SAE Mini Baja Frame

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Team 01

Progress Report

Document

Submitted towards partial fulfillment of the requirements for
Mechanical Engineering Design II – Spring 2014

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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. Design Modifications

2.1 Front End Redesign

There were a couple changes had to be made before construction of the front end of the frame. The first change was the tubing diameter and thickness size. The SAE Baja rules state that smaller tubing can be used outside of the roll cage. The original tubing selection had a 1.0 inch diameter and 0.035 inch wall thickness. Dr. John Tester advised the team to increase the diameter size and wall thickness of the tubing to strengthen the front end of the frame. The new selection of tubing has a 1.25 inch diameter and 0.065 inch wall thickness. Changing the size of the tubing assured the team that the front-end would not buckle under extreme cases.

The second change to the front-end design was the radii of the bends. Originally all the bends had a 3 inch radius. The only die available for the tubing bender at building 98C was one with a 4.5 inch radius, so the front-end was redesigned to accommodate for the larger bend radii. The front angle was decreased in order to keep the length of pipe on the bottom the same. The A-arms will attach there and without out this key change, there would not be enough space to mount the A-arms. Mounts for shock were also created. This will allow the shocks to mount in a more vertical position giving the vehicle better handling characteristics. The original design is shown in Figure 1 and the updated design is shown in Figure 2.

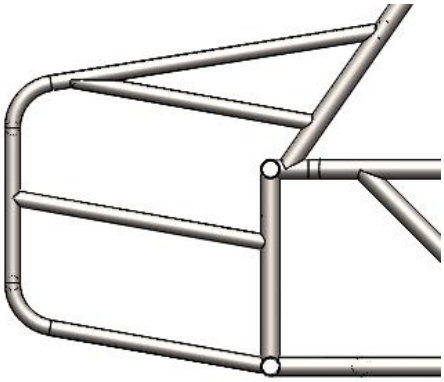

Figure 1: Old Design

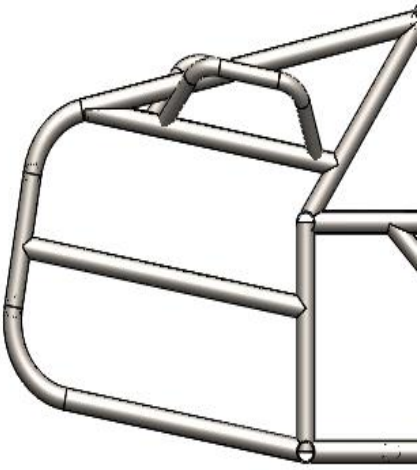

Figure 2: New Design

2.2 Rear End Redesign

There was one big change the team made to the rear end frame design. The frame was originally designed for enough space that can hold a separate gearbox and differential. The old design was large in order to accommodate all the necessary drivetrain components as shown in Figure 3.

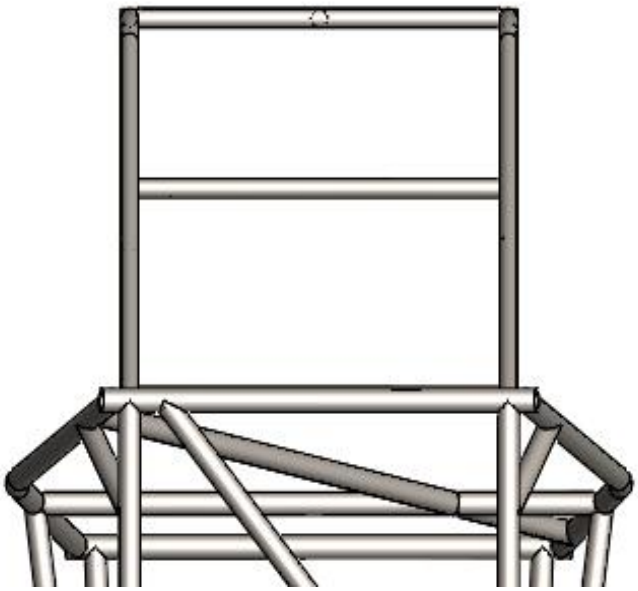

Figure 3: Old Rear-end Design

Instead of using a separate gearbox and differential, the team is using a single unit gearbox and differential. This unit is much smaller than the separate gearbox and differential. The rear end was reworked to accept the new drivetrain components. The rear end was made narrower and shorter to reflect the changes in drivetrain components as shown in Figure 4. Making the rear-end smaller will allow the team to run longer A-arms giving the vehicle more suspension travel while reducing the overall weight of the vehicle.

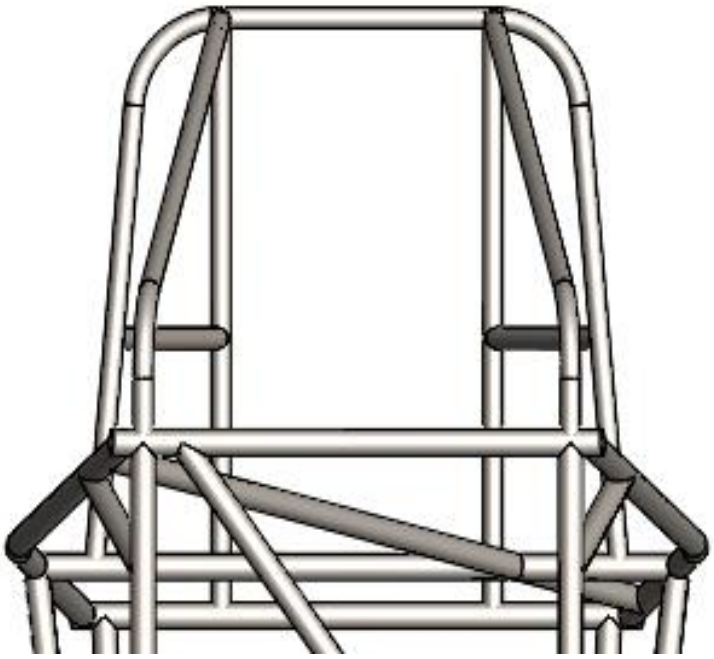

Figure 4: New Rear-end Design

Chapter 3. Current Progress

3.1 Frame Construction

Construction has begun on the frame. The roll cage and parts of the front have been completed shown in Figure 5. The Frame should be completed in the next couple of weeks. The team has been holding off on attaching the rear members as well as the cross members on the bottom until other parts such as the seat and shocks arrive. These parts are needed so the locations of the tubing will be correctly placed and these items will attach properly. The rear was also re-designed due to a change with transmission selection and design; a smaller single unit differential and gearbox was purchased and will be used.

Figure 5 Current Progress of the Frame

3.2 Project Plan Update

The frame was due to be finished by January 31st 2014 however with the design modifications, the finish date will be pushed back until February 15th 2014 shown in Gantt chart below. The final vehicle assembly has been pushed back to March 3, 2014 from February 24, 2014. Even though these two deadlines have been pushed back, the other teams can start assembling their components to make sure that everything fits properly.

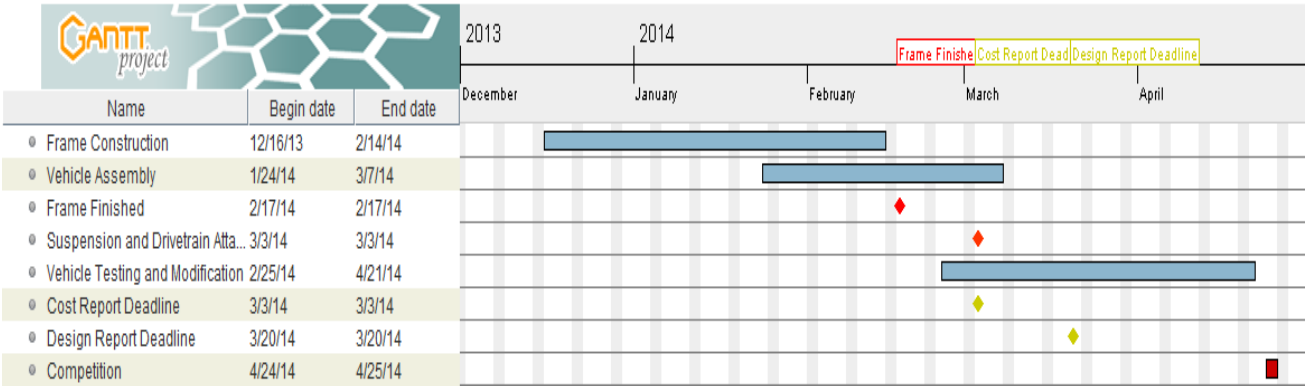

Figure 6. Gantt chart for Spring 2014

Chapter 4. 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 handbook. The front end was redesigned due to the availability tools at the fabrication shop. The bend radius was increased from 3 inches to 4.5 inches. The larger bend radius also decreased the front angle. The rear end was modified to accept the new single unit differential and gearbox. Construction has begun on the frame and the roll cage and parts of the front end have been completed. The team is currently on schedule, but some more time has been allocated for frame construction to account for the design modifications.