**Research Question: How do I design an exceptional formula car suspension?**

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|  | **Source 1** |
| **Citation** | Rudrendu Shekhar, Akshay Kr. Singh, Vishwajeet Karmwar, Design and Validation of Steering Kinematics for Generating Maximum Cornering Force using a Deterministic Sketch, International Journal of Applied Engineering Research, Volume 8, Number 14, pp. 1737-1747 |
| **Purpose** | This paper talks about the design of a steering system that maximizes cornering force. |
| **Why is the study necessary** | This study is necessary because if one can drive through a corner faster, he/she can enter the turn faster and drive out of the turn sooner and faster. This would dramatically affect lap times. |
| **Methods** | The authors started by calculating the lateral force on the car in a turn. They then broke it down into front and rear tires, both loaded and unloaded. Then began drawing up a kinematic design for the new steering system and evaluating it. |
| **Results** | The turn radii of 6000 mm had the optimum toe angle, both front and back, with the steering rack being positioned 60 mm ahead of the axle. |
| **Discussion/ Conclusion** | A greater steering angle is required if the steering rack is positioned father away from the axle. This is a good system to employ in the design process of a steering rack. |
| **How can this help my senior project** | We may need to redesign the steering system if an overhaul of the front suspension is needed. |

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|  | **Source 2** |
| **Citation** | Guy Richards, More Opera Than Soap, Engineering and Technology, pg. 38-41, 20 June-10 July, 2009 |
| **Purpose** | The purpose of this paper is to explain the different elements of a formula 1 racecar. |
| **Why is the study necessary** | The study is necessary because it explains the importance of these elements. |
| **Methods** | The different elements are thoroughly examined and documented. |
| **Results** | The inerter, or j-damper, is explained.  The balance between grip and handling is explained.  The aerodynamics are broken down and simplified. |
| **Discussion/ Conclusion** | Each element on a formula 1 car directly affects another and all the parts work together for a common goal. |
| **How can this help my senior project** | The main focus of our project is the suspension and this explains different aspects of suspension. |

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|  | **Source 3** |
| **Citation** | V. Totu, C. Alexandru, MULTI-OBJECTIVE OPTIMIZATION OF THE REAR GUIDING LINKAGE OF A FORMULA STUDENT RACE CAR, Bulletin of the Transilvania University of Braşov Series I: Engineering Sciences, Vol. 5, pg 54-58, No. 2, 2012 |
| **Purpose** | The purpose is to optimize the rear suspension of a formula racecar. |
| **Why is the study necessary** | This study is necessary because it teaches students how to make the most of the suspension geometry. |
| **Methods** | Virtual prototyping is done with CAD, MBS, and FEA. CAD is used to construct the model. MBS is used to test and optimize the design. FEA is used to observe deformities and clearances. |
| **Results** | The suspension geometry is improved. The toe, camber, and slip angles are optimized. |
| **Discussion/ Conclusion** | This process of optimization is a multi-objective problem that involves every aspect of the rear suspension. |
| **How can this help my senior project** | Our main focus is redesigning the rear suspension and this article teaches us how to optimize it. |

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|  | **Source 4** |
| **Citation** | Lothar Harzheim, Ulrike Warnecke, Robustness optimization of the position of an anti-roll bar link to avoid the toggling of a rear axle stabilizer, INDUSTRIAL APPLICATION, vol 42, pg 315-323, 2010 |
| **Purpose** | The purpose of this article is to optimize the robustness of the anti-roll bar. |
| **Why is the study necessary** | If not done correctly, the anti-roll bar can ruin a good suspension setup, so it’s important not to make it too stiff. |
| **Methods** | The first step is to find the distance the wheels travel. Then, location points on the control arms are found. An algorithm is used to determine where no toggling occurs. Another algorithm is used to determine the thickness needed. |
| **Results** | The optimum location for the sway bar is found. The optimum thickness for the sway bar is determined. |
| **Discussion/ Conclusion** | Several algorithms were used to determine the optimum setup for the anti-roll bar. They were used with a Monte Carlo simulation based on a Kriging model. |
| **How can this help my senior project** | We are thinking of incorporating an anti-roll bar onto the formula car. |

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|  | **Source 5** |
| **Citation** | Ming Foong Soong, Rahizer Ramli, Wan Nor Liza Wan Mahadi, 1145. Vehicle suspensions with parallel inerter: effectiveness in improving vibration isolation, © JVE INTERNATIONAL LTD.JOURNAL OF VIBROENGINEERING, VOLUME 16, ISSUE 1, pg 256-265, February 2014 |
| **Purpose** | The purpose of this article is to show the significance of an inerter, otherwise known as a j-damper. |
| **Why is the study necessary** | Inerters are used to limit the dive and squat tendencies of cars during braking and acceleration. Inerters react to acceleration like springs and dampers react to displacement and velocity |
| **Methods** | Several equations are used to calculate the acceleration that needs to be dampened. The strength of the inerter can then be calculated. The inerter is then incorporated into the suspension in a parallel orientation. |
| **Results** | The car squats less under acceleration and it dives less under braking. It gives the car a much more even stance. It still leaves the suspension passive and not active. |
| **Discussion/ Conclusion** | The parallel inerter dramatically reduced vibrations and did not interfere with any suspension setup, whether it be passive or active. |
| **How can this help my senior project** | We are thinking of incorporating an inverter onto the formula car. |