VMI Mini Baja Senior Design Competition 2009

Introduction

Baja SAE Alabama marked the Virginia Military Institute's third year competing in the Baja SAE East competitions. This year the team worked hard and overcame many hurdles to design and build their third generation car. With a completely redesigned frame and a more innovative approach in the rear end, the ten senior mechanical engineering Cadets on the team have cut costs, size, and weight, expected to present a very competitive design in this year's Eastern event.

Team Members (VMI's 2009 Racin' Roos)

Faculty Advisor – LTC Jay Sullivan

Team Leader – Thomas Gottwald

Drive Train – Kyle Braun, Drew Thompson, Garth Willard

Suspension – Andrew Beard, Shawn Graham

Frame – Leon Barrow, Ben Kyler, Mitchell Ress, Andrew Rohrback

Baja SAE Program Objective

Baja SAE is an intercollegiate engineering design competition for undergraduate and graduate engineering students. The object of the competition is to simulate real-world engineering design projects and their related challenges. Each team is competing to have its design accepted for manufacture by a fictitious firm. The students must function as a team to design, build, test, promote and compete with a vehicle within the limits of the rules. They must also generate financial support for their project and manage their educational priorities.

Competition Goals

Each team's goal is to design and build a prototype of a rugged, single seat, off-road recreational vehicle intended for sale to the non-professional weekend off-road enthusiast. The vehicle must be safe, easily transported, easily maintained and fun to drive. It should be able to negotiate rough terrain in all types of weather without damage.

Additional goals of the competition are to provide an opportunity for students to (1) learn that public safety is an important aspect of engineering, (2) learn the engineering design, fabrication and testing aspects that are necessary to produce a safe and competitive vehicle, and (3) provide a learning experience for students.

Component Summaries

Frame

In designing the frame, the team designed around the following desired characteristics: a short wheel base, minimize weight, maximize ground clearance, lower the center of gravity, and comply with all SAE rules. By using these guidelines and integrating the desired drive train and suspension the team was able design a very compact, yet comfortable frame. Autodesk Inventor was used to produce a 3-D model of the design. Following the initial design, the ANSYS package was used to determine any weak points. Using the finite element analysis, the frame was then finalized and constructed, using 4130 1-1/4 in normalized steel tubing.

Suspension

The suspension group's design was similar to previous years, as it was based upon independent A-arms in the front and rear. There was, however, an emphasis on changing the mount design. In order to reduce camber throughout the full 5 in travel of the A-arms, the suspension mounts were staggered, with the lower A-arms being longer than the upper A-arms. To increase A-arm length, and because of no water event this year, thinner rear tires were chosen. The large spring-shocks and brake calipers from last year's car were also used, in order to cut costs.

Drive Train

This year's drive train was designed keeping speed, maneuverability, reliability, and cost in mind. By entering considerations such as engine output speed, tire size, and estimated torque needs, an analysis was written in Mathcad, and a top speed was estimated to be around 36 mph. To get the required reduction, a Comet 790 CVT was bought and used to connect the supplied Briggs & Stratton 10 hp engine to the Tuff Torq transmission, which had been donated. This transmission was heavy, but it gave the car Forward-Neutral-Reverse capabilities. Interestingly enough, the VMI car was one of only a handful of cars at the competition to have the ability to shift into reverse or even neutral. This characteristic definitely stood out with competition judges.

Alabama and the Competition

The competition in Auburn consisted of evaluations on the cost and design reports, a technical inspection and brake test, four dynamic events, then a four hour endurance race. In the technical inspection, the team had some minor issues with the frame and harness mounting but was able to fix them by the second day. During the suspension event, the car, being laterally unstable due to the engine mounting, rolled over and the team was unable to complete it. Also, the endurance race was cut short by a broken A-arm. Even so, the team finished first in the traction event and 68th overall.