Team 112 SAE Baja

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Project Overview

Cal State LA Baja SAE is a student-run team that designs and builds an off-road vehicle to compete in the annual Baja SAE competition against universities worldwide.
In these competitions, they must follow rules and regulations made by the SAE Baja Organization while creating a vehicle that is reliable and functional.

Objective Statement

Our objective is to improve on areas where issues occurred during last year's competition. Here are the following systems that had issues:

- Differential
- Upright
- Wheel Hub
- Steering
- Disconnect
- Tensioner

Differential

The differential is what allows the Baja car to turn and transmit power to the ground. In off road applications the differential helps maintain tire traction when driving over uneven terrain. The main issue was that the current differential did not have a disconnect system and was not operating smoothly. A trade study was conducted using the given parameters. The size of the differential was the deciding factor to refresh and reuse the current system on the baja car. Other options to replace the current system were too big to use.

Key (Lowest 1- 5 Highest)	04 Honda TRX450FMA (current)	Open	E Locker	Torq-Locker
Size 50%	5	2	3	3
Locking 15%	2	1	5	5
Cost 5%	5	2	1	2
Case 25%	1	1	1	2
Total	3.3	1.5	2.55	2.85

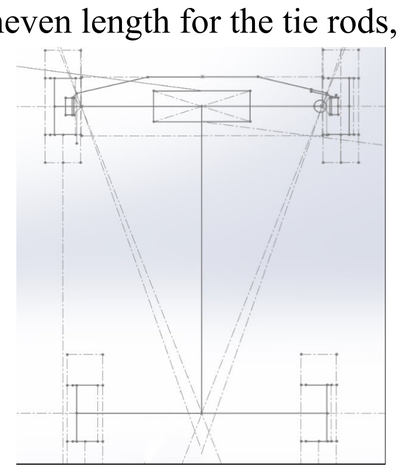
Trade study for differential



Torsen style differential Current differential

Steering

Steering is crucial to the car's mobility and stability. Because of this, new tie rods were needed to improve the vehicle's stability and tire angle since our car had an uneven length for the tie rods, causing unwanted toe out for our right front tire.



New Steering Geometry

Tie Rod Measurements	
Old	New
14.375in	14.03in
44° right tire angle	34° right tire angle
7° toe out	0°
Turning Radius	
86in	107in

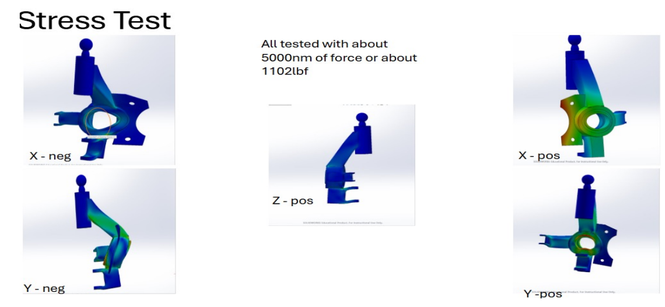
While a tighter turn radius is preferred for BAJA, the adjustability allows us to fine tune it to our needs rather than be static



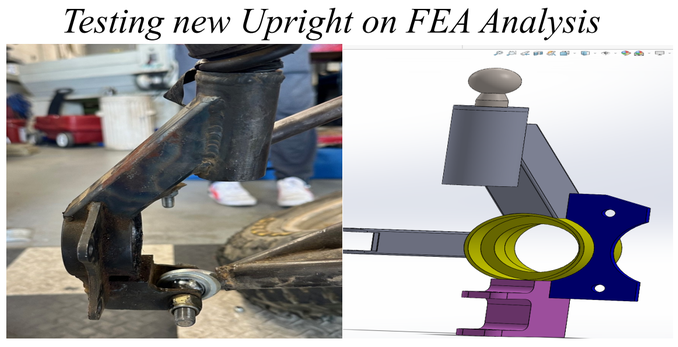
New Tie Rod

Upright

The upright gives the vehicle's brake system, steering system, and suspension all a place to converge while also giving the wheels a place to be mounted on to.



Testing new Upright on FEA Analysis



Previous Upright

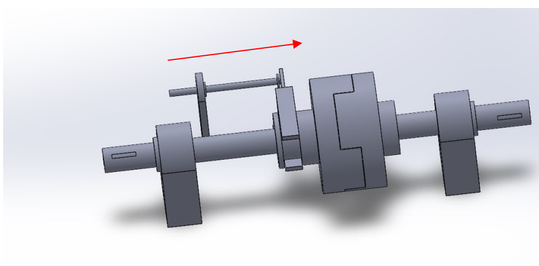
New Upright

The previous upright was limiting steering due to where the lower control arm would mount. It was bumping with the lower bracket causing the steering wheel to lock at a certain angle. To fix this issue we decided to rotate the lower control arm by 90 ° and lowering the bracket by half an inch to clear the axles.

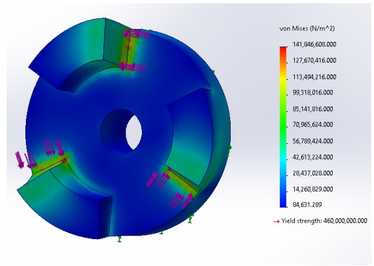
Disconnect

During BAJA events, the terrain can change from steep hills to tight turns, requiring different handling at each moment. A disconnect mechanism will enable the vehicle to adapt to varying conditions by alternating between 4WD and 2WD, optimizing its performance based on the current terrain. Our potential system had certain restraints because we operated from a chain drive system. Therefore, a trade study was conducted, primarily focusing on systems that could easily be incorporated into our current drive train. In the end leading to a dog clutch like system.

Criteria	Weight	Dog Clutch	Sliding Spline	Magnetic Coupling
Mass	30%	3	3	3
Durability	30%	4	3	2
Size	20%	3	2	3
User friendly	5%	2	3	4
Manufacturability	15%	2	4	3
Total	100%	3.1	2.95	2.75



FEA analysis: Local Stress on tooth
Max stress < Yield 460MPA

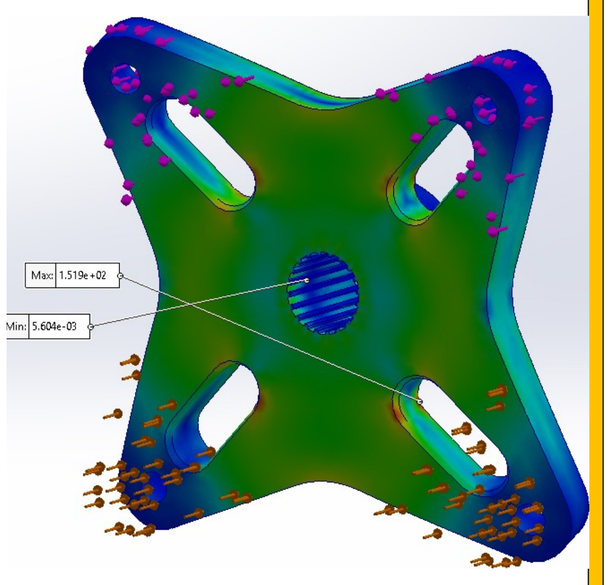


Wheel Hub

The wheel hub is a crucial component in the wheel assembly that is responsible for holding the wheel, brake rotor and connects all these components to the steering system.

- The objective was to improve hub performance across three loading scenarios — weight, turning, and braking forces.
- New hub design showed improved performance across all categories.

Design	Braking Force FOS	Turning Force FOS
Original Hub	2.906	0.2161
Hub Design 2	3.124	1.811



Tensioner

A tensioner is a mechanical device used to maintain the proper tension on the chain drive system. It was discovered during competition the internal threads stripped that lead the chain to slack, vibrate and power loss.
The goal is improving the current design in durability while maintain similar dimension and material. We decided to increasing the bolt size which led to enhancing the fatigue life of the internal thread. We made the tensioner with larger bolt sizes and tested for endurance on the baja car.

