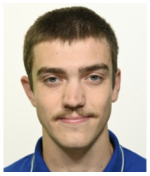
# Design and validation of the aerodynamics of a Formula Student vehicle


Graduate



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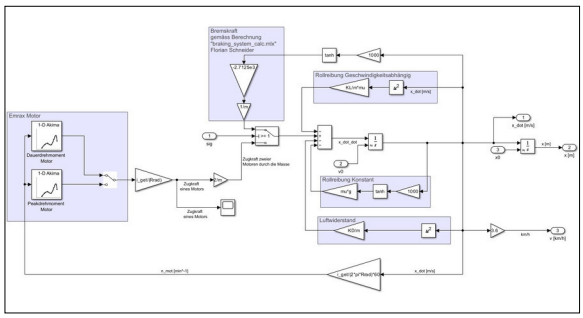
Objective: The Racing Team OST is still in the process of being established and therefore has little expertise in the field of aerodynamics for Formula Student racing cars. The aim of this work was to model various aerodynamic concepts used in Formula Student, simulate them using CDF, and evaluate them as a complete system based on their downforce and drag characteristics. High downforce increases tire grip, allowing for fast cornering and braking maneuvers. Drag should be as low as possible. The multi-objective optimization of these parameters results in a conflict of objectives, leading to a trade-off analysis.

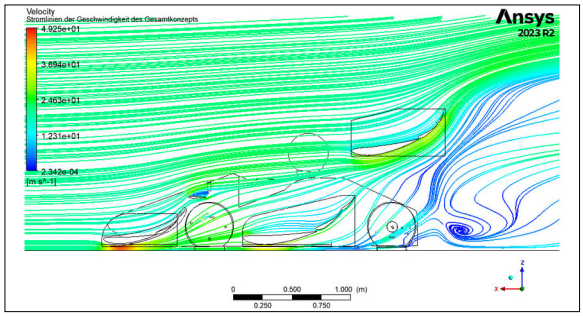
Approach: Using computational fluid dynamics (CFD) simulations with ANSYS CFX, variants for the front wing, rear wing and side box were analysed. In addition, aerodynamic auxiliary elements such as whiskers, louvres, vortex generators and Gurney flaps were analysed. Particular attention was paid to the Drag Reduction System (DRS), in which adjustable wing profiles on the front and rear wings were analysed. For the structural evaluation, the deformation of the front wing under load was analysed with different materials and constructions using ANSYS Mechanical to ensure compliance with the regulations. Finally, the overall package was evaluated using simple track simulations with and without aerodynamic components, which were created using Matlab and Simulink, whereby the Formula Student vehicle was approximated as a point mass.

Result: This work provides a comprehensive overview of different aerodynamic concepts and their effects on downforce and drag and thus on an idealised lap time, which was determined using a simple system simulation. It was also made plausible that an aerodynamic package can provide an advantage on a winding track. The knowledge gained can serve Racing Team OST as a basis for the targeted development of a high-performance aerodynamic package in the future.

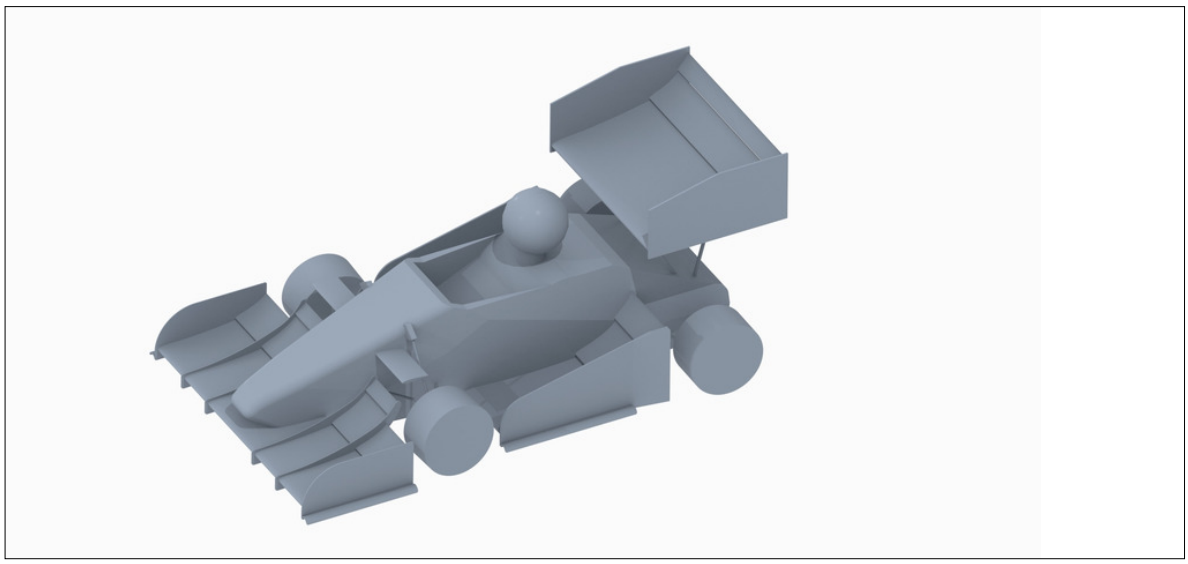
**System submodel for the simulation of the acceleration and deceleration of a vehicle, simplified as a point mass.**
Own presentment



**Visualisation of the streamlines and the velocity (color) across the components of the overall concept.**
Own presentment




**Overall model of the concept of a possible aero package with high downforce.**
Own presentment

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Subject Area
**Computational Engineering, Mechanical Engineering**