**Davis Moore**

**Research Question: \_\_What is the best frame and suspension design for a formula one car?\_\_\_\_\_**

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|  | **Source/Evidence/ Data #1** | **Source #2** | **Source #3** | **Source #4** | **Source #5** |
| **Citation** | A. Mihailidis, Z. Samaras, I. Nerantzis, G. Fontaras, and G. Karaoglanidis, "The design of a Formula Student race car: A case study," *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering,* vol. 223, pp. 805-814, 2009. | W. B. Riley and A. R. George, "Design, analysis and testing of a Formula SAE car chassis," in *Motorsports Engineering Conference and Exhibition, December 2, 2002 - December 5, 2002*, Indianapolis, IN, United states, 2002. | R. Capitani, T. Iacomelli, D. G. Rosti, and P. Tozzi, "Design for X approach to optimise a formula SAE car," in *Proceedings of the 7th Biennial Conference on Engineering Systems Design and Analysis - 2004, July 19, 2004 - July 22, 2004*, Manchester, United kingdom, 2004, pp. 475-481. | M. D. Gilchrist and L. Curley, "Manufacturing and ultimate mechanical performance of carbon fibre-reinforced epoxy composite suspension push-rods for a Formula 1 racing car," *Fatigue and Fracture of Engineering Materials and Structures,* vol. 22, pp. 25-32, 1999. | G. Savage, "Sub-critical crack growth in highly stressed Formula 1 race car composite suspension components," *Engineering Failure Analysis,* vol. 16, pp. 608-617, 3// 2009. |
| **Purpose** | * Chronicles the design of a student formula car * Highlight new features in the design | * To analyze the frame of a formula car and see how it deforms | * A description of how to optimize a formula one car for student design and production | * Analyze a push rod suspension using new materials | * To explain the advantages of using carbon fiber in formula one cars |
| **Why is the study necessary?** | * To describe the design and build process of a formula student car | * To see what aspects of frame design are the most important | * To give students a guideline on how to approach building a car | * To see if new composites would increase the performance and reliability of a push rod suspension | * To see the advantages of composites such as carbon fiber over steel or aluminum |
| **Methods** | * Design the frame first because it is the most important part * Focus on each subsystem separately * Using computer modeling for testing is a great help * Meeting SAE requirements is most important | * Analyze different torsion and bending on the frame * See what stiffness is required due to different forces * Model the frame in software and test | * Have a goal for each part when designing * Primary focus must be to first meet safety guidelines of SAE * Building frame in CAD software first allows for testing within software | * Examine breaking performance of push rod with different materials * Manufacturing push rods using new carbon fiber monocoque technique * Stress testing until failure under compressive load | * Composites offer better aerodynamics than other materials * A combination of fiber and titanium is able to handle great axial loads * There are a greater variety of fiber composites available for use in different parts of the car |
| **Results** | * Safety, engine and anything relating to human control are most important * Frame should be designed first followed by the subsystems | * Weight saving is not as important as stiffness | * The only results listed were charts | * All push rods experienced failure * Buckled differently depending on thickness | * The fatigue life of a composite fiber part depends on the resin |
| **Discussion/Conclusion** | * The vehicle performed well in tests and was reliable * Stats on each test are given | * Many different tests were conducted to achieve a certain stiffness | * The car was eventually built and tested * More tests were done to increase performance for next year | * The composite push rods offer similar strength to steel but are much lighter * Composites are more brittle than steel and therefore do not plastically deform as much, so less energy is absorbed in a crash | * Failure is due to manufacturing process not material * New resin introduced that passed failure tests |
| **How can this help my senior project?** | * This papers details the mindset for designing a formula car from start to finish | * There are detailed charts that show the different types of stresses the frame is subjected to and what the stiffness in each area should be | * It details the building of the frame and suspension and gives a thought out process * It is also specific in the requirements so we can compare our numbers to theirs to get an idea of performance | * We had discussed attempting a carbon fiber monocoque and with this article I can provide evidence that there is an advantage * The manufacturing process can be used as a guide if we attempt it on our own | * If within budget this study shows the advantages of using composites within the suspension for greater performance and durability and less weight |