NATIONAL WIND TUNNEL FACILITY EXPERIMENTAL DATABASE

NWTF Conference
May 2023

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Contents

- EPSRC Network Grant Funding
- Why do we take Experimental Measurements?
- Review of existing databases
- Lessons learned
- Interactive session
- Future plans

EPSRC Network Grant

Loughborough University

- Community hub for academics and industry
  - events and forums to increase connectivity, inclusivity and information sharing
- **Experimental database**
  - **catalogue and improve useability of open access research outputs**
  - **promote better connectivity with the CFD community**
- Subgroups addressing the needs of a cross-disciplinary community
- Increase inclusivity with academics from non-NWTF universities and industry
- Increase researcher mobility
- Marketing and promotion to generate greater awareness of NWTF nationally and internationally

- Started 1 April 2023
  3 years PDRA working on Experimental Database

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Why Experimental Measurements?

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1. To understand aerodynamic flows in order to generate new knowledge (long term, academic)
2. To support industrial design processes: evaluation of design options; determination of performance parameters key to the design process (short term, industrial)
3. To improve the accuracy of simulation techniques, which are then able to **work together** with experiment on 1. and 2. (medium term)

The NWTF database will cover all 3 of these reasons – but with a priority of 3, 1, 2

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Aim + Objectives

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- Aim to be the first place researchers look for aerodynamic data
  - Both UK and International

- Promote UK aerodynamics data and ensure it is utilised
- Improve integration of experiment and computer simulation to solve problems
- Establish guidelines, best practice and standards that can be adopted by others

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Third Automotive CFD Workshop

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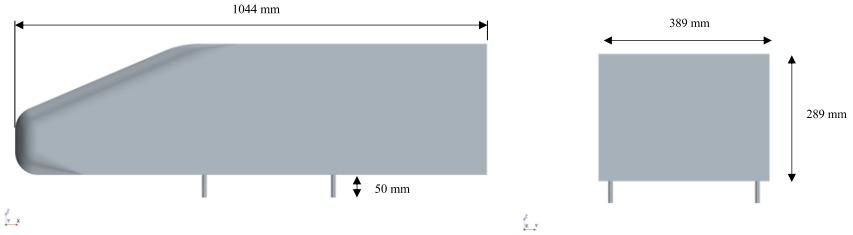
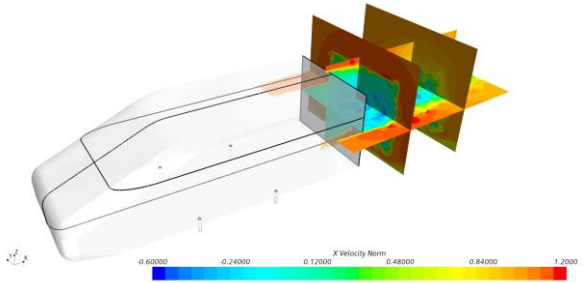
Case 1: Windsor body at yaw





- Loughborough measurements
- 47 calculations submitted
- 9 organisations
  - 3 Universities / Research Institutes
  - 1 large CFD vendor
  - 5 small/medium CFD vendors/consultancies

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Windsor Body Dataset

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CAD

PIV 3.6GB

Matlab code

versioning

Switch View | 6 files

Windsor Model Experimental Aerodynamic Dataset

Cite | Download all (6.39 GB) | Share | Embed | + Collect

3102 views

Version 2 Dataset posted on 2021-07-02, 09:35 authored by Max Varney, Giancarlo Pavia, Martin Passmore, Conor Crickmore

This is the dataset for the square-back variation of the 25% scale Windsor Model, collated by Max Varney on 27/10/2020. More information can be found in the following publications:
- "Base Drag Reduction for Squareback Road Vehicles", Varney, M., PhD Thesis, Loughborough University, https://repository.lboro.ac.uk/articles/thesis/Base_drag_reduction_for_squareback_road_vehicles/11823759
- avia, G., Passmore, M., Varney, M., & Hodgson, G. (2020). Salient three-dimensional features of the turbulent wake of a simplified square-back vehicle. Journal of Fluid Mechanics, 888, A33, https://repository.lboro.ac.uk/articles/journal_contribution/Salient_three-

USAGE METRICS

3102	1196	2
views	downloads	citations

1196 downloads

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CATEGORIES

- Aerodynamics (excl. hypersonic aerodynamics)

NATO AGARD AR-303, 1994

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- **AR-303 Vol 1 and 2, ‘A Selection of Experimental Test Cases for the Validation of CFD codes’**
- 39 experimental datasets for aerospace applications including 2D aerofoils, wing bodies, propulsion installation and supersonic cases.
- pdf of the two reports are still freely available
- ‘The relevant data of all test cases has been compiled on floppy disks, which can be obtained through National Centers.’
  - MS-DOS executables which when run extract the data
- **Very complete documentation**
  - **consistent format across all the cases**
  - **Includes information as to the owner of the data and a contact**

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ERCOFTAC ‘Classic’ Database

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- Hosted by the University of Manchester
- 93 data sets, relatively simple ‘building block’ flows: boundary layers, pipe flows, impinging jets
- Each case is well defined and clearly presented.
- Individual data files are in ASCII text column format
  - downloaded individually or all bundled in one file
- Does not seem to be any CAD definitions of geometry
- Some cases also contain reference simulation data that is presented consistently
- Excellent and clearly presented resource

http://cfd.mace.manchester.ac.uk/ercoftac/doku.php?id=start

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ERCOFTAC Knowledge Base

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- '*Welcome to the world's foremost repository of structured knowledge and advice designed to underpin quality and trust in the industrial application of CFD*.'
- Classifies by: Application Area, Underlying Flow Regimes, DNS, Experiment
- Difficult to browse, well detailed cases, lots of individual files to download, copyright ERCOFTAC, missing CAD
- Often CFD evaluation/validation and best practice recommendation and some cases are just comparisons of CFD

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Lessons Learned

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- Need to ensure long term sustainability of data
- Can be difficult to organise into categories
- Data tends to be simple text files
- Files are relatively small - rare to find say PIV raw data
- Data descriptions are often limited
- For all but the simplest cases good CAD definitions are problematic
- **Best sources of data are often specific CFD validation/workshop rather than data disseminated directly by experimentalists**

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Experimental Database Plan I

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- Will create exemplar descriptions and data sets based on existing Loughborough data
- Work with other Universities to create equivalent high quality descriptions and data sets
- Produce a best practice guide, templates etc.
- Publicise data
- NWTF will only host meta data (descriptions)
  - Underlying data will stay on University repositories (archived, DOI etc, Open Access license)

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Experimental Database Plan II

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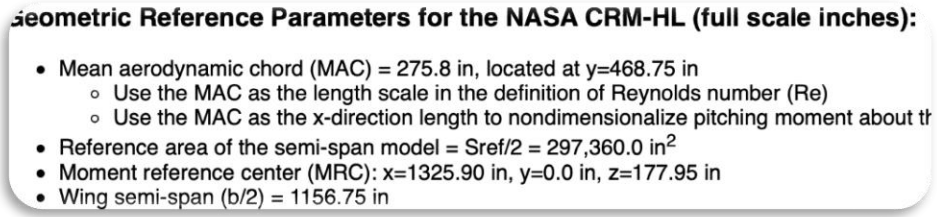
- Data formats: simple: text, csv; complex: netcdf, HDF5?
  - ASCII vs UTF-8, CR-LF, comma, # comment lines
- Compression/packaging (zip/gzip/tar), browsable
- Naming conventions, units and coordinate systems
- CAD standards/quality
- Open access license recommendations
- Geometry definition of wind tunnel inlet and WS
- Inlet condition surveys
- UK reference models?
- Link to other data?



eometric Reference Parameters for the NASA CRM-HL (full scale inches):

- Mean aerodynamic chord (MAC) = 275.8 in, located at y=468.75 in
  - Use the MAC as the length scale in the definition of Reynolds number (Re)
  - Use the MAC as the x-direction length to nondimensionalize pitching moment about th
- Reference area of the semi-span model = Sref/2 = 297,360.0 in^2
- Moment reference center (MRC): x=1325.90 in, y=0.0 in, z=177.95 in
- Wing semi-span (b/2) = 1156.75 in

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UK Turbulence Consortium

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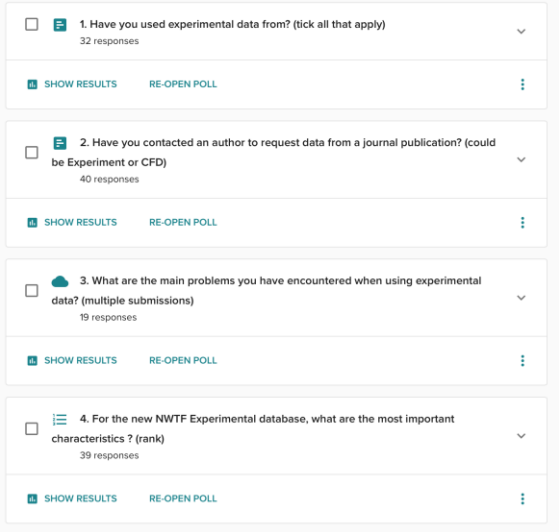
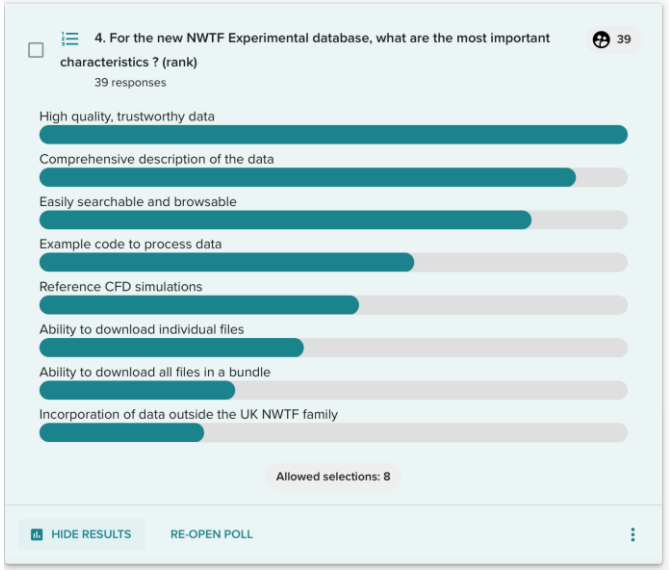
- Consortium for HPC access (Archer2) for research in broad area of turbulence and applications
- Presentation at UKTC annual meeting – 44 participants in Vevox survey





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Vevox Survey

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Join at:
vevox.app

ID:
188-376-526

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Conclusions

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- Aim that the NWTF Experimental Database will be the first place researchers across the world look for aerodynamics data
- Ensure expensive measurements are widely exploited
- Work with the whole community to meet their needs

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Thank you!

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