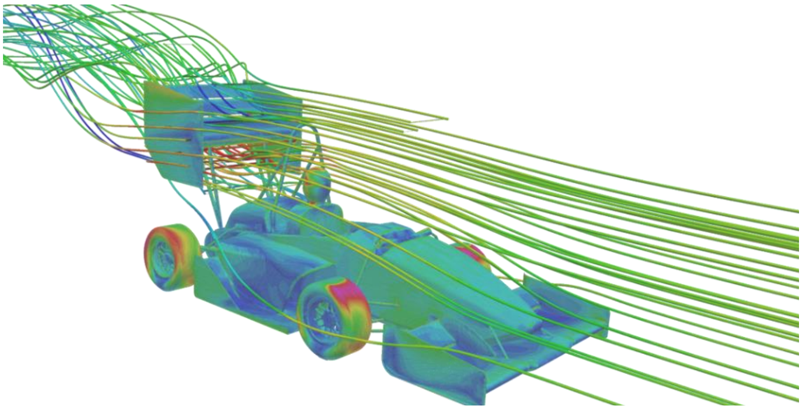
Automotive Engineer for a Day

[Click here for an instructional video to support the task]

Introduction

Automotive Engineers bring together expertise in vehicle design, mechanics, electronics, and aerodynamics to drive innovation in motorsport and road vehicles. Are you interested in knowing how race cars are designed to perform tricky manoeuvres and negotiate sharp turns at very high speeds? Or maybe you are considering a career in the automotive industry or motorsports? Then, be an **Automotive** Engineer for a Day to get insight into the engineering challenges associated with designing a winning car.

Background



Simulation of Air Stream over a Formula Student Car [SimScale]

Motorsports are all about maximising performance, to be the fastest is the absolute. To be faster, you need power, but there is a limit to how much power you can translate from the engine, through the wheels to the road, without getting slippage and wheel spin.

To increase this limit, the **Automotive** Engineer needs to design to increase the downforce on the wheel. This could be done by increasing the weight of the vehicle, but that would make handling difficult and would requires more power. So, we need some virtual weight; we call it downforce and can design the aerodynamics of the vehicle to increase it from airflow around the car. A wing can make a plane fly, but if we put it upside down, it will increase "aerodynamic grip" and translate the power of the engine to forward momentum of the vehicle. Aerodynamics plays a vital role in manipulating downforce for additional speed, handling, and apparent weight. The same concept used in aeronautics to lift aeroplanes off the ground is used in racing to keep cars on the ground. Instead of creating an upward force, fast-moving air is manipulated to push the car to the ground. Your task as and **Automotive** Engineer for a Day is to design the front and rear aerodynamics features of a standard chassis to maximise downforce.

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ENGINEER FOR A DAY

Drag is the force due to friction of the air against the exterior of the car. An aerodynamic car slices through the air, creating as little drag as possible. The less drag, the faster the car goes. The most obvious racing examples of aerodynamics would be in open-wheel cars, where appendages called spoilers or wings are added for downforce. These attachments can often be manipulated to change the amount of drag and downforce.

During the design stage, it is essential to quantify the effect of the aerodynamics features in terms of drag and downforce (negative lift). This information links directly to the vehicle's performance, top speed, and the maximum speed during turns. Both drag and lift forces are defined by similar equations but have different coefficients. The coefficients of drag and lift are specific to the geometry. The coefficients are often found experimentally or using computer simulations. When assessing the placement of wings, the values of the coefficients also depend on the air angle of attack, that is the angle of air stream interacting with the wing.

Drag Force, $F_D = \frac{1}{2} C_D \rho A V^2$, $[N]$

Lift Force, $F_L = \frac{1}{2} C_L \rho A V^2$, $[N]$

Density of Air, $\rho = 1.225\ kg/m^3$

Car Frontal Area, A, $[m^2]$

Velocity of Car, V, $[m/s]$

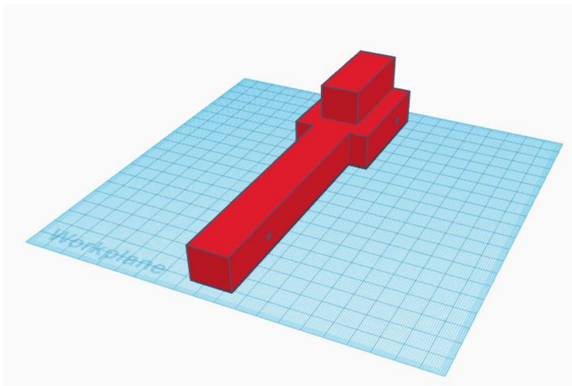
Drag Coefficient, C_D

Lift Coefficient, C_L

The Task

Support for the development of a 3D model of a Race Car can be accessed here and as follows:

1. In your web browser navigate to https://www.tinkercad.com/ to access TinkerCAD, a Computer Aided Design (CAD) package.
2. Log in to TinkerCAD and click on the search icon on the top right to search for designs to find the chassis.
3. Search for "EfaD" then select “Tinker this” to make a copy of the design for you to develop further.
4. Change the file name to a name of your choosing.
5. Use the right pane to locate, drag, and drop the required objects.
6. Refer to the YouTube Instructions for guidance on placing, moving, and editing the objects in the software environment.
7. Move and modify objects to connect them to the base chassis based on what you think will create an effective aerodynamics package.
8. When you are happy with your design, view the front elevation by selecting the "Front" side of the view cube.



Angle of Attack	C_L	C_D
0	1.5	0.7
5	1.75	0.8
10	2	0.9
15	2.25	1.0
20	2.5	1.1
25	2.75	1.2

9. Use the ruler or the grid to estimate the frontal area (A) of the car interacting with air; remember this is a scaled model, and you will need to estimate the area in full scale
10. Based on your wing placement angle, use an appropriate value from the table and the equations above to estimate the drag and negative lift (i.e. downforce) forces of your design at a speed of 50 m/s (180 km/h)
11. Based on your results, can you make some changes to the design to maximise downforce while ensuring the drag doesn't increase too much?
12. Take some screenshots of your design and pictures of your results/calculations and upload to the "Engineer for a Day" Padlet