College of Engineering
LAMAR UNIVERSITY

Department of
Mechanical engineering

2022 SAE Baja Collegiate Design series – Baja Birds

Project Description-Baja SAE 2022 Rochester NY.

The 2022 Baja SAE competition is a multi-faceted competition, designed to test college students' ability to design and fabricate an offroad vehicle within a production vehicle context. The competition has many design restrictions to prevent injury and enable a fair competition. Such as the competition's signature restriction, that all vehicles are required to use a Briggs & Stratton 10 HP OHV Vanguard Model 19 engine for the 2022 competition year. Along with the mechanical requirements, our team is also competing in business related events. We must pitch to a panel of judges, why our envisioned company should be the sole provider of vehicles for a fictitious desert racing event near Las Vegas. Our team's goal is to produce an operational prototype that's reliable and capable enough to complete in the many dynamic events being held at competition.

- Static events: Technical inspection, Business presentation, Design evaluation, Cost event, Rule knowledge event.
- Dynamic events: Acceleration, Suspension, Maneuverability, Sled pull, Endurance race(3 hours).

Fabrication and Meeting Rule Requirements

Our team is not the first to work on this frame. This was ideal, since our team is too small to start from scratch. However, there were many issues we needed to fix. As well as missing many rule-required features.

Major Inherited issues-

1. Suspension bracketry causes wheel misalignment and restricted suspension travel
2. CV axles not sized correctly for rear drive train, causing CV joint failure
3. Existing fuel tank mount violated SAE rules

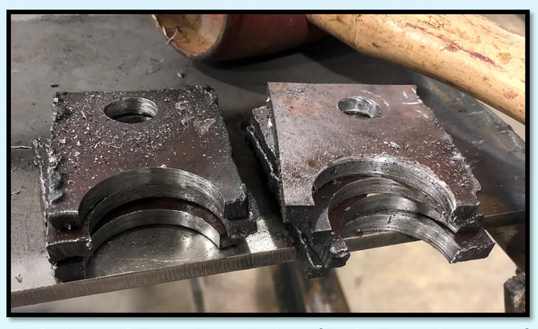
Minor Inherited issues-

-steering control arms to short -inadequate welding –upside down differential –unsupported steering shaft -battery box mount failure -transmission and differential alignment -rule violating harness mounts -non-functioning sensors

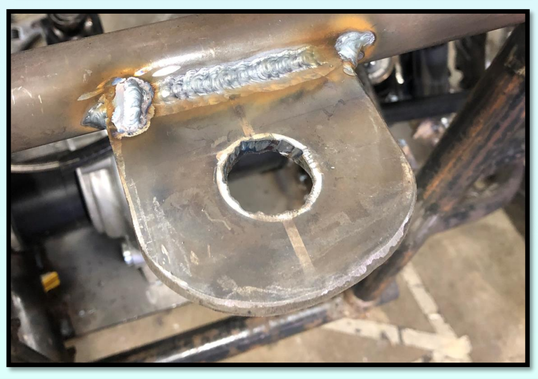
Solution

All these problems where remediated through the refabrication and installation of previously faulty components. The drivetrain and suspension issues where significant enough that it was all removed and re-installed with new mounts and improved orientation.

Remanufactured Suspension Mounts



Fabricated Rear Tow Point (Rule Requirement)



Disassembled Frame

Resourcefulness

This project required a great deal of "scrappy engineering" many parts and modified components were made in house, using what was available, (while still meeting rule requirements) this allowed for a relatively low-cost building season.

Transmission Tuning

Our vehicle uses a continuously variable transmission or CVT, to transmit power between the engine and gearcase. A CVT consists of a primary pulley, secondary pulley, and v belt. The primary pulley uses a series of weights and a spring to contract two conical sections, increasing the effective diameter that the belt is allowed to run on. The secondary pulley decreases in diameter as rpm increases, using a spring to delay this change. The change in diameters allows for the CVT to change continuously between torque and rpm focused mechanical ratios automatically, based on the rpm of the engine. Using high speed video captured during test drives, we realized our transmission was shifting too quickly, causing significant slippage of the belt. This resulted in inefficiencies including a lower top speed. To counteract this, we needed to adjust the spring rate on the secondary pulley. Higher spring rate will delay the shifting, resulting in less slippage.

Spring Rate Changes

Initial: 18 Lb/in

Adjusted: 30 Lb/in

Our Continuously Variable Transmission

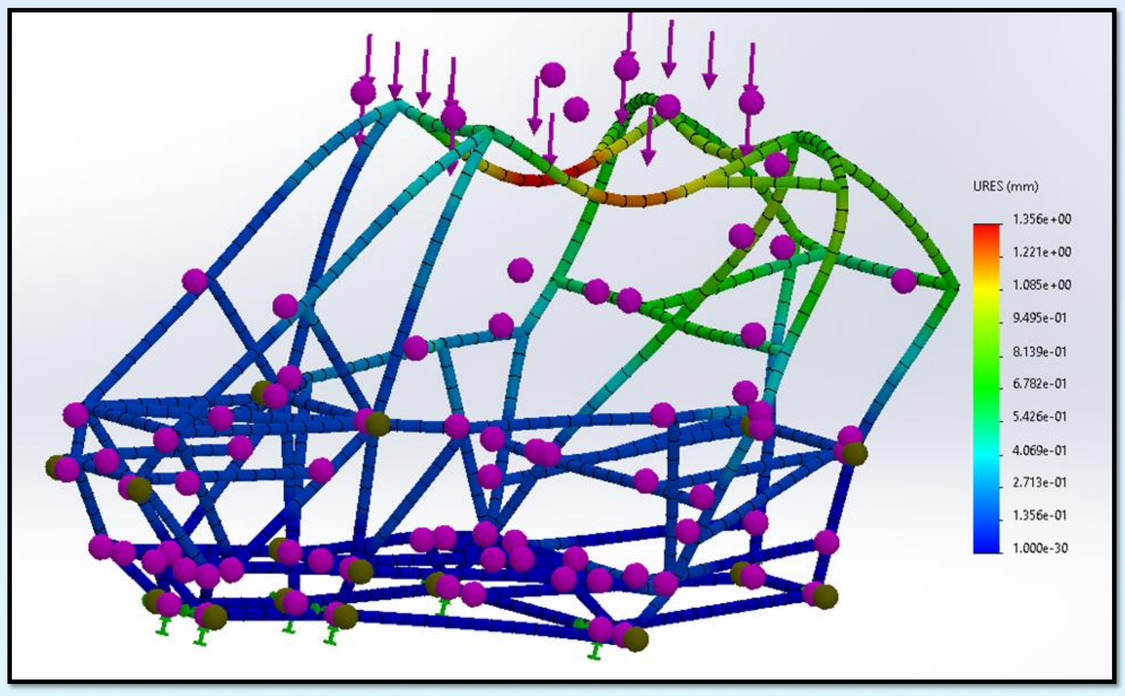
Design process

Our team is building from the previous team's design. After Investigating the vehicle, Multiple issues that would need to be corrected to compete at competition where discovered. The front and rear differentials were mounted upside down in addition to the CV axles being damaged from being forced to run at suboptimal angles. We produced four possible design changes to remedy these drivetrain problems. These options included; fixing the current design, changing to a rear solid axle , using a chain drive system, or removing the existing drivetrain altogether and replacing it with a Polaris gearbox that combines the gearcase and rear differential. We produced a design matrix and scored each option based on the estimated reliability, cost, effect to our suspension, work required , and how it would affect the overall weight. Higher score is theoretically better.

Design Option	Fix Current Design	Solid Axle	Chain Drive	Polaris Gearbox Swap
Reliability	2	10	1	6
Cost	5	4	6	6
Suspension Stance	5	7	7	9
Work Required	10	2	3	4
Weight	8	3	8	8
Final Score	**30**	**26**	**25**	**33**

FEA

To ensure our frame would hold up to the rigors of competition and maintain driver safety, FEA in Solid works was utilized. A rollover situation was modeled with the base of the frame being fixed and a force being applied to the top of the frame. We used an 850-pound force for the analysis, which is significantly higher than the overall loaded weight of the vehicle. We estimate this weight to be around 550-600 pounds. Based on the displacement calculations, the highest displacement of the frame will be 1.35 mm. The below images show the displacement scaled up by 208.19 times. We believe that this low amount of deformation for load well above the vehicle's own weight, to be satisfactory.



Financials

Our team's Goal is to make it to competition in Rochester NY, here are some cost totals and estimations to build and get there.

Item	cost
Food	$400
Fuel (4.00$ /gallon)(12mpg towing)	$1033
Lodging (2 rooms) (4 nights)	$1040
Total	$2473

Item	cost
Raw Materials and Fasteners	$310
Tools and Welding Materials	$90
Purchased Parts	$600
Total	$1000

Students

Lee Cravens, Ian Kennard, Matthew Davis, D'Angelo Dunning
Faculty Advisor: Dr. Jenny Zhou

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