

SAE Mini Baja Frame

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Team 01

Progress Report

Document

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Abstract

The frame of the SAE Baja vehicle needs to be lightweight and structurally sound to be competitive but still protect the driver. The vehicle needs to traverse all types of off-road conditions including large rocks, downed logs, mud holes, steep inclines, jumps and off camber turns. During the competition events there is significant risk of rollovers, falling from steep ledges, collisions with stationary objects, or impacts from other vehicles. There are certain needs and constraints that will be defined to create a frame that can be resilient to these conditions. Minor modifications have been made to the frame. The front end was redesigned with larger bend radii. The front angle was also modified to make sure that all suspension components fit with proper clearance. The rear end was modified to house the new single unit gearbox and differential. Construction has begun on the vehicle and the roll cage and parts the front end have been completed. The team is on schedule, but more time may need to be allotted to finish final construction of the frame itself.

Chapter 1. Introduction

1.1 Project Overview

The Society of Automotive Engineers International (SAE) has contracted the team to design a Mini Baja vehicle. The stakeholders for the project include Dr. John Tester and the Northern Arizona University student chapter of SAE. SAE is a United States based organization that provides international standards for the automotive, aerospace, and commercial vehicle industries. They sponsor a variety of collegiate competitions that simulate the real-world engineering process and challenge students in their area of study. The SAE Mini Baja competition is designed to challenge each team in the design, planning, and manufacturing process as applied to a small off-road vehicle that could be turned into a consumer product. The competition consists of a variety of different events to test speed and maneuverability, and culminates in a final endurance race. The frame team has been assigned the task of designing the frame of the vehicle and ensuring the overall vehicle compliance with the safety regulations.

1.2 Project Need Statement

NAU has not won an event at the SAE Mini Baja competition in many years. During the competition, there will be several events that will test the limits of the vehicle. They include the Presentation, Hill Climb, Endurance, and Acceleration tests. The team must make a sales presentation to a panel of judges on the viability of the design as a consumer product. The maneuverability test consists of a variety of tough obstacles and tight turns, and the hill climb event tests the vehicle's traction and stability while climbing a steep hill. The endurance race is a three hour driving test to test the long-term reliability and average speed of the vehicle. The acceleration event tests the maximum speed of the vehicle. It has been many years since NAU has won an event, and a single event win would satisfy our stakeholders. Therefore, the solution to our need is to win a single event at the 2014 SAE Mini Baja competition.

1.3 Project Goals

The specific goal for our sub-team is to design the lightest possible frame that satisfies all the criteria specified in the 2014 SAE Mini Baja rulebook. This will maximize the Baja Team's chance of winning an event at the completion. To achieve this goal, the team must use lightweight materials and minimize the size of the frame. At the same time, the frame must be designed to meet all the safety requirements. After the frame is completed, the team's goal shifts to the overall safety of the vehicle. The team will ensure that all the sub-teams adhere to the strict safety guidelines throughout the design process and perform safety checks before the competition.

Chapter 2. Previous Progress

As of the last progress report, the frame was mostly completed with the roll cage and the front end finished. Design modifications were proposed for the rear end of the frame to accommodate changed drivetrain components. Further frame design clarifications were on hold, pending the arrival of the CVT and the shipment of parts from Polaris.

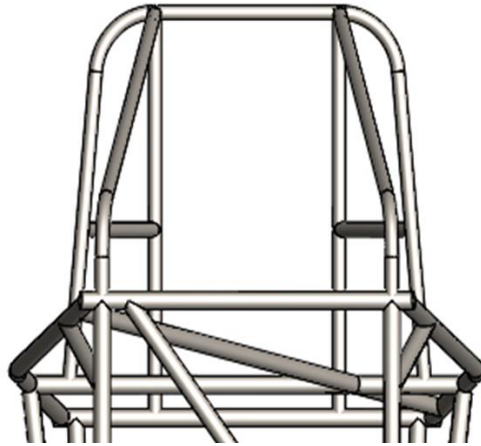


Figure 1. Rear end design modifications.



Figure 2. Frame as of the last progress report.

Chapter 3. Current Progress

3.1 Frame

Since the last progress report, the rear end modifications were finalized and added to the frame. The frame will now properly accommodate the combined engine/drivetrain mount that includes the engine, CVT, and differential. The mount itself has been machined and is ready to be installed in the vehicle. The tubing members that comprise the floor of the roll cage were designed and installed, including the mount for the seat. The shipment of parts from Polaris has arrived, allowing a queue of mounting features to be dimensionally verified and finalized.



Figure 3. Current state of the frame with the rear end and seat mount installed.

3.2 Firewall

SAE requires that a steel sheet metal firewall be installed on the rear roll hoop between the engine and the driver. As its name suggests, the firewall protects the driver from fire in the case of an engine failure or fuel leak during a crash. The firewall also offers protection from flying debris from a catastrophic suspension or drivetrain failure. The team originally designed the firewall as a single piece of sheet metal to be placed on the inside of the roll cage, but quickly realized installation would be difficult or impossible. The solution was to cut the firewall into two sections for easy installation. This is allowed by SAE if the gap is sealed properly. The picture below shows the firewall being held in place, ready to be installed.



Figure 4. Dry-fit of the firewall.

3.3 Safety Kill-Switch

SAE requires teams to mount an emergency ignition kill-switch that is accessible from outside the vehicle. The team designed and machined a mount from aluminum that can be attached to a tab on the frame. If the kill-switch fails or breaks, the mount can be easily disassembled to replace the switch.

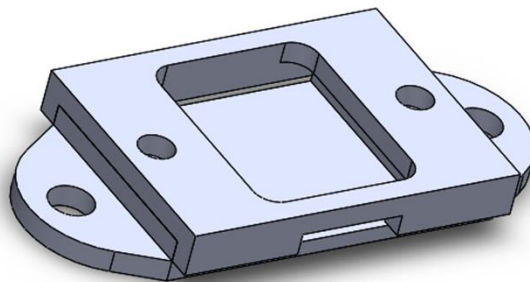


Figure 5. 3D model of the kill-switch mount.



Figure 6. Finished mount with switch installed.

3.4 Cost Report

The team created an overall vehicle cost report as part of the list of documents that are submitted to SAE for the competition. This cost report is for all three capstone teams, and includes all the parts and labor used to build the vehicle. For donated parts, the wholesale cost is used. SAE provided guidelines for calculating the labor costs for welding and assembly. It is intended to be an estimate of the unit cost if the vehicle were to be commercially produced, which is \$13,018.30 for this year's vehicle.

3.5 Fundraising

The team has secured an additional \$4000 in funding for the NAU chapter of SAE from The Associated Students of Northern Arizona University. The combined NAU Baja capstone teams gave a short presentation to the ASNAU senate, and the motion to grant the \$4000 to SAE passed unanimously. Also, a fundraiser for SAE Baja is being held on Friday, March 14th at Louie's Chicken Shack in Flagstaff. Flyers have been placed at various locations around town and emailed to the engineering department. From noon to 5 p.m. on the day of the fundraiser, 15% of the proceeds will be donated to SAE.

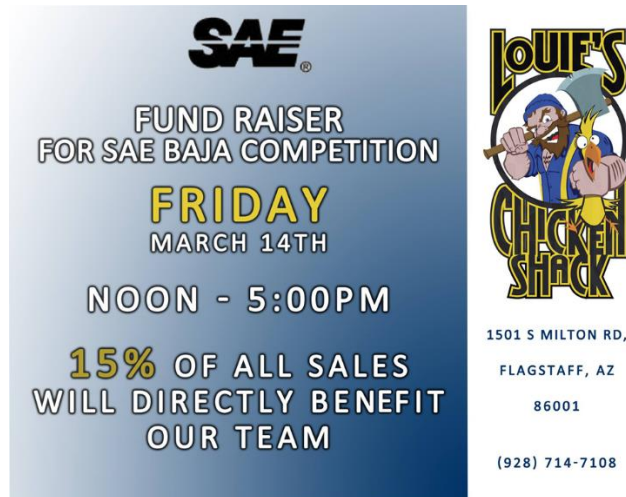


Figure 7. Flyer for the March 14th fundraiser.

Chapter 4. Project Plan

The team has completed the construction of frame itself. The firewall, body panels, and some tabs for the seat belt still need to be attached. The firewall will be attached by March 7th and the tabs for the suspension and seatbelts should be on the frame by March 10th. By the end of Spring Break, the vehicle will hopefully be rolling with all the components attached. This will allow the teams one month to conduct testing to make sure that all the systems and sub-systems work with one another. The design report for SAE is due by the 20th of March. Work has begun by all teams to make sure that the report gets submitted on time. The competition is April 24-27. The team will travel down to El Paso on April 23rd and return on the 28th. The hotel rooms have already been booked. The team is on schedule to finish the project on time as shown in the Gantt chart below.

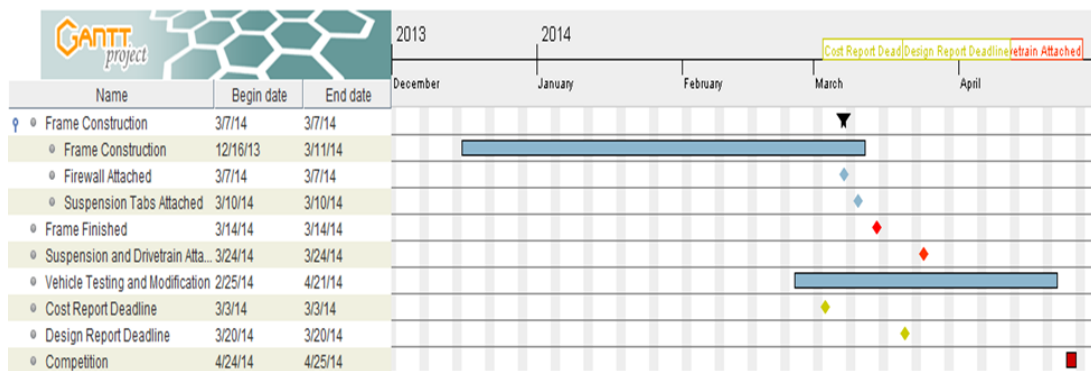


Figure 8. Updated Gantt chart for Spring 2014.

Chapter 5. Conclusion

The team was contracted to build a Mini Baja vehicle which can be competitive and possibly win at competition. The vehicle must conform to stringent rules and regulations outlined in the SAE Baja rulebook. The new rear-end design presented in the last report has been manufactured and welded to the rest of the frame. The bottom members of the roll cage were installed, including the seat mount and the seat itself. The firewall was designed and manufactured, then cut into two pieces for ease of installation. Mounting tabs for the firewall were cut, and the firewall is ready for installation. A mounting bracket for the safety kill-switch was designed and machined, and is also ready for installation on the vehicle. The cost report document for SAE was finished and submitted for review. An additional \$4000 from ASNAU was added to the budget, with a separate fundraiser at Louie's Chicken Shack scheduled for March 14th. The team is currently on track to finish the vehicle on time, but more time was allotted for the installation of the suspension mounting points.