2nd Automotive CFD Prediction Workshop: Windsor Model Data Submission

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Introduction

This document defines the data submission requirements for Case 1 of the Second Automotive CFD Prediction workshop.

Geometry and Reference Conditions

For completeness this section restates the information provided in the Case description document. The model geometry (with wheels case 1A) is shown in Figure 1. The reference frontal area used for drag and lift coefficient is defined by the vehicle height and width and rounded to be $0.112m^2$. ($0.056m^2$ for half model). The reference length used for pitching moment is the wheelbase 0.6375m.

The CAD geometry of the model has its origin on the ground plane, in the symmetry plane midway between the wheels. The coordinate system has x in the streamwise direction (hence the nose is negative x), z upwards and hence positive y is towards the right of the vehicle. The nose of the vehicle is at x=-0.56075m, the rear at x=0.4835m. (The sides of the car are at y==+/-0.1945m, the car underbody at z=0.05m and the car roof at z=0.339m).

With this coordinate system, drag is in the positive x-direction, lift is in the positive z-direction, pitching moment is around the y-direction with a nose up moment being positive.

The freestream velocity magnitude and pressure used in the definition of force coefficients. should be taken from a probe at [-2.0,0,1.3]m. This is ahead of the car, on the centreline and near the roof. It replicates the approach taken in the wind tunnel and means that the freestream velocity magnitude and pressure is slightly different to that applied as a boundary condition to the inlet.

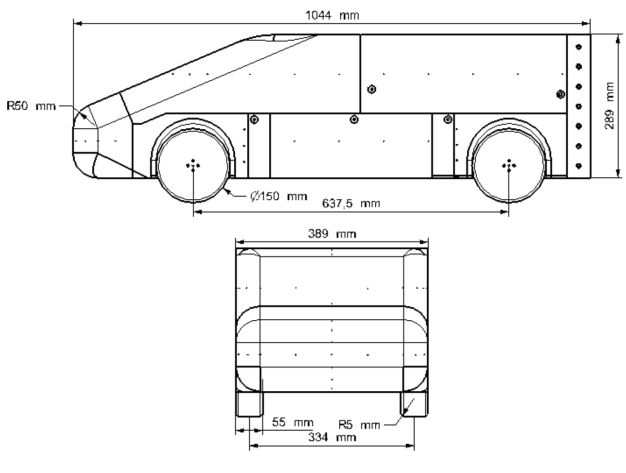

Figure 1 Windsor Model (with wheels) [2]

Data Submission

The required data is split into six parts:

1. Information about you, your code, simulation parameters and force and moment results, filenames of the remaining data
2. Surface pressure coefficient line data: along the symmetry plane surface cut (Group 1, y=0m); the upper glasshouse horizontal cut (Group 2, z=0.2594m)
3. X velocity and turbulence kinetic energy profile ahead of the model. (normalised by your reference velocity magnitude, x=-1.0m, y=0.0, z=0.0 to 0.2m)
4. Time histories of force and moment data (time in seconds or iteration number, drag, lift and pitching moment coefficient)
5. Surface pressure coefficient data over the base surface (Group 4, x=0.48325m)
6. Velocity cut planes to match PIV measurements at y=0m, z=0.194m, x=0.630m, x=0.922m (normalised by your reference velocity magnitude).

Parts 1-4 are compulsory if you wish your results to be included in the workshop, Part 5 and 6 are optional but highly recommended. The data should be provided using a simple multicolumn text format as either an .xlsx or .csv file using the templates provided. In the case of 5 and 6, if preferred these can be using the Ensight Gold format with a case file and associated geo and dat file.

The first file has a final section which defines the names of the files that make up the rest of the submission.

You may have more than one submission for a given code and turbulence model (options for wheels/no wheels, RANS/ER, WM/WR). Each submission should be packaged into a single gzipped tar file or zip file.

The naming convention is complex:

ID_LASTNAME_CASE_TYPE_TURBMODEL_v1.tar.gz

Where:

ID: submission ID allocated

LASTNAME: last name of submitter

CASE: wW1A or nW1B

TYPE: WMRANS, WRRANS, WMER, WRER or LBM

TURBMODEL: KE, SST, SSTDES etc

Some of this information is also included in the Part 1 submission file.

Email your package to G.J.Page@lboro.ac.uk including a subject line that starts with Auto CFD2 or upload to the shared onedrive drop off folder (link supplied separately)

If you need to resubmit/upload a newer submission (i.e. noticed an error), then please resubmit with an incremented version number in the file name. The scripts to process will just use the highest number available.

Experimental Pressure Probe Locations

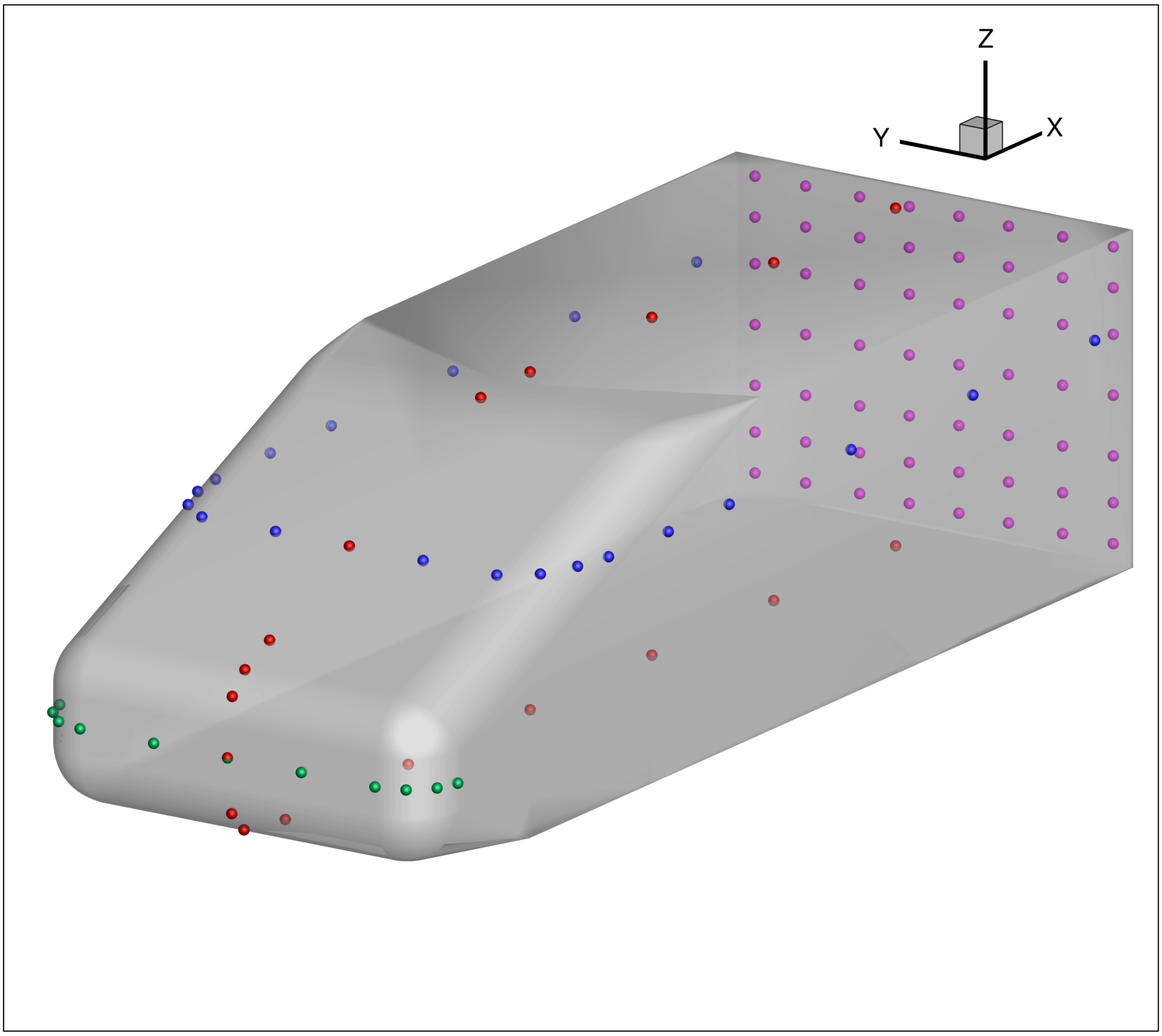

Figure 2: Experimental pressure tapping locations

Group 1 is a vertical cut plane through the symmetry, Group 2 is a horizontal cut plane at z=0.2595m, Group 3 is around the 'bumper' and is not required here, Group 4 is a grid at the base. The supplied data should be at the resolution of your surface grid (i.e. not just at the experimental tapping locations).

Experimental PIV Slice Locations

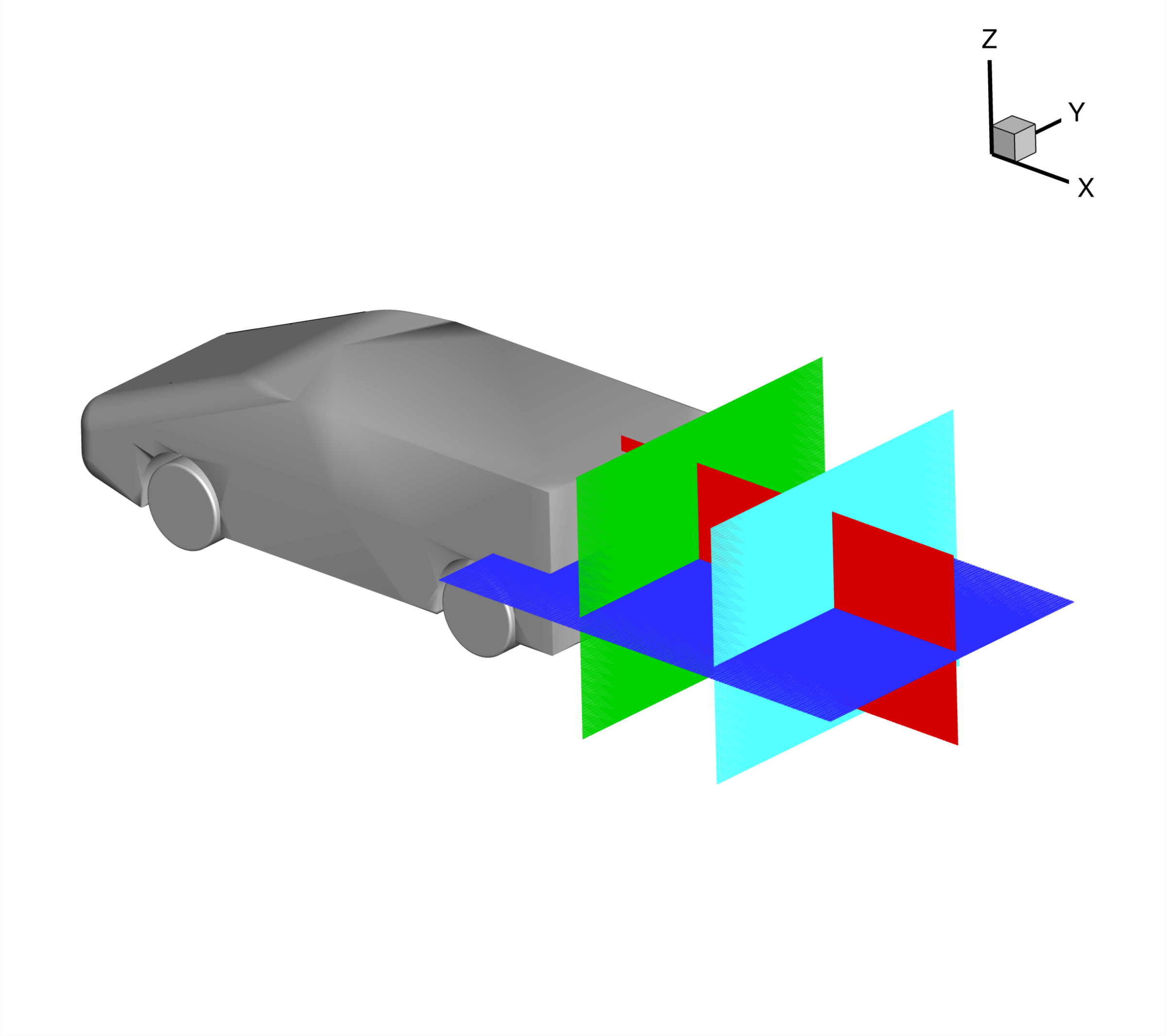

Figure 3: Experimental PIV slices

The vertical slice (red) is defined by: y=0m, x=0.467m to 1.184m, z=0.0m to 0.366m

The horizontal slice (blue) is defined by: z=0.194m, x=0.36m to 1.20m, y=-0.3m to 0.3m

The cross flow slices (green and light blue) are defined by: x=0.630m and x=0.922m, y=-0.3m to 0.3m, z=0m to 0.44m.

References

[1] G. Pavia and M. Passmore, “Characterisation of Wake Bi-stability for a Square-Back Geometry with Rotating Wheels,” in Prog. Veh. Aerodyn. Therm. Manag. (J. Wiedemann, ed.), (Cham), pp. 93–109, Springer International Publishing, 2018.

[2] Varney, M., “Base Drag Reduction for Squareback Road Vehicles,” Loughborough University, Feb, 2020. 10.26174/thesis.lboro.11823759.v1

[3] https://repository.lboro.ac.uk/articles/dataset/Windsor_Body_Experimental_Aerodynamic_Dataset/13161284

[4] Johl, G., Martin A. Passmore, and Peter M. Render. 2010. “Design Methodology and Performance of an Indraft Wind Tunnel,” The Aeronautical Journal, September 2004. https://hdl.handle.net/2134/6674

Version History

0.2 12 June 2021: initial released version