**Dustin Whiddon – Literature Review**

**Research Question:** Design a new frame for the SAE BAJA car, and also design a new suspension system, as well as incorporate all wheel steering (if possible within the time constraints).

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|  | **Source/Evidence/ Data #1** | **Source #2** | **Source #3** | **Source #4** | **Source #5** |
| **Citation** | [1] | [2] | [3] | [4] | [5] |
| **Purpose** | -To adequately test the roll cage of an SAE BAJA car to ensure occupant safety, comfort, increase performance, and drivability.  - Perform static analysis of frontal collisions. | -to evaluate through  simulations the effects of active chassis systems on  vehicle propensity to rollover caused by aggressive  Handling maneuvers. | -Improving vehicle noise, vibration and harshness (NVH) in an automotive vehicle, all of which stem from the manner in which the powerplant (engine) is mounted. | -To determine the whole body vibrations and hand-arm vibrations of the pilot of an off road BAJA car. | -The project was aimed to design the frame and suspension of the SAE NAJA car. |
| **Why is the study necessary?** | -Because the SAE BAJA manual restricts the vehicle weight, size, and shape, proper testing must be done to ensure the safety of not only the occupant, but spectators, and over participants. | -Because the BAJA car is an off-road race car, it has a higher center of gravity. This results in a greater risk of the vehicle being involved in a rollover crash. | -In addition to the powerplant being properly restrained when mounted in the chassis, the vast majority of vibrations in the car come from the engine.  -In addition to driver discomfort, it can cause deformations, fatigue, etc. | -This is important because as more students participate in this activity, they are subjecting themselves to health and safety risks such as trauma of the spine, bone, articulation, neurological, and muscular disorders.  -It’s important to monitor these levels. | -The design of the BAJA from is defined by the design safety rules set forth by the SAE. The frame design must comply with these rules. |
| **Methods** | -The roll cage is developed in Ansys. All of the pertinent details can be input into this modelling program to determine where the maximum stresses are. | -The vehicle model used in this study has a total of 16 degrees of freedom, which can perform 3 translations and 3 rotations. | -By modeling the various engine options, with different chassis designs. | -determinations of WBV and HAV were realized in a prototype off-road vehicle. | -The modeling of the frame and suspension was done with pro-e software.  -The design was check by Finite Element Analysis after estimating the load and weight of the frame. |
| **Results** | -The value for the deformed shape is 2.784mm, which is acceptable.  - The von misses stress is 191.299 MPa, which is in the required limits. | -3 methods of reducing rollover were tested, and ultimately it was found that any time 2 of the 3 systems employed were utilized, the rollover chance reduced to 0. | -They were able to calculate the optimum location for mounting the engine, of several different types of engines. | -The results were a part of a graph, not sure I would reproduce those results on this matrix. | -They were able to optimize a frame and suspension design, while adhering to the guidelines of the SAE. |
| **Discussion/Conclusion** | -Based on the material properties, and design of the frame, the overall safety factor is 1.54, this is acceptable. | -They saw an increase in the stability factor by about 12%. |  | - In general the vibrations transmitted were low, and not considered overall harmful. During acceleration the levels were high, which reinforces the need to find ways to reduce vibrations from both the seat and the steering wheel. | -They were unable to offer a solution for a rollover, but were able to accurately predict where a failure would occur in the event of a rollover (which apparently later happened). |
| **How can this help my senior project?** | -In the event we are asked to design a new frame for next years’ BAJA car, this is essentially what we will be doing. | -While this article is mostly about systems in place to reduce rollover of an SUV, there are parts of it that are directly related to the BAJA car. Namely the active chassis components, and the rear steer. The electronic systems likely wouldn’t be used in our project. | - The only thing I think we could take away from this article would be alternative mounting options for the engine to reduce vibration and fatigue. | -If we find ourselves designing a chassis, then a large part of that will be in designing the cockpit, and subsequently how the pilot sits in the vehicle. | -This article would be a great resource if we have to build our own chassis. |

[1] V. Sharma and D. Purohit, "Simulation of an Off-Road Vehicle Roll Cage: A Static Analysis," *Simulation,* vol. 2, pp. 126-128, 2012.

[2] A. Hac, "Influence of active chassis systems on vehicle propensity to maneuver-induced rollovers," SAE Technical Paper2002.

[3] E. Courteille, L. Leotoing, F. Mortier, and E. Ragneau, "New analytical method to evaluate the powerplant and chassis coupling in the improvement vehicle NVH," *European Journal of Mechanics-A/Solids,* vol. 24, pp. 929-943, 2005.

[4] F. C. Oliveira, G. P. Villibor, J. K. K. Junior, and É. H. F. Lima, "Vibrations evaluation levels on a pilot in an off-road vehicle used in academicals competitions."

[5] T. R. K. Prasad, G. Solasa, N. S. Satyadeep, and G. S. Babu, "Static Analysis and Optimisation of Chassis and Suspension of an All-Terrain Vehicle," *International Journal of Engineering and Advanced Technology (IJEAT) ISSN,* pp. 2249-8958, 2013.