# Baja Suspension System

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## Overview

The Purpose of this project is to design the most efficient suspension possible by analyzing different suspensions.

## Introduction

- SAE Baja is an intercollegiate design competition run by the Society of Automotive Engineers (SAE). Teams of students from universities all over the world design and build small off-road cars. The cars all have engines of the same specifications.

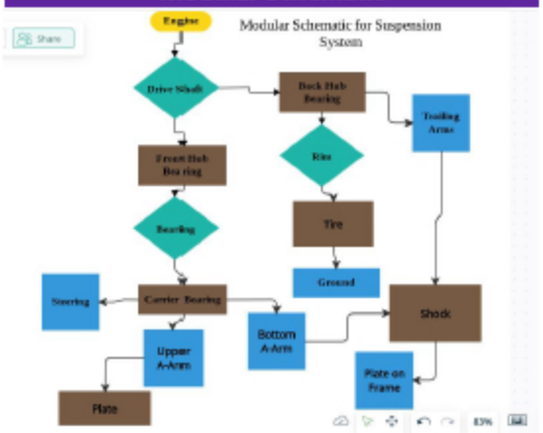
## Bill of Materials

| Item | Part No./Figure No. | Quantity | Price [$] | Total [$] | Notes |
|---|---|---|---|---|---|
| Hub Bearing | 7 | 4 | 14.99 | 59.96 | Purchase |
| Hub | 3 | 4 | 87.49 | 349.96 | Purchase |
| Tire | 19 | 4 | 40.00 | 160.00 | Purchase |
| Upright | 14 | 2 | 400.00 | 800.00 | Manufactured |
| Rim | 18 | 4 | 60.00 | 240.00 | Purchase |
| Upper A-arm | 10 | 2 | 129.00 | 129.00 | Manufactured |
| Lower A-arm | 11 | 2 | 129.00 | 129.00 | Manufactured |
| Semi-Trailing Arm | 15 | 2 | 129.00 | 129.00 | Purchase |
| Straight Bracket | 12 | 10 | 16.00 | 160.00 | Purchase |
| Angled Bracket | 13 | 4 | 20.00 | 80.00 | Purchase |
| Shocks | 9 | 4 | 1150.00 | 4600.00 | Purchase |
| Heim Joints | 8 | 12 | 26.94 | 323.28 | Purchase |
| Back Plate Panel | 20 | 1 | 526.00 | 526.00 | Purchase / This price is used for both plates |
| Side Plate Panel | 21 | 2 | | | |
| | | | Total | 7686.20 | |

## House of Quality

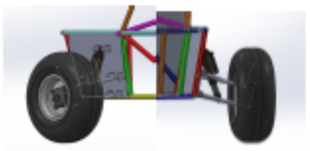
| Improvement Direction | | ↑ | ↑ | ↑ | ↓ | ↓ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↓ | ↑ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | | - | Weeks | in/s | in | in | lb | Pa | in/s | Miles | Degrees | psi | lbs | - |
| Customer Requirements | Importance Weight Factor | Connection to Frame | Timeline | Velocity of the Baja | Maximum Length of Frame | Maximum Width of Frame | Spring/Damping Constants | Stress/Strain | Control Response | Travel Distance | Turn Angle | Joint Rigidity | Total Weight | Four-Wheel Drive |
| Cost | 10 | 1 | | | 9 | 9 | 9 | | 1 | | 1 | 3 | | 3 |
| Weight | 7 | 1 | | 3 | 9 | 9 | 9 | 9 | 1 | 9 | 1 | 6 | 9 | |
| Strength | 7 | 3 | 3 | | 9 | 9 | 9 | 9 | 3 | 1 | 1 | 3 | 9 | 3 |
| Ease of Machining | 5 | 1 | 3 | | | | | | | | 1 | | 1 | |
| Ease of Design | 5 | 1 | 1 | | | | | 1 | | | 1 | | | |
| Safety | 9 | 3 | | 3 | 9 | 9 | 3 | 3 | 3 | | 1 | 6 | 9 | 1 |
| Stable Under a Load | 8 | 9 | | 9 | | | 3 | 3 | 3 | 3 | 3 | 3 | 9 | 9 |
| Quality and Performance | 10 | 1 | | 9 | 3 | 3 | 9 | 3 | 3 | 3 | 9 | 3 | 9 | 9 |
| Ground Clearance | 9 | 9 | | 3 | | | 1 | | | 1 | 1 | | | 1 |
| Long Travel Distance | 6 | | | | | | 1 | 3 | | 9 | | 1 | 1 | |
| Raw Score (CR x EC) | (1,980) | 221 | 41 | 126 | 234 | 234 | 239 | 117 | 82 | 94 | 69 | 135 | 227 | 141 |
| Relative Weight % | | 11.28% | 2.09% | 6.43% | 11.94% | 11.94% | 11.17% | 6.99% | 4.18% | 4.80% | 3.52% | 6.89% | 11.58% | 7.19% |
| Rank Order | | 4 | 12 | 9 | 1 | 1 | 5 | 7 | 11 | 10 | 12 | 8 | 3 | 6 |

## Modular Schematic




## Results

Concept 1 Concept 2



## Conclusions

The Goal of this project was to design and build a suspension system for a
Baja using Solidworks and research.

We came close to finishing our goal but ran out of time, so the next step is to have it fabricated and tested.

## FMEA

| Function | Failure Mode | Effects of Failure | Causes of Failure | Detection | S | O | D | RPN |
|---|---|---|---|---|---|---|---|---|
| The arms move with the shock. | Part gets disconnected from the arms. | The shock is damaged. | The arms move past the axis of rotation. | Direct Obs. | 10 | 1 | 2 | 20 |
| The bushings are connected to the system. | The lubrication dried out of the system. | The metal parts are damaged. | The metal parts had a lot of friction against each other. | Direct Obs. | 3 | 4 | 5 | 60 |
| The Baja travels through rough terrain. | Debris gets in the plates. | The suspension systems gets jammed. | Buildup in the system causes the arms to stop moving. | Direct Obs. | 3 | 5 | 4 | 60 |

| Recommended Corrective Action | S | O | D | RPN |
|---|---|---|---|---|
| Check tire pressure if slipping. | 3 | 3 | 4 | 36 |
| Check tire treads every time. | 2 | 2 | 5 | 20 |
| Arms needs to be oiled every 25 hours. | 5 | 3 | 4 | 60 |
| Check all suspension components for wear every time. | 8 | 2 | 1 | 16 |

## Product Design Specifications

**Product Identification**

- Product Name: SAE Baja Suspension
- Basic Functions of the Product: The product performs as a suspension system.
- Special Features of the Product: We will be designing a disengaging all-wheel drive system for the Baja suspension.
- Key Performance Targets: The Suspension needs to be stable for the driver while maintaining stiffness so that the car won't loss traction with the ground. Also, be able to go over obstacles and have plenty of maneuverability.
- User Training Required: User will need to use an operation manual.

**Market Identification**

- Description of Target Market: Future members of the SFASU SAE.
- Anticipated Market Demand: For people who enjoy off-roading.
- Competing Products: Alternate suspension designs from other universities.
- Branding Strategy: Naming product and advertising on social media.

**Physical Description**

- Material: Steel
- Weight Targets: Light enough to still be *maneuverable* and quick for a time trail.
- External Dimensions: Width of the Baja has to be less than 64in and length needs to be less than 108in.

**Life Cycle Targets**

- Overall Life: 10 years
- Useful Life: 2 years

**Social, Political, and Legal Requirements**

- Standards: Some of the Legal Requirements we need to follow is American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM international), and American Society of Mechanical Engineers (ASME).

**Manufacturing Specifications**

- Suppliers: Amazon, Ebay, FK Bearings, Ryerson, Monster Scooter Parts.