

Getting Aerodynamics Right - Mechanical Simulation Corporation partners with AirShaper

Introduction

CarSim by Mechanical Simulation streamlines the design, engineering & testing of passenger vehicles and light-duty trucks based on physical inputs, like vehicle dimensions and detailed properties of each vehicle subsystem. The more detailed this input, the more accurate the CarSim output. Since many vehicle properties are already known to a high degree of accuracy, it makes sense to do the same for aerodynamics as early in the simulation process as possible.

To get the aerodynamic properties right, CarSim announces its partnership with AirShaper, the cloud platform for aerodynamic simulations (www.airshaper.com). The fully automated workflow allows users without a background in aerodynamic simulations to upload a 3D model, set up, and run simulations. The resulting aerodynamic data can be fed directly into CarSim.

Customer benefit

- OEM: Vehicle manufacturers constantly look for ways to shorten design cycles to go to market faster. Detailed aerodynamic coefficients allow for accurate predictions on power consumption, side wind sensitivity, etc. It brings the CarSim simulations a step closer to the real performance of the vehicle, reducing time and resources required for the physical testing that follows.

- Suppliers: bringing profitable yet safe vehicle components and sub-systems to market requires accurate knowledge of the loads acting on components and the dynamics of the vehicle. With aerodynamics influencing a car's balance & performance, both on straight lines and in corners, more accurate aerodynamic coefficients can make a measurable difference.

How it works *(see details in Appendix)*

Step 1. Upload the 3D model of your vehicle to AirShaper. This can be a rough concept model (AirShaper accepts open surface models with holes) or a detailed (preproduction model).

Step 2. Set the driving speed, matching the average speed of your vehicle. Select the angles of attack, according to the number of angles you want to specify in CarSim. By default, these are [0°, 20°, 90°, 135°, 160°, 180°] or more for racecars.

Step 3. By default, the AirShaper outputs the aerodynamic forces & moments in a format that can be easily imported into CarSim.

Pricing

The AirShaper platform does not require any purchase of software or monthly fees. Nor does it require expensive hardware or software. You simply pay per simulation (see www.airshaper.com/pricing).

The standard simulation package to obtain aerodynamic values for CarSim starts at 5.250€ ex VAT. This includes 6 Ultimate Simulations. On request, higher accuracy and/or numbers of simulations are available depending on your needs. [Request a quote.](#)

For CarSim and TruckSim pricing and information, please contact Mechanical Simulation at <https://www.carsim.com/contactus/index.php>

Appendix: how to integrate AirShaper results into CarSim

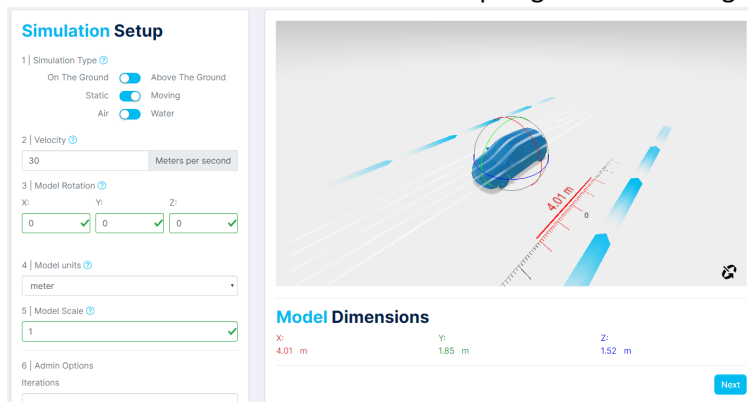
This appendix describes how to use AirShaper to integrate accurate estimations for aerodynamic coefficients into CarSim. The example that is used is the generic B-class car that is included in every version of CarSim.

Step 1 – Defining the required side slip angles beta

- Regular cars: for regular cars, like the B-class example model, there are 6 side slip angles that are used for the aerodynamic simulations: 0°, 20°, 90°, 135°, 160° and 180°. Of course, you are free to increase the number of points on the curves, should you require more accuracy.
- Race cars: for race cars, typically more accuracy is required in terms of side slip angles, but also in terms of ride height and so on. With AirShaper, you can calculate the aerodynamic coefficients for each setup of your car (ride height front/back), on top of the different side slip angles.

Step 2 – Running the simulations on AirShaper

- Create a free AirShaper
- Start a new project at Detailed or Ultimate Accuracy (depending on your needs).
- Upload a 3D stl file of your car
- On the setup page, choose “moving”, provide the average driving velocity and rotate the model to match the wind orientation & side slip angle. Select the right units and click next.



- On the payment page, fill in your company & credit card details and launch the simulation
- Repeat this process for each side slip angle. You can launch them all in parallel.

Step 3 – Extracting the aerodynamic parameters

Once the simulations are finished, you'll get a full report for each side slip angle beta. In those reports, you can find the aerodynamic forces & moments that are relevant for CarSim:

PERFORMANCE ANALYSIS

FORCES

The force generated on the object by the wind has three components:

- F_x : Drag force: Along the direction of the wind
- F_y : Lateral force: Perpendicular to the direction of the wind - horizontal
- F_z : Lift force: Perpendicular to the direction of the wind - vertical

There are two ways in which the wind generates force:

- Pressure force: arises from the pressure difference between two opposite sides of an object. It is the sum of all the local forces pushing or pulling perpendicular to the surface.
- Friction force: arises from the wind sliding across the surface of the object. It is the sum of all the local friction forces parallel to the surface.

Note: Negative values indicate a force acting in the direction opposite to the arrows shown below. Original coordinate system: origin location & axis orientation as provided with the original 3D file. Wind tunnel coordinate system (shown on images): origin set to the center of the object and the axes aligned with the air vector.

ORIGINAL COORDINATE SYSTEM

	F_x	F_y	F_z
Pressure	154.82 N (15.78 kg)	11.63 N (1.19 kg)	6.11 N (0.62 kg)
Friction	10.61 N (1.08 kg)	-0.09 N (-0.01 kg)	0.89 N (0.09 kg)
Total	165.42 N (16.86 kg)	11.55 N (1.18 kg)	7.00 N (0.71 kg)

WIND TUNNEL COORDINATE SYSTEM

	F_x	F_y	F_z
Pressure	154.82 N (15.78 kg)	11.63 N (1.19 kg)	6.11 N (0.62 kg)
Friction	10.61 N (1.08 kg)	-0.09 N (-0.01 kg)	0.89 N (0.09 kg)
Total	165.42 N (16.86 kg)	11.55 N (1.18 kg)	7.00 N (0.71 kg)

MOMENTS

The moments have been calculated around the global coordinate system as defined in the uploaded 3D model. Moments also have a friction & pressure component and have been calculated around the X, Y and Z axis.

ORIGINAL COORDINATE SYSTEM

	M_x	M_y	M_z
Pressure	0.52 Nm (0.05 kg·m)	-250.29 Nm (-25.51 kg·m)	1.33 Nm (0.14 kg·m)
Friction	-0.05 Nm (-0.01 kg·m)	5.09 Nm (0.52 kg·m)	-0.11 Nm (-0.01 kg·m)
Total	0.48 Nm (0.05 kg·m)	-245.20 Nm (-25.00 kg·m)	1.22 Nm (0.12 kg·m)

WIND TUNNEL COORDINATE SYSTEM

	M_x	M_y	M_z
Pressure	6.44 Nm (0.66 kg·m)	-329.55 Nm (-33.59 kg·m)	2.34 Nm (0.24 kg·m)
Friction	-0.09 Nm (-0.01 kg·m)	-0.39 Nm (-0.04 kg·m)	-0.13 Nm (-0.01 kg·m)
Total	6.35 Nm (0.65 kg·m)	-329.93 Nm (-33.63 kg·m)	2.22 Nm (0.23 kg·m)

Via the frontal surface area of the car, these coefficients will be translated by AirShaper into the coefficients needed for CarSim: CF_x , CF_y , CF_z (for the forces), CM_x , CM_y , CM_z (for the moments).

Step 4 – integrating the aerodynamic

To integrate these parameters into your CarSim project, you can go to the aerodynamics section of the car and either input the parameters directly, or use the PARFILE to provide them:

Once you have done this for each of the aerodynamic parameters (CF_x , CF_y , CF_z for the forces, CM_x , CM_y , CM_z for the moments), the aerodynamics of your CarSim simulation have been set up.