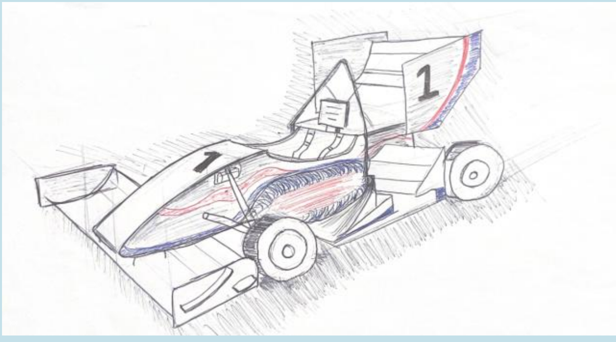
Design and Virtual Prototyping of Composite Body of the Formula Student Vehicle



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Aim of the Project

The Aim of the project is to design and develop a composite body for a Formula Student Vehicle that is aerodynamic, lightweight and efficient using virtual prototyping techniques such as SolidWorks and ANSYS Software while also complying to the formula student regulations.

Objectives

- Preparation of a set of input data for the design process for selected subsystems
- Development of initial concepts of 3D CAD models of components
- Conducting analysis and optimization of vehicle subsystems using the CAE tool
- Development of final CAD models of components
- Preparation of technical documentation of the project in the form of technical drawings, visualizations, and animations of vehicle components

Background

Formula student is an engineering competition where students from colleges from all over the world showcase their engineering abilities by designing, developing, fabricating and testing a small-scale singular seated formula vehicle. These vehicles are then evaluated on different areas such as performance, cost efficiency and design.

Virtual prototyping allows for cost-efficient testing and iteration of designs, reducing physical prototyping needs. Utilising these software's is crucial in designing and developing an efficient and Competitive formula student vehicle. Due to the growing importance of sustainability, the design was developed for an electric formula student vehicle which meant an even bigger importance on the use of virtual prototyping to ensure cost and waste was minimised.

Concept Design

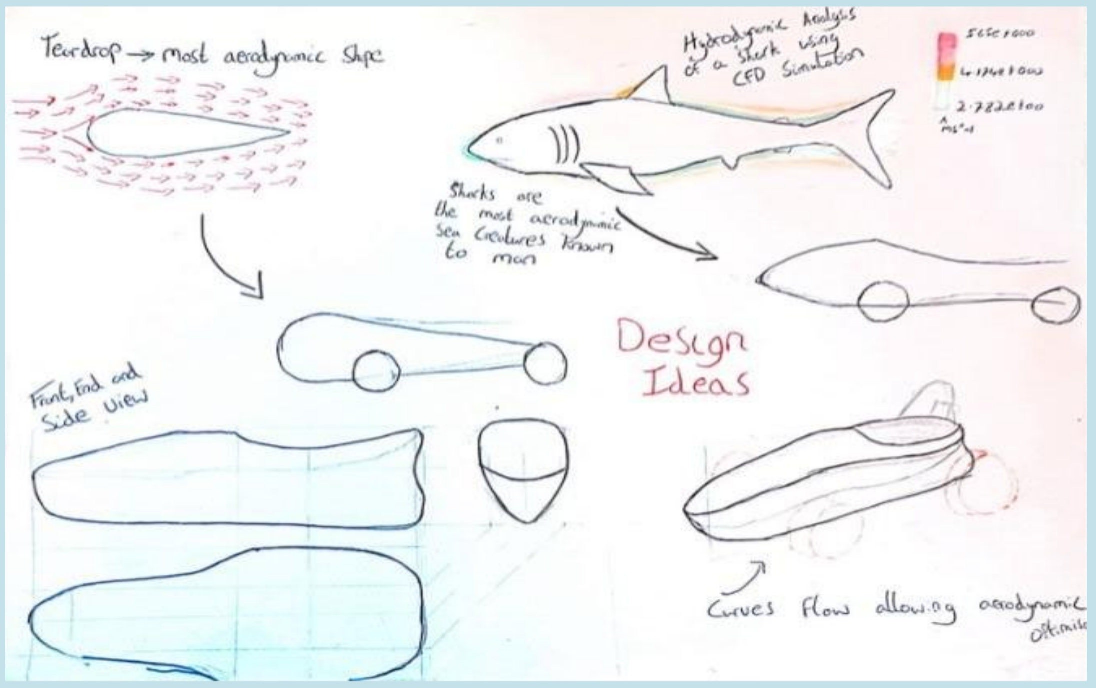

Figure 1 Formula Student Vehicle Design Ideas.

- It is commonly acknowledged that the teardrop form is the most aerodynamic shape seen in nature. By enabling air to move smoothly across the surface, it lessens drag, which lowers turbulence and can aid in vehicle design for peak performance. By incorporating this into the design, it can reduce the turbulent wake behind the car, which lowers drag.
- Both stability and natural aerodynamics is offered by the shark shape. Because of the structure of their bodies, sharks are among the fastest and most agile animals in water.

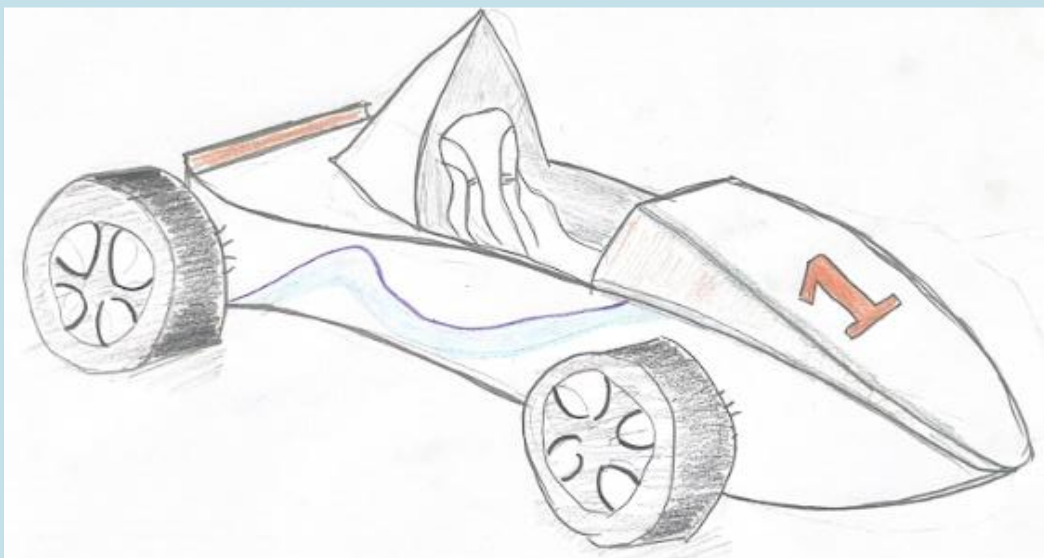

Figure 2 Formula Student Vehicle design EV concept.

- The smooth, curved design can reduce the drag, which can improve the energy efficiency, range, and speed of the vehicle.
- Without extra components such as the front wing and spoiler this design makes it easier to troubleshoot when improving the aerodynamics.
- Fewer additional components help reduce the weight of the vehicle.

SolidWorks

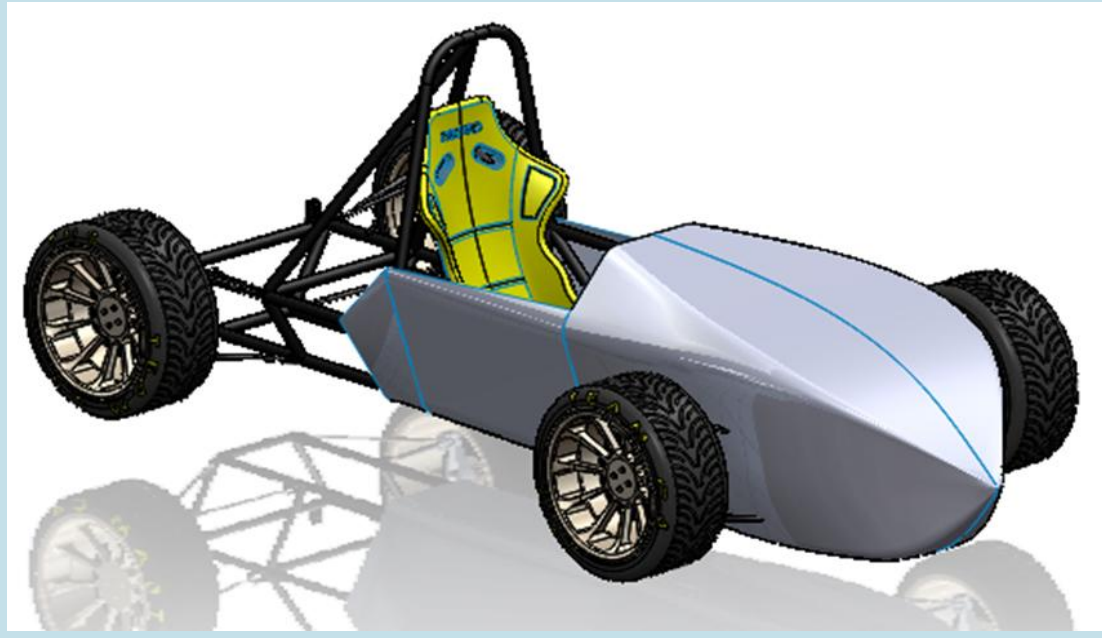

Figure 3 Formula Student Vehicle design 1.

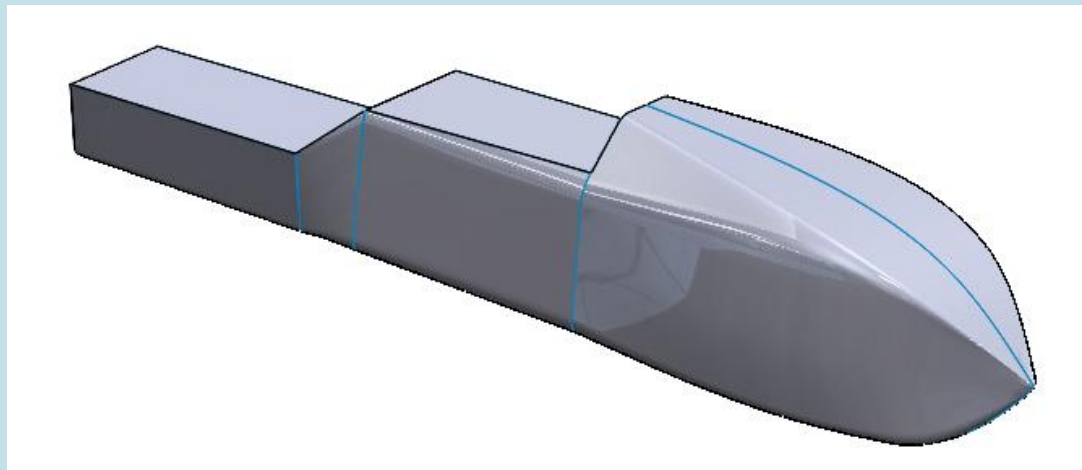

Figure 4 Formula Student Optimised Vehicle design.

ANSYS

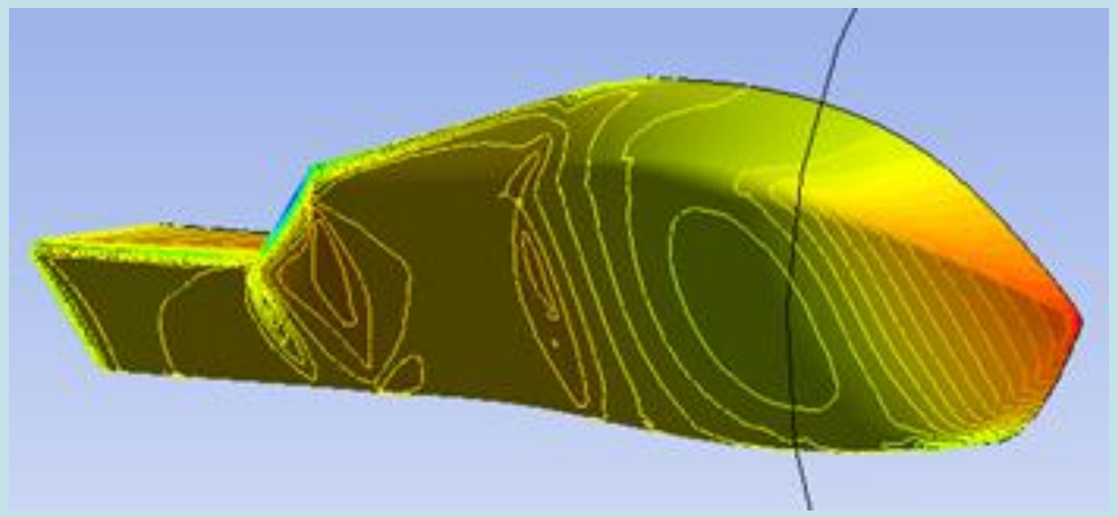

Figure 5 Formula Student Vehicle Pressure Distribution Analysis

Figure 5 shows the static pressure distribution from the streamline velocities for a straight running case. The Red contours shown at the nose of the composite body indicates higher pressures at 490 Pascals due to the stagnation of the velocity speeds as it interacts with the body compared to the side of the composite body which have lower pressures indicated with orange and yellow contours.

ANSYS

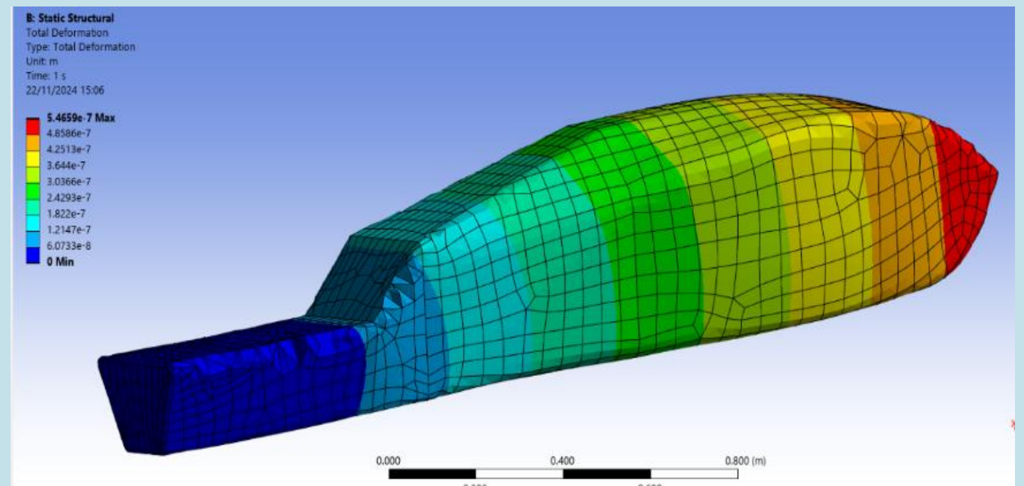

Figure 6 Total Deformation Analysis

Total Deformation analysis predicts and visualises how much material is removed from forces applied on the body over a period of time. The front of the Body exhibits the highest pressures and as a result exhibits the highest deformation at only .5469 microns, 31 times thinner than a human hair. The rear of the vehicle exhibits no deformation displayed by the blue contours.

Conclusion

- Understanding Formula Student rules ensures an efficient, high-performing, and compliant composite body design.
- Concept sketches save time in virtual prototyping and design iteration.
- SolidWorks enabled precise, aerodynamic, and visually appealing 3D bodywork designs.
- Curved designs optimize airflow, improving performance and reducing drag.
- Simulations showed velocity increases from 28 m/s to 36 m/s due to effective aerodynamic shaping.
- Balanced velocity and pressure distributions ensure both speed and cornering stability.
- High pressures are concentrated at the front due to airflow interactions with the nose.

Acknowledgements

We would like to acknowledge and thank our supervisor Miroslaw Mrzyglod and our module lecturer Dr Emma Kelly for all the work they helped us with over the course of the 11 weeks of this project.