SAE Mini Baja West

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Team 11

Concept Generation
Document

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Introduction

This report provides a brief discussion about certain elements that are put in for the frame team's project for SAE Mini Baja Competition. These project elements are the frame design concepts. Each one of the frame team members had input into designing the decision matrix for the design concepts that have been designed by the team members. The decision matrix was then used to determine which two designs that the frame would be built off of.

Since we are participating in the SAE Mini Baja Competition in May, the team's mission is to design a manufactural frame that will last through the SAE competition's dynamic events. Since the weight of last year's baja has been a concern to our client Dr. Tester, the frame team would like to design a frame that is light in weight and small in size. Also, we want to build a mini baja vehicle that outperforms last year's baja vehicle, and have the roll cage ready for testing by Dec. 7st.

Modified Timeline

The Timeline from last report has been slightly adjusted. Due to design taking longer than expected. The design will finished by Oct. 25th, which also pushes back the final build of the prototype to Dec. 7th. The adjusted Gantt Chart is below in *Figure 1*.

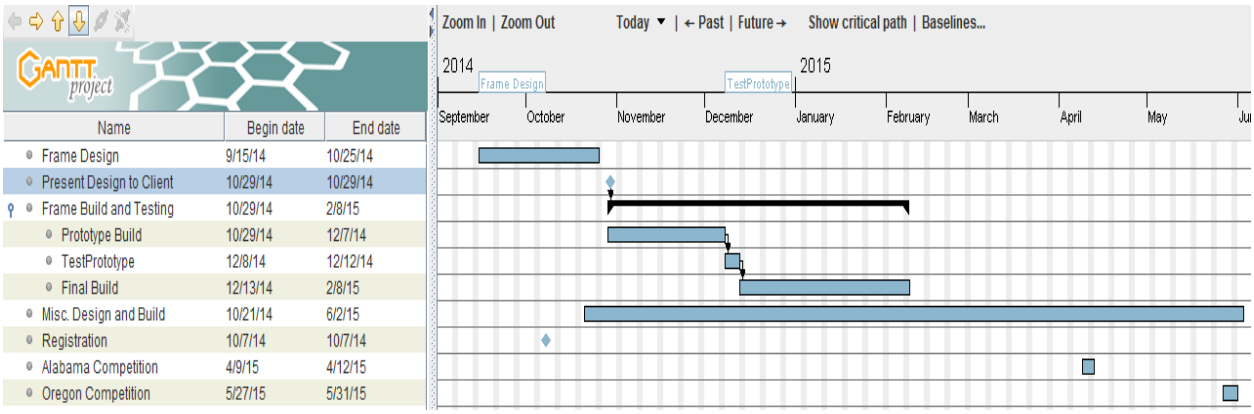

Figure 1: *Updated Timeline*

Concept Generation

The team came up with six different designs for the overall frame. Below are the descriptions of each design.

Truck Frame Design

One of the frame design concepts was a truck frame design. The concept behind this frame design was to build a vehicle as a truck with toe and chamber off road racing suspension. Since a lot of trucks are built to be driven rough road and under rough conditions, a truck design can be a durable baja frame. In addition, the SAE mini baja competition is going to take a place in Portland, Oregon where the competitor mini baja vehicles are going to be tested under rough road conditions against each other, and in order to last through the SAE competition dynamic events, our mini baja team needs to build a vehicle that is tough in strength, light enough to complete the competition successfully. The advantage to using this design is due to its light weight and unique. In all the previous competitions, there has never been a frame design that had a bed, which would be appealing to a fictitious buyer. The disadvantage to this design would be not much room the other components such as the motor. A sketch and an image are included below, to better represent the idea of the Truck Frame Design (*Image 1*)

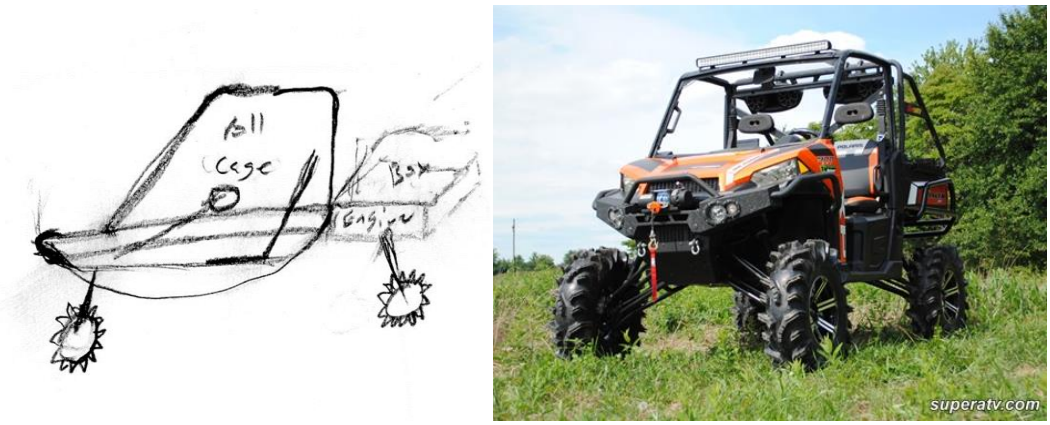

Image 1: *Truck Frame Design* ***[1]***

Old Volkswagen Design

The Old Volkswagen Buggy Design is a baja frame that is built like an old Volkswagen buggy vehicle with toe and chamber off road racing suspension. Since this is a common off road vehicle that is small, it would be appealing for this competition since the frame for these vehicles perform well in off road environments. The advantages to this design is the size, which would decrease weight and cost along with a unique oval design. This design also can be equipped with a front trunk that is also appealing to a fictitious company. The disadvantage to this design would be the design would be hard to keep within SAE Baja 2015 Rules. A sketch and an image are included further, so the idea can be better seen and visualized (*Image 2).*

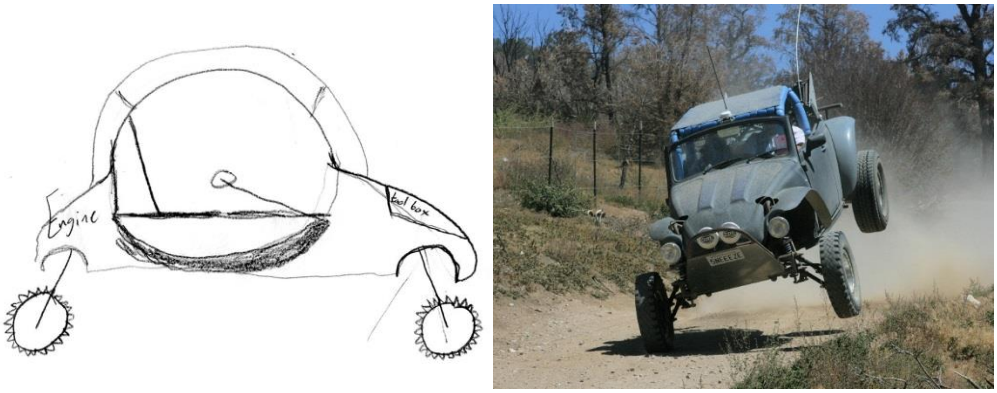

Image 2: *Old Volkswagen Design [2]*

Front Bracing Design

Below is *Image 3*, a right side view of the frame design.

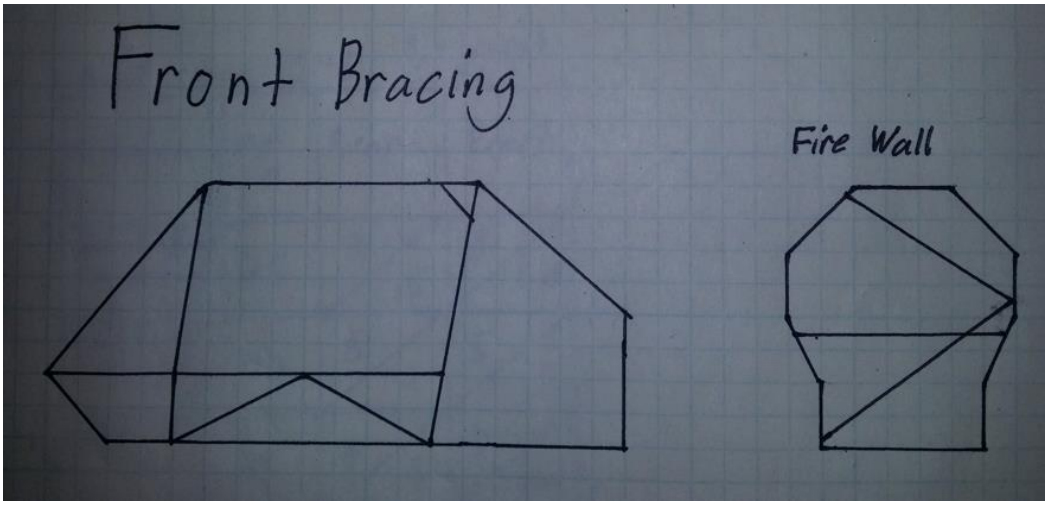

Image 3: *Front Bracing Design*

The Front bracing concept also incorporates the minimum amount of required members needed for front bracing due to the SAE Rules for 2015. This design also has a front approach angle integrated as the Rear Bracing Design. Some advantages of this design are that this design allows for pure customization of the rear of the vehicle for suspension and drivetrain sub groups to install their designs with ease. It adds weight to the front of the vehicle which positively impacts the weight front to rear weight ratio. As an added strength component, the rear roll hoop has an extra member added. The main disadvantage of this design is that there is an added member in the front of the vehicle that can lower the vision of the driver.

Rear Bracing Design

Below is *Image 4*, a right side view of the rear bracing design.

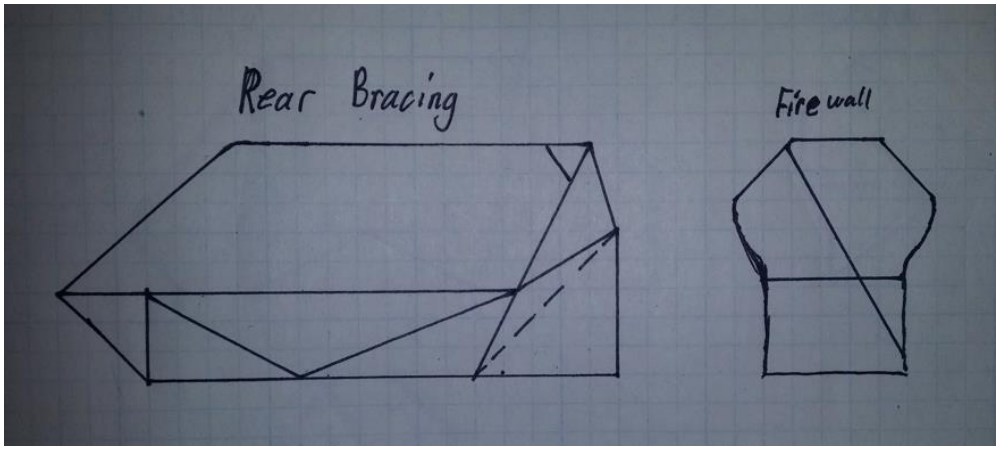

Image 4: *Rear Bracing Design*

The rear bracing concept incorporates the minimum amount of members required by the rules established by the SAE Rules for 2015. Along with having the minimum amount of members required, the frame design also has a front that is angled for approaching hills and rocks. Some advantages to this design: It allows for a simpler firewall design because of the extra added support members that will be in the rear of the vehicle, behind the driver. The rear bracing member can be moved depending on the needs of the suspension and drivetrain team as show below in *Image 5* with the blue dotted lines.

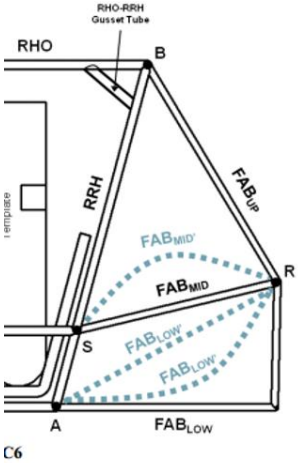

Image 5*: Rear Supporting Members* ***[3]***

The main disadvantage to the rear bracing design is that it negatively impacts the weight ratio of the vehicle with more weight being added to the rear of the vehicle.

Compact Concept Design 1

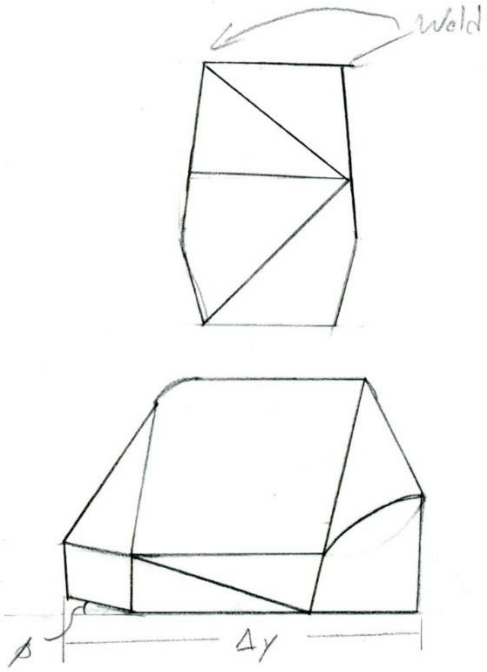

Image 6: Compact Concept Design 1

Compact Concept Design 1 is a rear supported frame design which conforms to the SAE Baja 2015 Rules. The focus of this design was to decrease the length (Δy) of the frame as much as possible to keep the weight down. Also to decrease weight, this concept uses as few as members as possible. The advantages to using this design is that since there are few members, it would be simple to build. This would also decrease the cost of the frame along with the weight. The disadvantages to this design is that it would not be as strong as some of the other designs due to fewer number of members supporting the frame. Also since it is taller, it has a higher chance to flip due to a higher center of gravity.

Compact Concept Design 2

Compact Concept Design 2 is a front supported frame design which conforms to the SAE Baja 2015 Rules. The focus of this design was to decrease the width (Δx) and the height (Δz) as much as possible to keep the weight down. The advantages to using this design is that the weight distribution of the frame will be towards the front, helping the overall weight distribution. This frame is also short which allows for a lower center of gravity. The disadvantages to this design is that it is more complex to build, which takes longer to build.

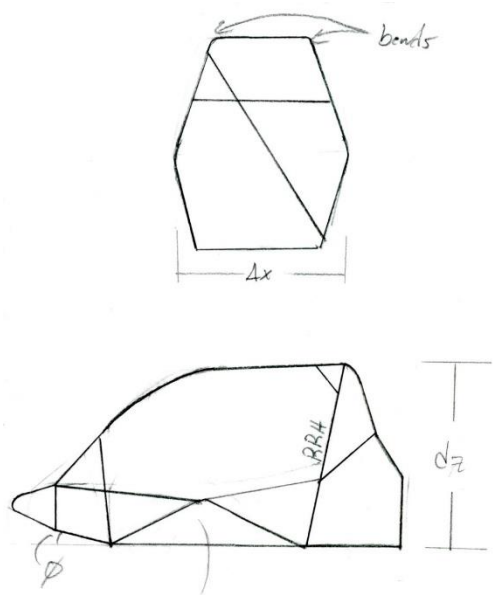

Image 7: Compact Concept Design 2

Matrix and Criteria

To determine which designs would be used, the team made a decision matrix with the following criteria: Overall Weight, Cost, Strength, Room for Modifications, Simplicity, Ability to Install Accessories, Driver Accessibility. Each criteria was weighted differently, with Overall Weight and Cost be highest and Ability to Install Accessories being least in points. Each team member was then given a decision matrix to fill out on their own for the six designs. *Table 1* shows the final decision matrix, which is the average points of all the team member's decision matrices.

Table 1: Final Group Decision Matrix

Group Matrix	**Criteria (Rating System: 1-5)**							
Design	Overall Weight	Driver Accessibility	Strength	Simplicity	Room for Modifications	Cost	Ability to Install Accessories	Total Score
Truck Frame Design	2.67	3.67	3.33	3.33	3.00	3.00	3.33	3.12
Volkswagen Buggy Frame Design	3.00	3.67	4.33	2.67	2.33	3.33	3.67	3.30
Rear Brace	4.67	4.33	4.00	3.67	4.00	4.33	3.67	4.17
Front Brace	4.67	4.33	4.33	3.67	4.33	4.00	3.67	4.21
Compact Design 1	4.67	4.33	4.00	4.33	4.00	4.33	3.67	4.23
Compact Design 2	4.33	4.33	4.67	3.00	4.00	4.33	3.67	4.15
Scale	0.2	0.09	0.18	0.1	0.14	0.2	0.09	

As shown in the Group Decision Matrix (*Table 1)* the two top designs were the Rear Bracing Design and the Compact Design 1.

Conclusion

Out of the six designs, Rear Bracing Design and the Compact Design1 won due to how light weight they are. Dr. John Tester explained that his greatest need for the new frame is for it to be light in weight, which is why the two designs were chosen from the decision matrix, along with being inexpensive. Now these two design will now be used to design a single frame that will be presented to Dr. Tester for approval along with analysis on the frame.

Once the team receives approval from Dr. Tester, based off funding, the team will then start to build a prototype frame for crush testing and more analysis by December 7th.

References

[1]. http://www.superatv.com/Polaris-Ranger-XP-900-6-Lift-Kit-P8182.aspx, access 2014.

[2]. http://socalbajas.com/, access 2014.

[3]. 2015 Collegiate Design Series Baja SAE Rules