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Birmingham Research Fellow

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About

Dr Hemida has more than ten years of working experience in both academia and industry running research projects that involve steady and unsteady simulations of single and multiphase flows. He has a PhD in Trains Aerodynamics and a Licentiate (Diploma) of Engineering in the field of Thermofluids. Although, he has focused much of his work on wind loads on ground vehicles, he has conducted other successful projects that involve multiphase flow, heat transfer, combustion, mass transfer and shape optimization.

He has also been a university teacher and a teaching assistant for many academic courses (graduate and undergraduate levels) such as Computational Fluid Dynamics (CFD), Environmental Fluid Mechanics, Applied Fluid Dynamics, Heat Transfer, and Thermodynamics as well as a principle supervisor for a large number of undergraduate students.

Qualifications

- PhD in Train Aerodynamics
- Licentiate of Engineering in Thermofluids
- MSc in Heat Transfer
- BSc (Hons) in Mechanical Power Engineering

Biography

Dr Hemida was appointed as Birmingham Research Fellow on September 1, 2010.

He obtained his BSc (1995) and MSc (2000) from Mansoura University, Egypt and his LicEng (2006) and PhD (2008) from Chalmers University of Technology, Sweden. In 2007, he joined the multiphase group in Epsilon (Consultant Engineering firm), Gothenburg, Sweden, as a senior CFD engineer. In January 2009, he joined the Birmingham Centre for Rail Research and Education as a research fellow for 18 months before moving to the current appointment.

He is currently a Birmingham research fellow in the School of Civil Engineering. His research interests range from fundamental Thermofluids and Computational Fluid Dynamics (CFD) to applied engineering for Train Aerodynamics. Dr Hemida has established a strong world-wide reputation in the field of CFD and its application for train aerodynamics. He is a pioneer in using the novel unsteady computational approach, Large-Eddy Simulation (LES) for the flow around trains. He has been involved in many research projects, looking at slipstream and side-wind forces on trains and buses, sponsored by RRUK, Network Rail, Swedish agency for academic research (VINNOVA), Scania and Bombardier.

Beside his expertise in CFD, Dr Hemida has also been involved in a number of projects including Finite Element Analysis of Train-Rail interaction. The quality of his research has been recognised through 13 journal papers and over 20 peer reviewed conference papers, one of them has been awarded the best conference paper in 2007.

Teaching

Teaching Programmes

- Introductory Maths and Data Handling (Foundation year)
- Fluid Mechanics, Heat Transfer and Thermodynamics (First year Civil)
- Environmental Fluid Mechanics (MEng Civil)
- Guided Research (Third year Civil)
- Research Project (MEng Civil)

Postgraduate supervision

Dr Hemida is interested in supervising doctoral research students in the following areas:

The national and international trend is to increase the speed of both passenger and Freight trains. There are many aerodynamic problems that arise when increasing the speed. These can be summarized as:

1. Train aerodynamic stability in high winds
2. Wind loading and the kinematic envelope
3. Train slipstream effects on the external environment

4. Effect of train pressure pulses on other trains
5. Tunnel pressure effects on train interiors

Moreover, the forms drag proportional to the square of the speed of trains. With the future requirement of reducing energy consumptions and hence CO_2, the train drag needs to be reduced.
That has been said, Dr Hemida's research interest will be focusing on these issues. Specifically the following research points he would like to work with:

1. Drag reduction using active and passive flow control.
2. Shape optimization to reduce the side wind flow consequences.
3. The slipstream of Freight trains.
4. Use of CFD to better prediction of the aerodynamic forces of trains at exposed positions.

Dr Hemida is also interested in supervising doctoral students in the field of Finite Element Analysis.

If you are interesting in studying any of these subject areas please contact Dr Hemida on the contact details above, or for any general doctoral research enquiries, please email: **dr@contacts.bham.ac.uk (mailto:dr@contacts.bham.ac.uk)** or call +44 (0)121 414 5005.

For a full list of available Doctoral Research opportunities, please visit our **Doctoral Research programme listings (http://www.bham.findaphd.com/?es=y&apl=y&aplt=&show)** .

Research

RESEARCH THEMES
Dr Hemida's research can be summarised as the application of CFD modelling to environmental fluid flows, especially the flow around trains. He has successfully applied CFD for the side wind flow around trains and buses using the most accurate while practical CFD techniques, Large-Eddy Simulation (LES) and Detached-Eddy Simulation (DES), to solve the instantaneous flow around vehicles aiming to calculate vehicle aerodynamic forces and the frequency of the flow motion.

Having worked as a CFD consultant engineer, he is keen to inform the CFD community on best practice, based on findings from his research. He is also collaborating with colleagues who are applying CFD to range of Civil Engineering flows, typically water and flow around buildings. He is also applying CFD to a range of non-Civil engineering applications such as microchannel flow and heat transfer.
In addition, Dr Hemida has successfully run research projects including Finite Element modelling of Train-Rail interaction.

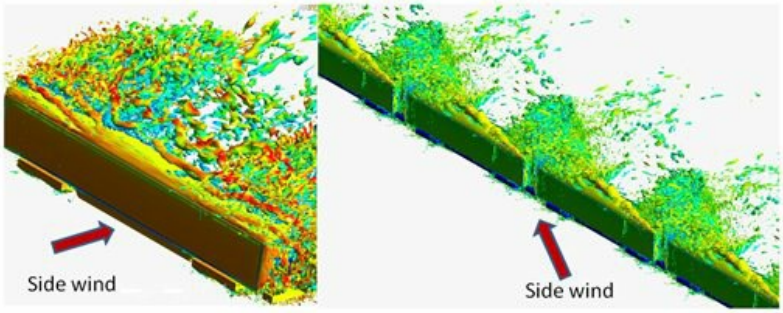
RESEARCH ACTIVITY

Current research

1. **Ongoing projects**

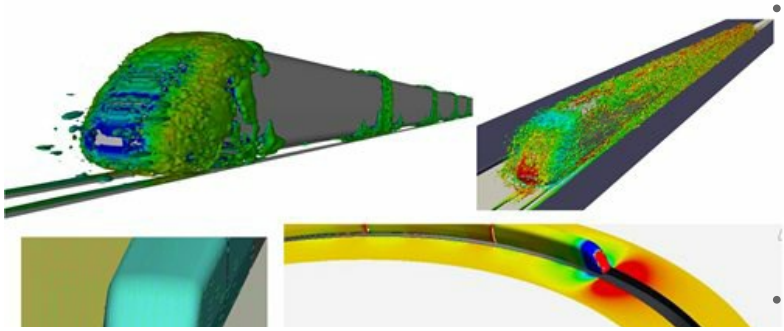
- **Wind loads on Freight trains**

Although, freight trains are usually heavy and running at lower speed compared to passenger trains, they carry containers that, when empty are in a danger of blow off. Several freight train side wind accidents were reported and the most recent one in the UK was reported on March 2008. The purpose of this research is to investigate the aerodynamic response of a freight train subjected to a crosswind at different yaw angles using Large-Eddy Simulation (LES). The freight train under investigation consists of many identical wagons. The wagons of the train are of the single-stacked container type that is having a box-like shape.



- **Train Slipstream**

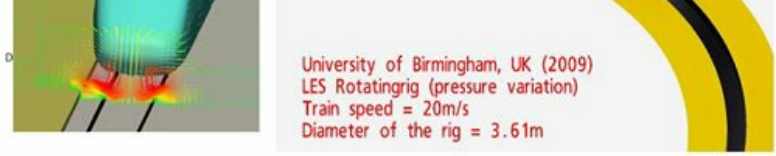
The effects of train slipstreams have become of increasing concern in recent years with regards to the safety of waiting passengers on platforms and of trackside workers, the stability of pushchairs and baby carriers and the forces imposed by the transient pressures and velocities on trackside and station structures. Existing safety practices for people on platforms and staff at the trackside depend on maintaining particular safe clearances, which essentially are based on generalised pragmatic judgements. There is pressure internationally to tie them to measurable quantities. This in turn produces a need to understand and quantify the physical processes and reactions of people to slipstream disturbances. The assessment of train slipstream behaviour is now part of the train acceptance procedure through the TSI process. As the magnitude of aerodynamic forces broadly increases with the square of train speed, these effects can be expected to become of more significance as train speeds become higher. In this work, the slipstream structures and the wake of high speed trains in an open air and on platforms with different heights are determined using Large-Eddy Simulation (LES).



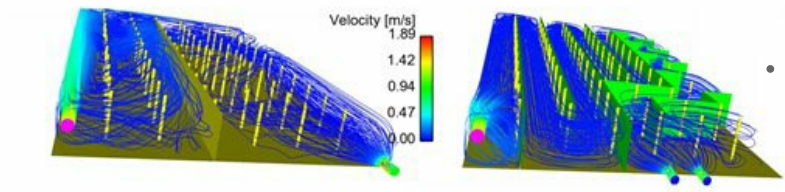
- **Disinfection by-product formation in water treatment**

This research investigates the effect of installing baffles in a water reservoir in the concentration of the disinfection material, chlorine, in drinking water. CFD simulations have been performed on a tank with and without baffles using different turbulence models. The flow rate of water was kept constant in both configurations and the chlorine concentration was monitored at the exit. The results show that installing baffles in the tank increases the residence time in the tank and hence reduces the chlorine concentration of the drinking water before it inters the drinking network.

- **FEA of Switch and Locking Mechanism**



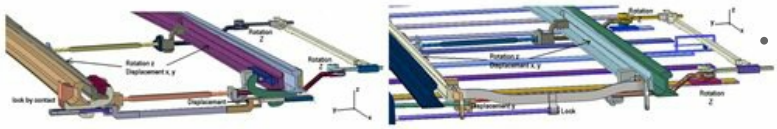
Current standards of switches require the locking force to have a maximum limit, such that should a train run through the switches whilst they are locked in the opposite direction, the locking mechanism shall give way to allow the wheel flange to pass between the switch and stock rail without derailing. Two types of mechanisms were investigated: The HW and the RCPL.



2. **Finished projects**

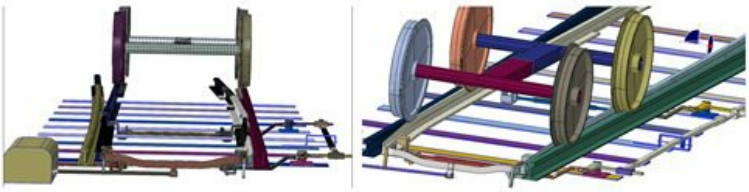
- **Natural heat transfer from corrugated plates**

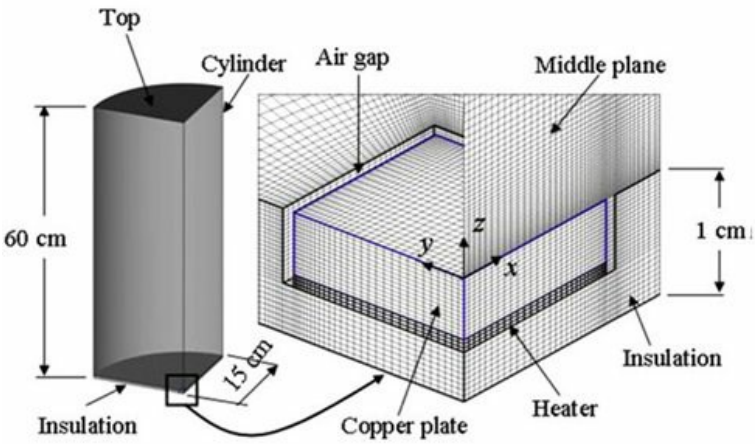
In this project, a CFD model has been developed to solve the flow and temperature field in a natural convection macrofin arrays. The objective of this work was to build a model to be used to test different micro fin height and spacing and to investigate their effect on heat transfer coefficient. The model results have been compared with experimental data and good agreement has been achieved. The figure below shows the computational model and results.



- **Side Wind Flow Around a Simplified ICE2 Train**

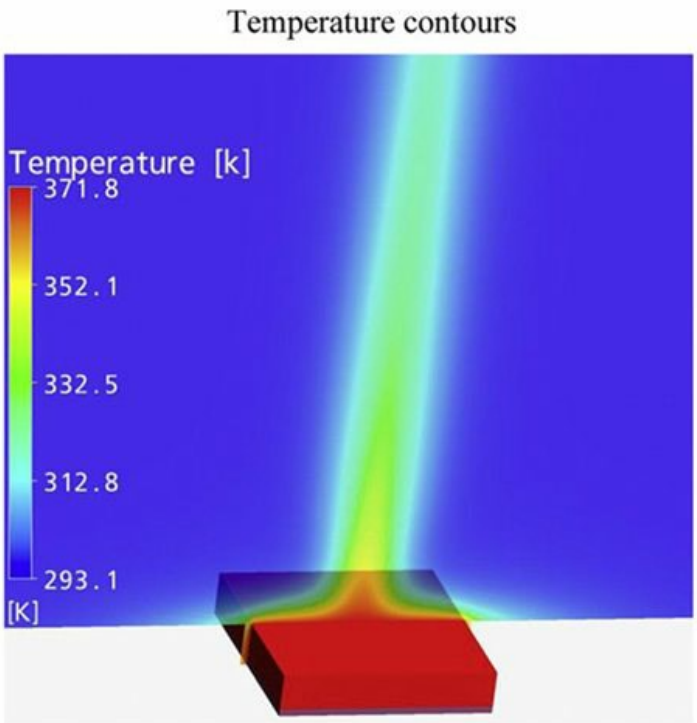
In this work, Large-Eddy Simulation (LES) is made to investigate the flow around a simplified ICE2 train subjected to side wind conditions. Two computations on two different meshes with different number of nodes are made to check the effect of the mesh resolution on the results. The fine and the coarse meshes give similar results meaning that the results are mesh independent. The results are also verified against available experimental data. Good agreement is obtained between the LES results and the experimental data. The LES results show that two flow regimes exist in the wake. The first flow regime consists of steady vortex lines in the upper part of the wake flow. It changes into unsteady shedding after a distance of about five train heights from their onset on the surface of the train. The second flow regime is the unsteady movement of the lower part of the wake vortices. They attach and detach from the surface of the train in a regular fashion. The time-averaged flow and the instantaneous
flow around the ICE2 train are explored.





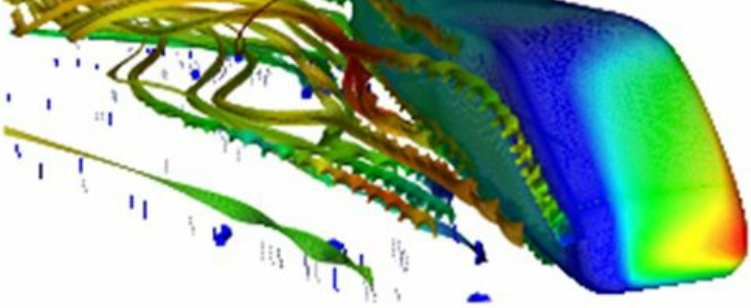
- **Effect of The Shape of The Front Vehicle of a Train on its Aerodynamics**

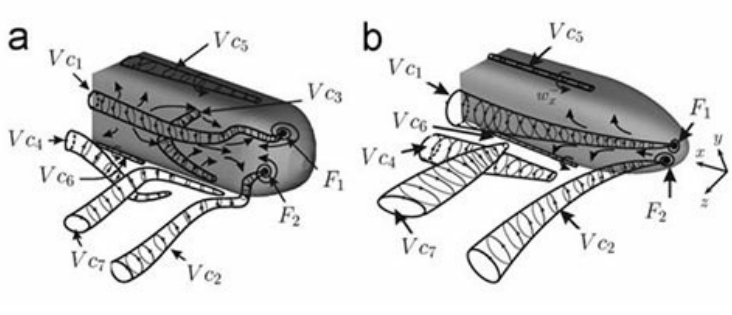
Cross-wind flows around two simplified high-speed trains with different nose shapes were studied using large-eddy simulation (LES) with the standard Smagorinsky model. The cross section and the length of the two train models were identical whilst one model has a nose length twice that of the other. The three-dimensional effects of the nose on the flow structures in the wake and on the aerodynamic quantities such as lift and side force coefficients, flow patterns, local pressure coefficient, and wake frequencies are investigated. The short-nose train simulation shows highly unsteady and three-dimensional flow around the nose yielding more vortex structures in the wake. These structures result in a surface flow that differs from that in the long-nose train flow. They also influence the dominating frequencies that arise due to the shear-layer instabilities. Prediction of vortex shedding, flow patterns in the train surface, and time-averaged pressure distribution obtained from the long-nose train simulation are in good agreement with the available experimental data.

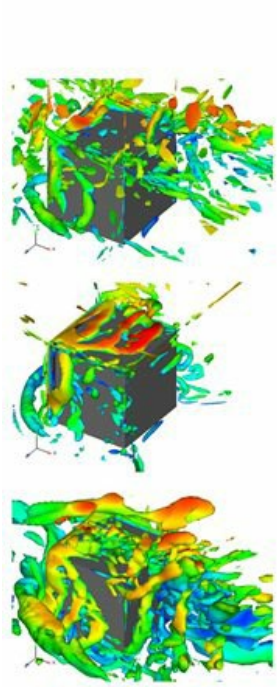


- **The Use of Passive Flow Control in Enhancement of Heat Transfer**

The purpose of this work was to investigate the influence of attaching small vortex generators on the surface of a cube mounted at the middle of similar cubes on the heat removal. Large number of LES computations have been made of the flow and heat transfer around the cube with and without different shapes of vortex generators.

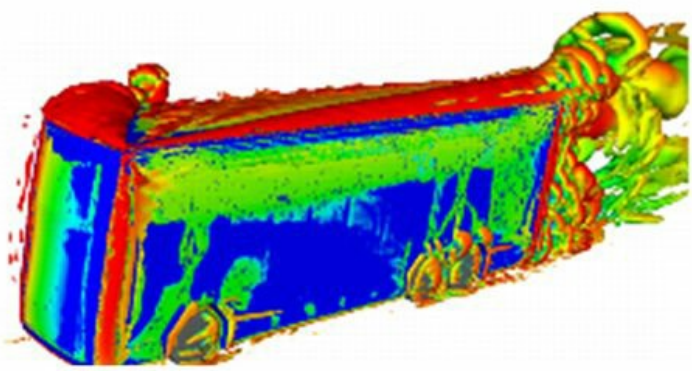






- **Side Wind Flow around a double-deck Bus**

A bus in motion is subjected to different aerodynamic forces such as drag, lift, and side force and aerodynamic moments such as yaw, rolling and pitch. These forces and moments depend very much on the relative wind speed and the direction of wind relative to the bus travelling direction. In this work, the aerodynamics of a double-decker bus subjected to steady side wind has been obtained using the Detached-Eddy Simulations (DES).



- **Shape Optimisation of a Double-Decker Bus**

  The directional stability and passengers comfort are of great concern for a Double-Decker bus subjected to cross winds. Since the shape of the bus determines by large extend its aerodynamics, a proper design is needed to avoid the consequences of large side forces. In this work the shape of the front of the bus has been designed using CFD and the response surface model.

Past research

- Enhancement of heat transfer using pulsating flow
- Investigation of heat problems in induction machines
- Modelling of a Diesel Particle Filter (DPF)
- Filling process
- Spray modelling
- Optimization of a dust cleaning unit
- Investigate the soot formation in a combustor using large-eddy simulation (LES)

PHD STUDENTS

- **Dominic Flynn: The numerical flow around freight wagons (/research/activity/railway/research/aerodynamics/cfd/dominic-flynn-numerical-flow.aspx)**
- **Nainesh Patel: Large-Eddy Simulations of the airflow around a truck (/research/activity/railway/research/aerodynamics/cfd/nainesh-patel-large-eddy-simulations.aspx)**

Other activities

- Visiting Researcher at Chalmers University of Technology, Sweden.
- Chair of the Birmingham CFD user group.
- Member of the RRUK-A

- Member of the Swedish Association of Graduate Engineers
- Member of the Egyptian Engineering Association

Publications

Journal publications

Baker C. Hemida H. Iwnicki S. Xie G. Ongaro D., (2011), The integration of crosswind forces into train dynamic modelling" Journal of Rail and Rapid Transit Vol. 225, Issue 2, pp. 154-164.

Mahmoud S.M., Al-Dadah R. K., Aspinwall D. K., Soo S. L, H Hemida. (2011). Effect of micro fins' geometry on natural convection heat transfer of horizontal microstructures, Applied Thermal Engineering, 31, 5, 627-633. ISSN: 1359-4311

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Hemida, H. and Krajnovic, S. (2009), LES Study of the Influence of Yaw Angles and Nose Shape on Flow Structures Around Trains, Journal of Wind Engineering and Industrial Aerodynamics, doi:10.1016/j.jweia.2009.08.012.

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Hemida, H. and Krajnovic, S., (2008), LES study of the influence of train nose shape on the flow structures under cross-wind conditions, Journal of Fluid Engineering, Vol. 130, issue 9, 091101.

Hemida, H. and Hamdi, E. (2003), Steady-State Heat Transfer in Axi-Symmetric Induction Machines-Part I: Finite Element Formulation, WSEAS Transactions on Systems, 2(3), pp 524--528.

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Hemida, H., and Sabry, N. (2002), Theoretical analysis of heat transfer in a laminar pulsating flow, International Journal of Heat and Mass Transfer, 45(1), pp. 1767-1780.

Peer Reviewed conference papers

Hemida, H., and Baker, C., 2011 The calculation of train slipstreams using Large-Eddy Simulation techniques, WCRR, Lille, France, 24-27 May 2011.

Hemida, H., and Baker, C., Flow around Freight Trains Subjected to Side Winds: Large Eddy Simulation "9th UK Conference on Wind Engineering, Bristol, UK, 20-22 September, 2010.

Hemida, H., Gil, N. and Baker, C., CFD Simulation of a Train Slipstream 17th National Conference on Computational Mechanics, Nottingham, UK, 6-8 April, 2009.

Krajnovic, S., Hemida, H. and Basara, B., Optimization of Aerodynamic Performance of Vehicles Using Response Surface Models Robust design through engineering simulation, October 2008, Pole Leonard de Vinci, Paris - La Defence, 2008.

Krajnovic, S., Hemida, H. and Georgii, J., DES of the Flow Around a High Speed Train Under The Influence of Wind Gusts 7th International ERCOFTAC Symposium on Engineering Turbulence Modelling and Measurements, ETMM7, 4-6 June 2008, Amathus, Cyprus

Hemida, H. and Krajnovic, S., DES of the Flow Around a realistic Buss Model Subjected to a Side Wind with 30 degree Yaw Angle, In Proceedings of the fifth IASME / WSEAS International Conference on FLUID MECHANICS and AERODYNAMICS, Athens, Greece,25-27 August 2007.

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Krajnovic, S., Hemida, H. and Diedrichs, B. Time-Dependent Simulations for the Directional Stability of High Speed Trains Under the Influence of Cross Winds or Cruising Inside Tunnels, FLUID DYNAMICS APPLICATIONS IN GROUND TRANSPORTATION: "Simulation, a primary development tool in the Automotive industry", Lyon, France, 2005.

Hemida, H. and Krajnovic, S. and Davidson, L. Large-Eddy Simulations of the Flow Around a Simplified High Speed Train at a 35 degree side-wind yaw angle, Svensika Mekaniksdagen, Lund, SWEDEN, 13-15 Jun, 2005.

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