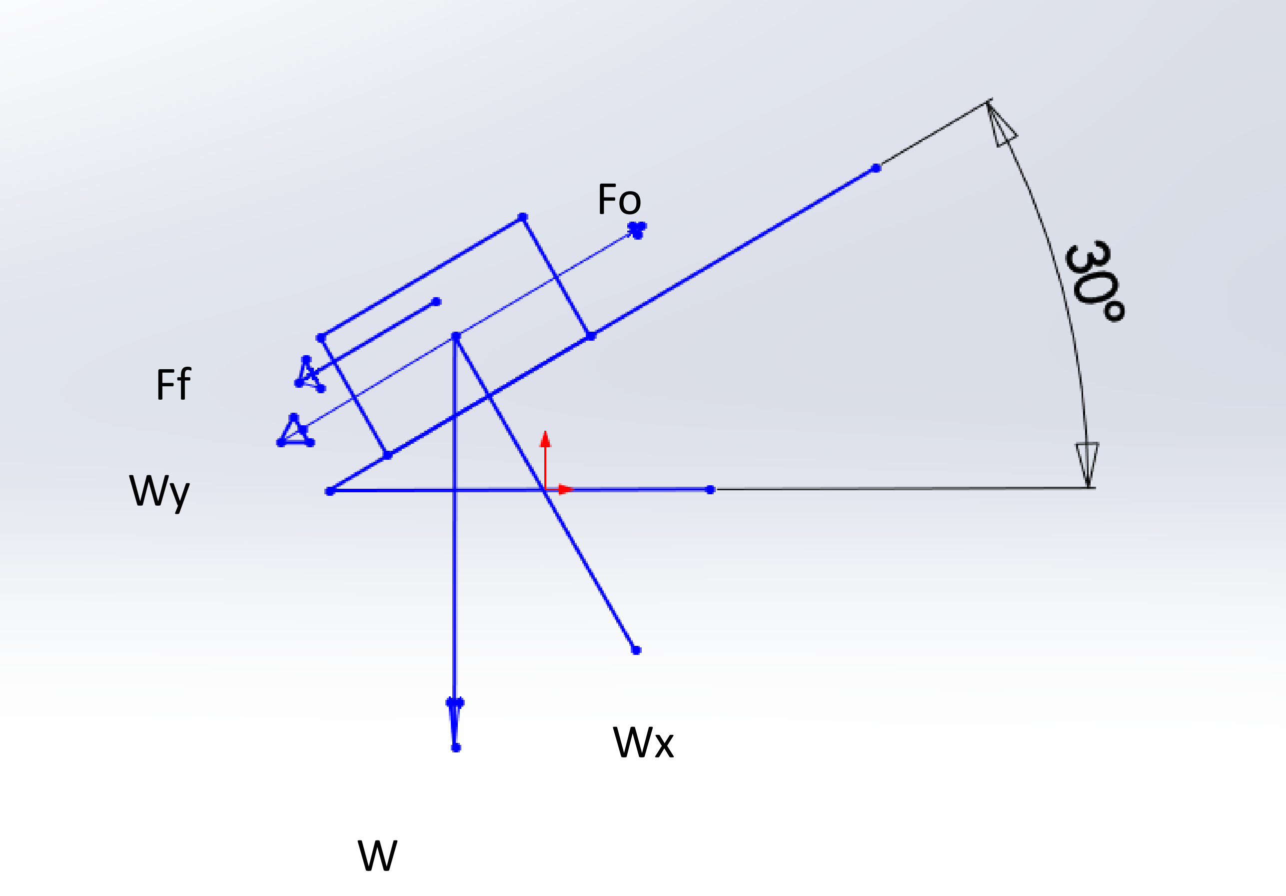
Fo = Force needed to be overcome

W = Weight(x and y components included)

Ff = Frictional Force

Fo = Wy+ Ff

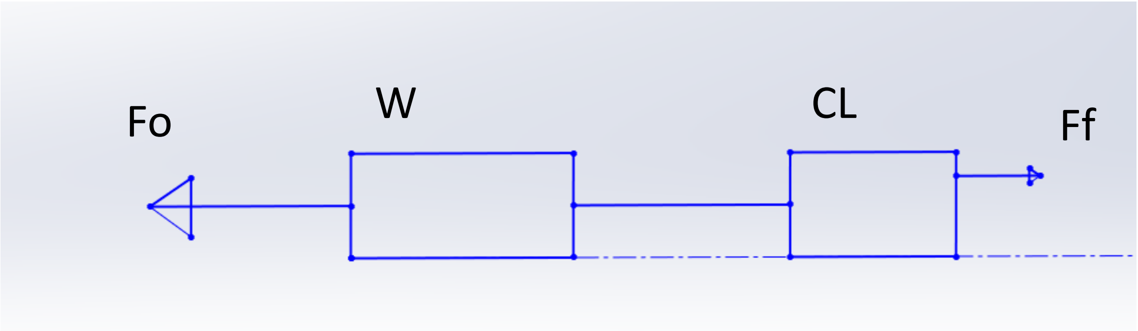
Torque = Fo * Radius of the wheel



Powertrain Dynamics Test: Torque Requirements 2

- Load carrying capacity test
- Functional requirement: **Overcome static friction**

Fo = Force needed to be overcome to put the car in motion



W = Weight (Car + Driver)

CL = Carried Load

Ff: Frictional force

Ff = Friction Coefficient * Total Load

Fo > Ff

Torque = Fo * Radius of the Wheel

Dynamic Test : Inclined Plane Uphill Climb

Weight Cars (lbs)	450	Total Load to overcome	482.6166235
Weight Driver (lbs)	200	Total Torque on System	**402.1805196**
Max Inclination	30		
Friction Coefficent	0.28		

Dynamic Test: Load Carrying Capacity on a Flat Plane

Attached Load (lbs)	200	
Friction Coeff.	0.62	
Load Overcome	527	lbs
Torque Needed	**439.1666667**	ft*lbs

Engine Speed (RPM)	Driving Pulley Diameter (in)	Driven Pulley Diameter (in)	Transaxle Input	Transaxle Output	Tire Diameter (in)	Efficency	Torque (HP)
1315.00	7.00	3.00	1.00	10.50	20.00	0.65	10.50
	.		Transaxle Ratio				
	2.333333333		0.095238095				

Driveshaft RPM	Engine Output Torque (ft*lbs)
292.2222222	**440.3292776**

Ground Speed (Rear Tires)
11.3017

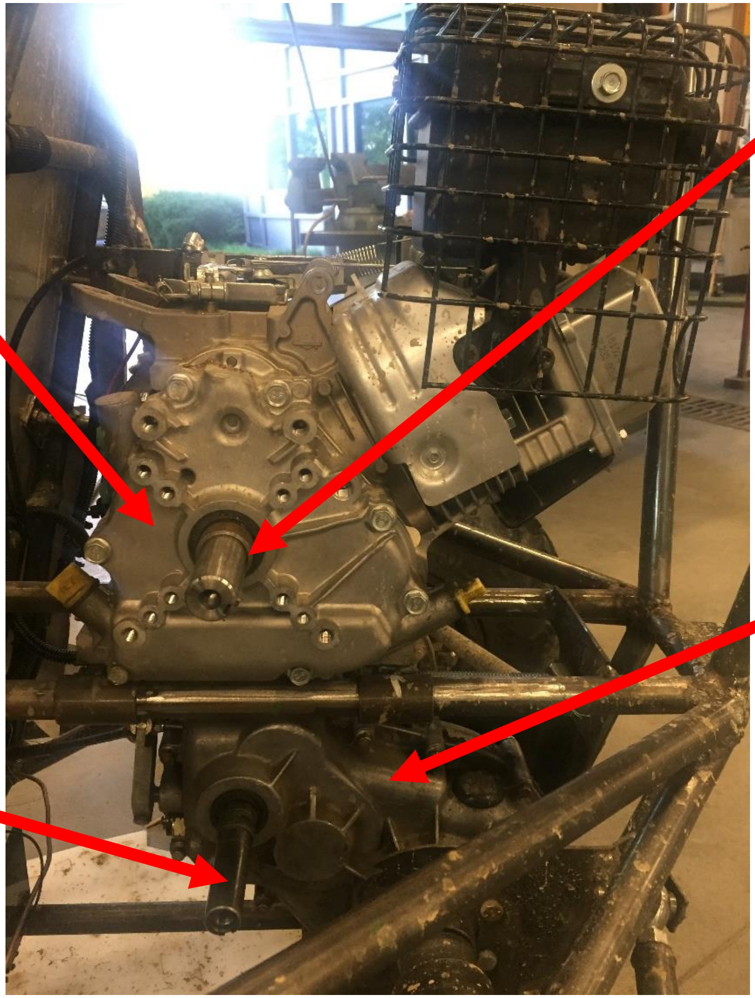
Manufacturing Process

1. Assembly (assembling the purchased parts together)
2. Fabrication (Safety cover)

Purchased parts:

- Engine
- Differential
- CVT Pulleys
- Transmission belt

Engine: Briggs & Stratton 10 HP OHV Intek, Model 19

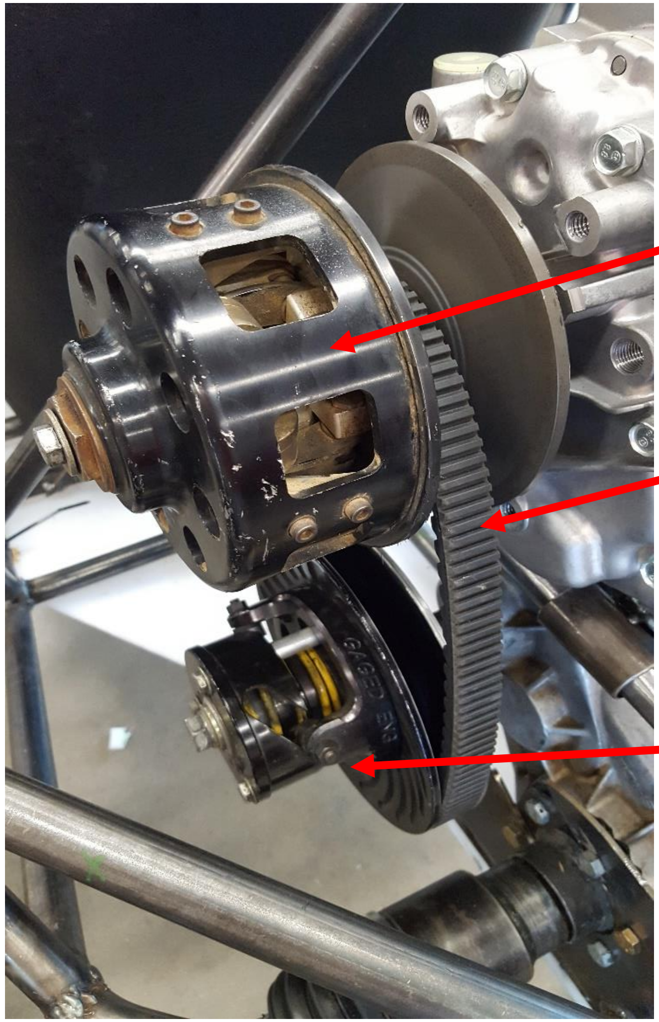


Output shaft for the engine, prior to attaching the CVT drive Pulley

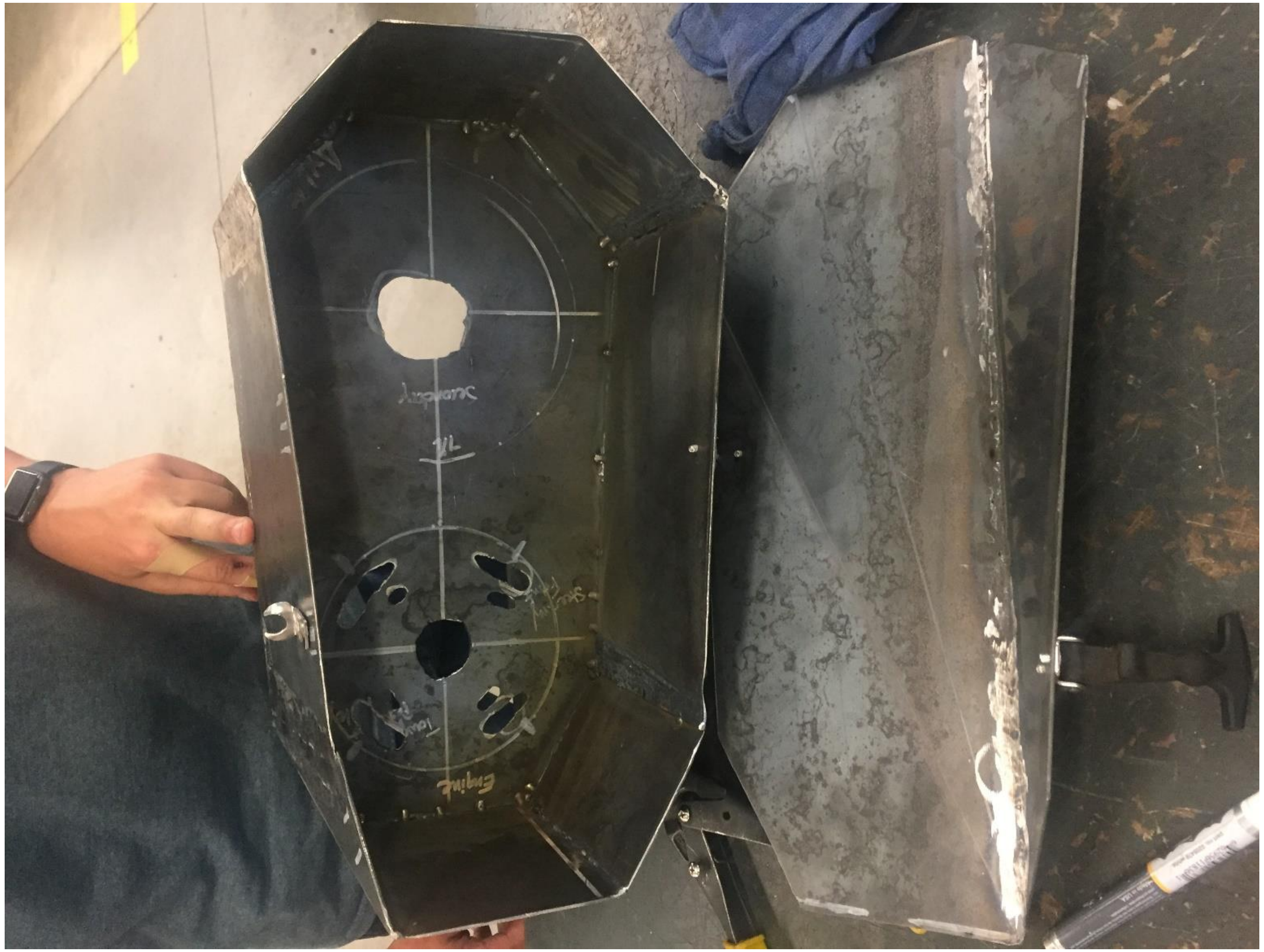
Differential

Input shaft for the differential, prior to the attaching the CVT driven pulley

CVT Assembly



Fabricated Part: Safety Cover



Drivetrain Speed Expectations Vs Manufacturing Outcome

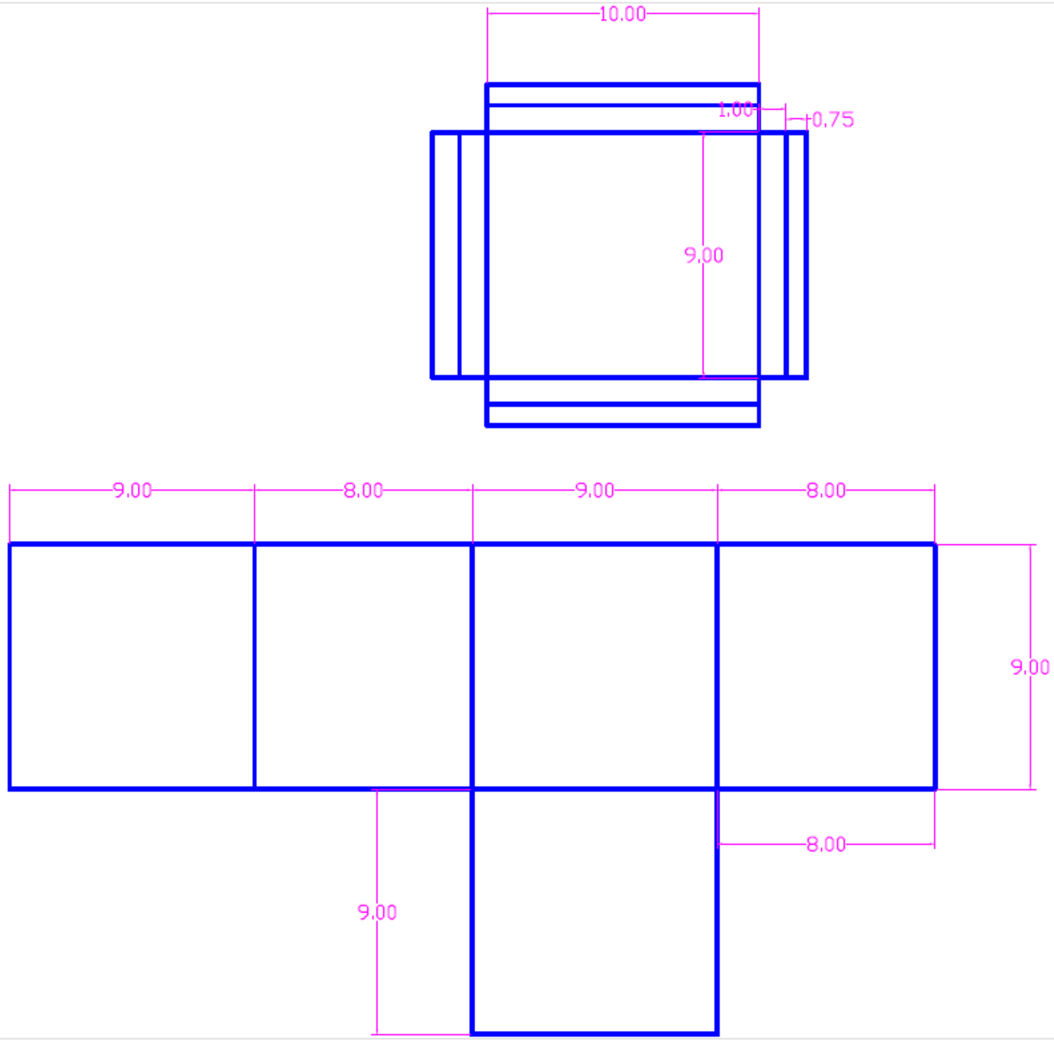
Values	Expected Value	Actual Output
Overall Efficiency	**80%**	**65%**
Ground Speed	**35**	**32**

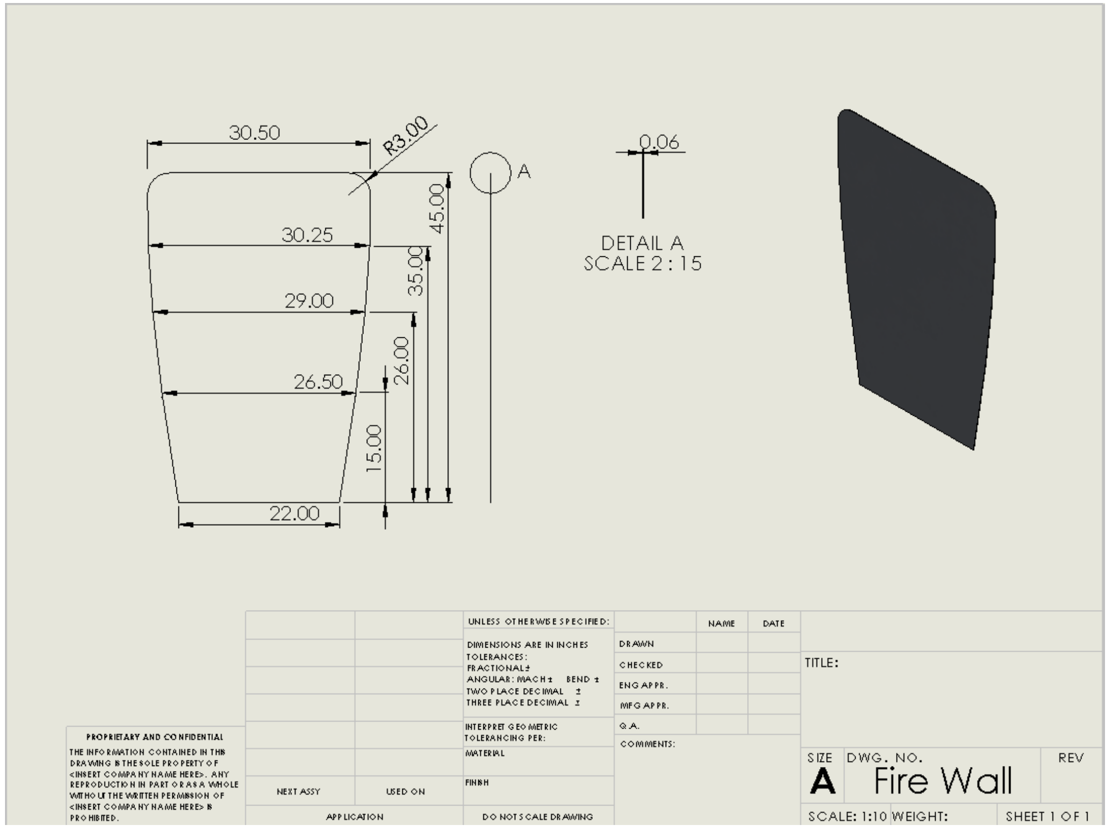
Engine Speed (RPM)	Driving Pulley Diameter (in)	Driven Pulley Diameter (in)	Transaxle Input	Transaxle Output	Tire Diameter (in)	Efficency	Torque (HP)
3800.00	7.00	3.00	1.00	10.50	20.00	0.65	10.50
	.		Transaxle Ratio				
	2.333333333		0.095238095				

Driveshaft RPM	Engine Output Torque (ft*lbs)
844.4444444	152.3771053

Ground Speed (Rear Tires)
32.6588

Drawing:





Created By Hani Alnakhly

Machines Used to make Fuel Box:

Water Jet Cutter

Fuel Box

Safety: Design Requirement

1- Brake Light:

Type: Polaris #2411450

2- Reverse Light:

Type: Backup light J759

Safety: Design Requirement

3- Kill Switches:

Type: Stock Polaris #4013381.

2 Kill Switches.

External Switch Mount.

4- Belt Restraint:

Metal to Metal Buckle (50 in).

Safety Harness at least (5 point).

Lab Belt and Shoulder Belt.

Front Kill switch

Back kill switch

Belt restraint

5- Helmet & Head Restrain:

Driver helmet (6 in) clearance.

Shoulder, Knee, Hips, Arms Elbow , Hands (3 in) clearance.

Head clearance for the driver

6- Fire Extinguisher:

Quick Release.

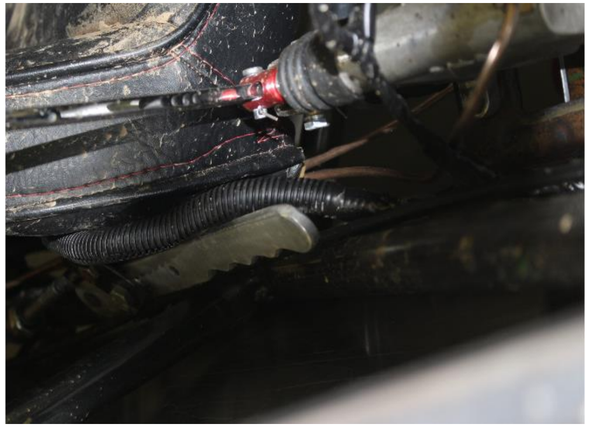
Mount on the cockpit Labeled.

Fire extinguisher

Other Safety Features:

7- Steering Wheel able to replace easily.

8- All wiring must be sealed.



Sealed wires

9- Batteries mounted with sound engineering, and able to provide power to brake light etc.

Battery

2017 Baja SAE Official Costing Sheet

Gorilla Racing

YOU MUST ENTER YOUR CAR NUMBER FOR EACH EVENT.
Enter numbers only (ie: 2,6,13,24) If you are NOT entering the event leave blank

	CAL	KAN	ILL
Car Number		113	
Total Cost		$ 14,146.34	

Enter Team Name in Cell F3

Sect #	Item	Description	Subassembly Costs Material	Subassembly Costs Labor	Vehicle Assembly Labor Time(min)	Vehicle Assembly Labor Cost	Subtotal Material	Subtotal Labor	Cost Adj. Form	Adjustment	Judges Adjusted Cost
1	Engine		$831.27	$65.20		$0.00	$831.27	$65.20			$896.47
2	Transmission		$2,617.77	$108.65		$0.00	$2,617.77	$108.65			$2,726.42
3	Drive Train		$1,073.92	$14.58		$0.00	$1,073.92	$14.58			$1,088.50
4	Steering		$471.14	$112.52		$0.00	$471.14	$112.52			$583.66
5	Suspension		$2,504.84	$356.20		$0.00	$2,504.84	$356.20			$2,861.04
6	Frame		$743.30	$826.61			$743.30	$826.61			$1,569.91
7	Body		$161.21	$171.72		$0.00	$161.21	$171.72			$332.93
8	Brakes		$1,738.72	$54.15		$0.00	$1,738.72	$54.15			$1,792.87
9	Safety Equipment		$165.00	$8.75		$0.00	$165.00	$8.75			$173.75
10	Electrical Equipment		$311.06	$20.42		$0.00	$311.06	$20.42			$331.48
11	Fasteners		$134.54			$0.00	$134.54	$0.00			$134.54
12	Miscellaneous		$727.56	$122.50		$0.00	$727.56	$122.50			$850.06
13	CAL Event		$0.00	$0.00		$0.00	$0.00	$0.00			$0.00
14	KAN Event		$798.88	$5.83		$0.00	$798.88	$5.83			$804.71
15	ILL Event		$0.00	$0.00		$0.00	$0.00	$0.00			$0.00
		CAL Total:	$11,480.33	$ 1,861.29		$ -	$ 11,480.33	$ 1,861.29			$13,341.63
		KAN Total:	$12,279.21	$ 1,867.13	0	$ -	$ 12,279.21	$ 1,867.13			$14,146.34
		ILL Total:	$11,480.33	$ 1,861.29		$ -	$ 11,480.33	$ 1,861.29			$13,341.63

Created By Hani Alnakhly

Conclusion

- How can we improve it better for next year?
- Causes for unmet expectations
- Better analysis

Short Video