Designing and building a formula SAE car is a complicated matter which draws upon multiple subjects. It is difficult to pin down a precise procedure but it is generally understood that the car's frame should be designed first, which can be broken down into four separate sections: the front, cockpit, engine compartment and the rear.[[1](#_ENREF_1)] Computer aided design, (CAD), is a common way to reduce costs as a 'virtual' car can be created, built and in some regards tested using Computational Fluid Dynamics, (CFD), before any actual materials are used.[[2](#_ENREF_2)] In this virtual environment, wing designs, heights, angles, etc can be simply moved or shifted and the effects on the overall vehicle can be analyzed. [[2](#_ENREF_2)]

Once the design phase is complete building and testing of the car's design can take place. Testing using strain gages for simulations of expected conditions and actual track testing have been conducted to ensure all bending stresses are fully understood .[[3](#_ENREF_3)] Wind tunnel experiments have been conducted to help understand the movement of air across the vehicle. This can be particularly important when it comes to the design of the front and rear wings.[[4](#_ENREF_4)] Placement of these wings, angles of attack and width can increase the down-force of air on the car, helping to keep it on the track.[[4](#_ENREF_4)] This is a highly complex evaluation as the car as a whole must be considered. Small changes to the front wing of the car can affect how the wind streams hit the rear wing, providing lift instead of down-force on the car.[[4](#_ENREF_4)] With all of the above considerations, care must also be taken to ensure the frame design allows for proper placement. [[4](#_ENREF_4)] Modifying one design parameter on the frame can often affect parameters placement of fluid dynamics. [[4](#_ENREF_4)]

Frame design can be crucial when it concerns the constantly changing rear suspension.[[3](#_ENREF_3)] Since the car's drive power comes from its rear tires, maintaining the tires contact to the ground while turning or hitting bumps in the track is essential.[[5](#_ENREF_5)] While attempting to maintain this contact, components such as suspension rods, axel shafts, etc. will experience large amounts of bending strains.[[5](#_ENREF_5)] Inconsistent movement between the front and rear suspension systems can make the vehicle operate in unpredictable ways.[[5](#_ENREF_5)] It is important to ensure plastic deformation is controlled and understood, while chances of failure remains remote.

The Old Dominion University Fall Formula SAE team is intent on designing, building, fabricating and testing a frame and rear suspension system for the 2016 SAE Formula Car challenge. Designs will be first be analytically conceived, then drawn using CAD software. It will then be tested and further analyzed there before the final designs are virtually tested using CFD software. Fabrication is next followed by further testing of actual components to ensure final design endurance.

References:

[1] B. Auer, J. McCombs, and E. Odom, "Design and optimization of a Formula SAE&reg frame," in *2006 SAE World Congress, April 3, 2006 - April 6, 2006*, Detroit, MI, United states, 2006.

[2] C. Meinan, T. Wenhui, Y. Bo, and H. Xingjun, "Computer-aided Front and Rear Wings Aerodynamic Design of a Formula SAE Racing Car," *Applied Mechanics and Materials,* vol. 120, pp. 20-5, / 2012.

[3] 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.

[4] G. X. Wang, Y. Hu, T. T. Xu, Z. F. Li, and B. Yang, "Numerical simulation and wind tunnel experiment of the aerodynamic characteristics of a formula student racing car," in *2013 International Forum on Mechanical and Material Engineering, IFMME 2013, June 13, 2013 - June 14, 2013*, Guangzhou, China, 2013, pp. 460-464.

[5] E. F. Gaffney Iii and A. R. Salinas, "Introduction to formula SAE&reg suspension and frame design," in *48th Earthmoving Industry Conference and Exposition, April 9, 1997 - April 10, 1997*, Peoria, IL, United states, 1997.