

SAE Baja

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Introduction

What is Baja SAE

Baja SAE is a global program explicitly designed to challenge engineering students in the operation of designing, planning and building an off-road vehicles. They are then to compete in a formal Baja SAE competition to set on the team with the overall greatest performing vehicle. The project make ensure that students utilize the fundamental understanding that they have been given through their degrees.



Mini Baja

SAE Baja Rules

1. The vehicle and associated documentation must be conceived, designed, manufactured and fabricated by the team members without direct involvement from professional engineers, faculty or professionals in the off-road and racing communities.
2. Vehicle's fabricated from a kit or published designs are ineligible to compete. Vehicles which have been professionally fabricated will be disqualified from the competition or receive a penalty. If a team does not have access to machine shop facilities, the frame can be professionally fabricated without a penalty attached.

Competition events

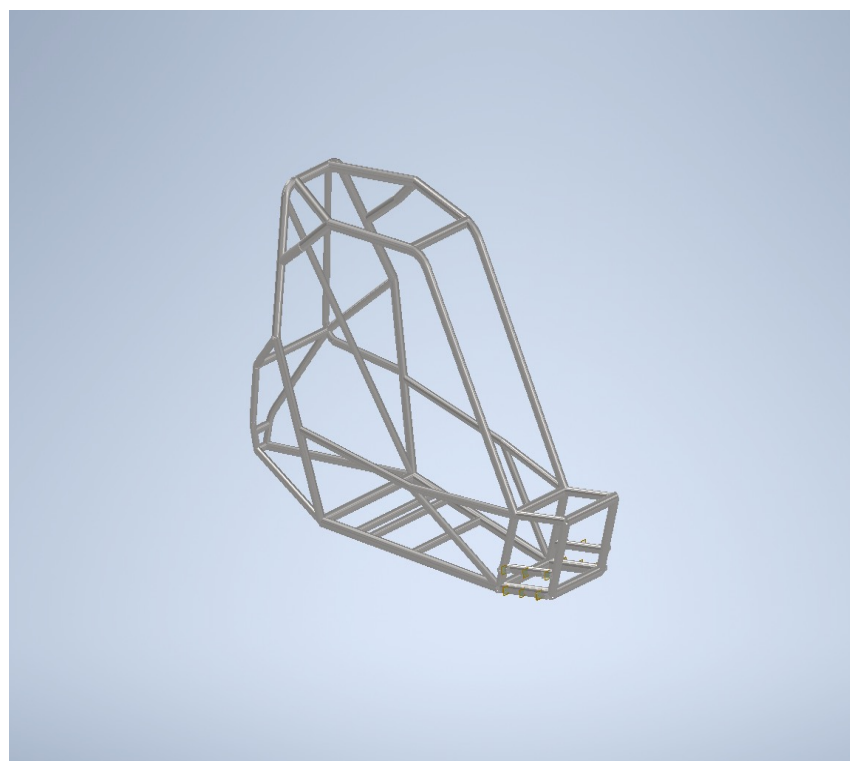


Tennessee Tech BAJA SAE

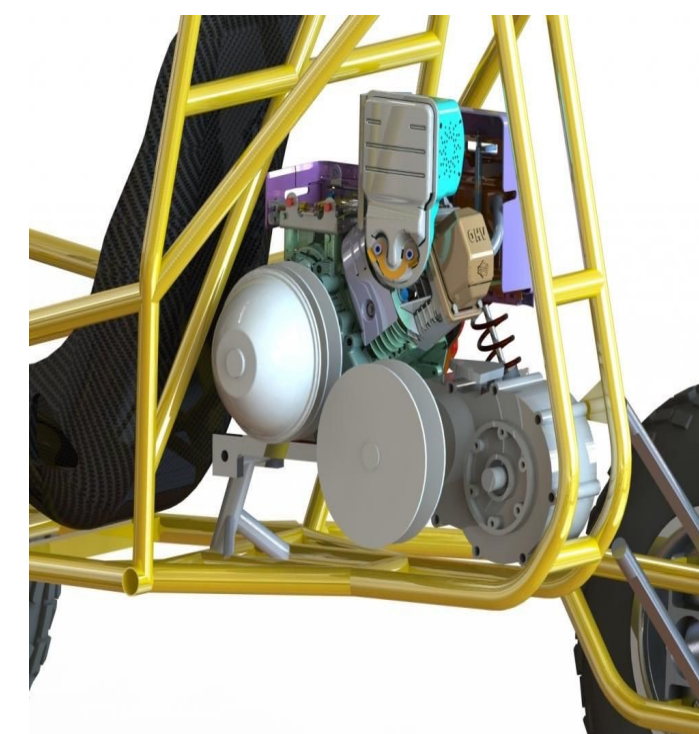


BAJA SAE Rochester

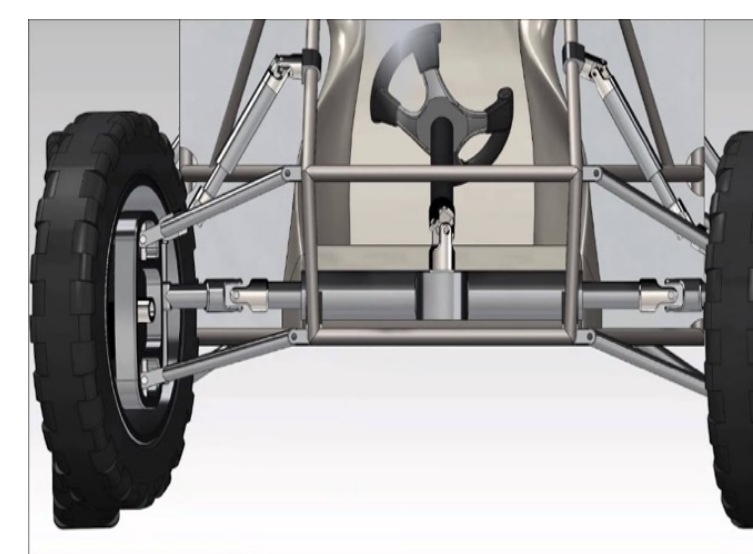
Components in Baja



Frame



Power train



Steering & Suspension

Frame

The frame is required as a wider, stance and a roll cage for the driver to sit in which is lengthened and constructed to satisfy SAE specifications and protect the driver in case of a crash.

Power Train

The power train component can reflect as the heart of the Vehicle, the Powertrain subcategory consists of the engine and the transmission and all the drive line components, such as the axles and the driveshafts that makes the car run and move. The SAE Rules require that specific model, 10 horsepower Briggs Stratton engine is used. The power is generally fed through a transmission with converts the power from engine and send it through the driveshafts into the differentials and to the wheels. The 2021 rules require the vehicle to be capable of 2-wheel drive. Which brings in more components, weight and cost.

Suspension and Steering Systems

The steering and suspension systems goes together as one subgroup reason being is that both imply control and maneuverability of the vehicle. The steering system will have control overturning the wheels of the vehicle. Although, the incorporation of a suspension system with the steering system makes it more complicate. The vehicle should have a reasonable clearance capability with the sprung weight as well as a reasonable spring coefficient to ensure smoothness during cornering. Typical Baja entrees utilize a front and rear suspension system know as a double A arm setup. This allows teams to keep the vehicle's wheelbase within regulation and provides capable suspension travel to handle rough terrain. Included in this would be a shock absorber which controls the rate at which the suspension cycles in and out.

Design Requirements

Frame

- Should carry one-person 190cm (75 in.) tall weighing 113kg(250 lbs.).
- Roll cage and Frame Members must be fully welded, must not be ground, sanded or modified to prevent inspection.

Power Train

- 10 horsepower Briggs Stratton engine
- Must be 2-wheel drive
- Engine must remain complete stock
- The only permitted spark plug is RC12YC

Suspension & Steering

- Should weight less than 450lbs
- Steering should turn tire to 45 degrees minimum
- Should have relatively light tires (30 lbs. Max)

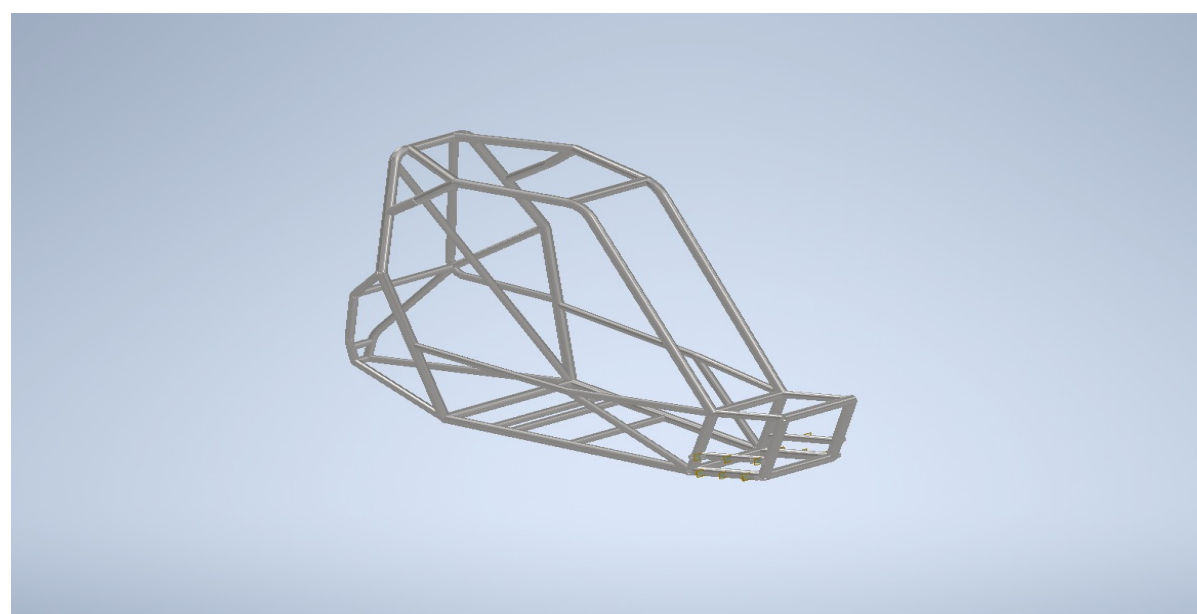
2021 SAE Summary

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Frame

The frame group reconstructed the frame to create the Mini Baja silhouette and accommodated the necessary components. The group then came to an agreement about how it will be made. They choose to make a wider stance and a cabin for the driver was also lengthened. Below is a picture of how the frame was made in inventor. A picture of the frame can be seen below



frame

Design Requirements

- Roll cage minimum clearances, and fit into a comfortable driving position, while wearing the entire required driver's equipment.
- Should be steel tubes having a minimum wall thickness of 0.89 mm (0.035 in) and a minimum outside diameter of 25.4 mm (1.0 in). Circular steel tubing with an outside diameter of 25 mm (0.984 in) and a wall thickness of 3 mm (0.118 in.) and a carbon content of at least 0.18%.

Static Structural Analysis

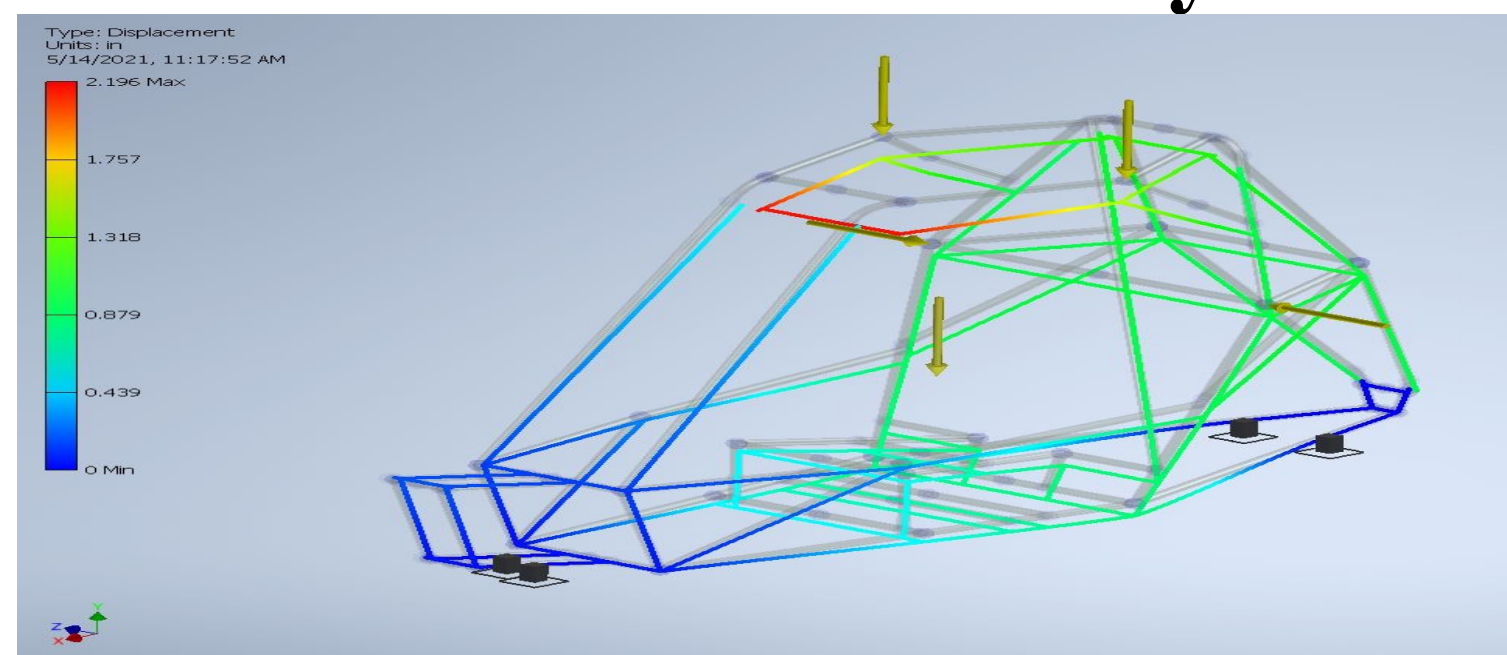


Table 3 – Cost of Required Materials

Part Description	Website	Price	Quantity	Subtotal
Estimated Frame Cost	N/A	N/A	N/A	\$1700
Steering Wheel:	Purchase Location	\$26.99	1	\$26.99
Gas pedal assembly:	Purchase Location	\$61.08	1	\$61.08
Brake pedal assembly:	Purchase Location	\$68.99	1	\$68.99
Kill switch:	Purchase Location	\$8.49	1	\$8.49
Taillight:	Purchase Location	\$26.95	1	\$26.95
Racing Harness:	Purchase Location	\$59.99	1	\$59.99
Flame Retardant Shirt:	Purchase Location	\$31.99	1	\$31.99
DOT Helmet:	Purchase Location	\$54.21	1	\$54.21
			Total:	\$2,038.69

Steering and Suspension

The steering and suspension plays very important role in this project as the team continue to work on the Mini Baja some of the information, they came across was gathering the list of materials and components needed for the baja. The suspension of a Mini Baja is a component that contributes a max friction between the tires and the road also provide good handling.

- **Some of the objective the team focused on was**
- Safety factor
- Should minimize unsprung weight
- Should have 12 inches of suspension travel
- Suspension and steering components must weigh no more than pounds
- should have 14 inches of ground clearance at full droop.

Pre-liminary Design

Based off the group's ideas about the preliminary analysis they choose the following suspension system that would be suitable for the application and they systems are MacPherson Strut, Double A arm, Trailing arms and a leaf spring reason being why they choose these parts is because they have been proven in auto manufacturing for years and had readily available parts, that can be order instead of fabricate.



Macpicrson



Double Arm

Leaf sprung

Front and Rear Suspension

Front suspension

These are some of the design process the tea decided go through in order to get to how they want their project to come out

1. The front A-arm suspension was designed and were weighted the highest on the front.
2. The team then started rough sketches to calculate suspension geometry, and the overall length of the arms to fit the criteria.
3. After the steering linkage and CV shafts were taken into consideration the shock mount was moved to the upper A-arm for the clearance and the final version can be seen in figure 10.

Cost Analysis

Front & rear suspension

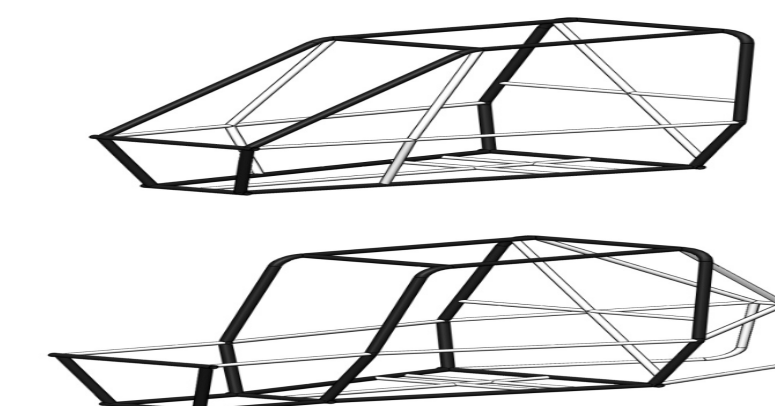
Prices Per System		
System	Number of Components	Total
Rear Suspension	38	\$ 399.42
Front Suspension	22	\$ 465.48
Steering	4	\$ 268.46
Braking	5	\$ 951.26
	Total:	\$2,084.62

Powertrain

The power train group focused on components like the engine, transmission, axles and driveshafts that makes the vehicle run and move .They then made the mini-Baja a four-wheel drive meaning a lot of components and cost was made. The design process for the powertrain, was based of a weighted objectives tables with options for primary drive like the ATV transmission and a sequential transmission.

Final Design of the Powertrain

A final design was made by the group where there was two differentials of the design. Top and the bottom, However it was determined that the CV shafts and wheel hubs was from the same setup so that the splines and sizes of everything match.



Front & Back Suspension

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Introduction

A suspension system on the baja is what connects the frame to the wheels and consequently the road. This system heavily impacts the capabilities of the vehicle, if set up wrong it can hinder the vehicle and if set up correctly it can boost a vehicles performance drastically. It helps absorb the impacts of bumps and helps keep the frame stable while driving, this is especially important in the case of bajas because of the rough terrain and the sharp corners that the baja must endure.

Design Requirements

- Should minimize un-sprung weight
- Should effectively dampen small bumps
- All suspension mounts integrated into frame
- Must have same diameter tires front and rear
- Should have 12 inches of suspension travel
- Should have 14 inches of ground clearance at full droop
- Safety Factor is 2.

Objectives

- Select a type of suspension system based off the weighted objectives tables
- Go through all the parts currently available to see what we can use
- Write a list of what we already have and what we need to be ordered
- Create a 3D model for the Rear Trailing Arm and supporting Components and a 3D model for the front A-Arms
- 3D Print all Components to make sure all measurements are correct and work
- Begin rear suspension and front suspension 3D assembly with all components

Front Suspension Results



Front suspension prototype

