TFMRC CPD Series
Thermo-Fluid Mechanics Research Centre (TFMRC) Continuing Professional Development (CPD) Series
University of Sussex in Association with the Institution of Mechanical Engineers (IMechE) SE Region 2008-2009

Key words:
CPD; Continuing Professional Development; Training; Education; Turbomachinery; Temperature; Rotating; Flow; CFD; Computational Fluid Dynamics; Turbulence Modelling; Heat Transfer; Creative Methods; TRIZ

TFMRC Continuing Professional Development Series
This series of Continuing Professional Development events, developed and run in association with the Institution of Mechanical Engineers (IMechE) South Eastern Region, is suited to professionals wishing to expand their skills in the subject area concerned, from heat transfer and CFD to energy audits and TRIZ, or those professionals wishing to refresh their knowledge. These training sessions can be taken individually or part of a series of professional development.

Rotating Flow	Prof Peter Childs, Dr Christopher Long	9th April 2008, 1730-2030
Temperature measurement	Prof Peter Childs and Dr Nick Atkins	4th June 2008, 1800-2100
Introduction to turbomachinery	Prof Peter Childs, Prof Naser Sayma, Dr Nick Atkins	16th July 2008, 1730-2030
Introduction to heat transfer	Dr Christopher Long, Prof Naser Sayma, Dr Nick Atkins	8th October 2008, 1800-2100
Heat transfer modelling of engineering systems	Dr Christopher Long, Prof Naser Sayma, Dr Nick Atkins	12th November 2008, 1800-2100
Introduction to Computational Fluid Dynamics	Prof Naser Sayma and Prof Peter Childs	28th January 2009, 1800-2100?
Transient heat transfer	Nick Atkins, Dr Christopher Long, Prof Naser Sayma	18th February 2009, 1800-2100
Introduction to turbulence modelling in Computational Fluid Dynamics	Prof Naser Sayma and Prof Peter Childs	18th March 2009, 1800-2100
Creative methods	Prof Peter Childs, Dr Nick Atkins	29th April 2009, 1800-2100
TRIZ tools	Shuo Kai Tsai, Dr Nick Atkins, Prof Peter Childs	3rd June 2009, 1800-2100
Energy auditing	Dr Christopher Long, Prof P Childs, Dr Nick Atkins, Prof Naser Sayma	8th July 2009, 1730-2030
Advanced topics in heat and mass transfer	Prof Naser Sayma, Dr Christopher Long and Dr Nick Atkins	9th Sept 2009, 1800-2100

Location
These CPD events will take place in the Creativity Zone, University of Sussex. The Creativity Zone is a multi-configurable and technology enabled learning environment. The Creativity Zone is an integral part of InQbate, the £4.1M HEFCE funded Centre of Excellence in Creativity. Use of the

facilities provided by the Creativity Zone enables group presentations, breakout opportunities, group work, personal reflection and feedback sessions.
The Creativity Zone, Pevensey 3, University of Sussex, Falmer, Brighton BN1 9QH

Travel directions:
www.sussex.ac.uk/about/howtofindus.html

Campus map:
www.sussex.ac.uk/about/images/campusmap/map.pdf

Why come?

- Acquisition of key technical skills
- Internationally recognised learning environment
- Professional facilitators engaged in active technical research
- Provide a significant proportion of your Continuing Professional Development over the coming months.

Event synopses

- Rotating Flow
    - This session will introduce examples of rotating flow in technology, science and nature. The fundamental methods of modelling such flows will be explored in conjunction with simplified techniques that enable approximate solutions to practical applications. Specific subjects covered include fundamentals of rotating flow modelling, rotating disc flow, flow around rotating cylinders and in rotating annuli, Taylor vortex flow, flow in rotating cavities, geophysical flows.
- Temperature Measurement
    - Temperature measurement is a common requirement in industry and commerce. This session will introduce the concept of temperature and its definition. A wide range of technologies are available for measuring temperature and a wide range of these will be introduced, prior to more detailed consideration of thermistors, resistance temperature devices including platinum resistance thermometers, thermocouples, liquid in glass thermometers, bi-metallic thermometers, pyrometers and thermal imagers.
- Creative Methods
    - Creativity can be considered to be the invention or development of something new of value. Creativity is a highly valued attribute in both our personal and professional activities. Our understanding of creative processes is improving with recognition of environmental, personal and organisational factors that enhance our creativity. There is a wide of creative methods available that can be used in our professional activities to enhance our creative and generative activities. This session will explore the environmental factors that can assist in creative and generative activity as well as introducing a series of creative methods such as group brainstorming, grid brainstorming, morphological analysis, lateral thinking, boundary shifting and 6 hats.
- Introduction to Heat Transfer
    - Heat transfer and energy flow in general, play a central rule in our lives. Understanding the mechanisms of heat transfer is essential in many industrial as well as building services applications and environmental applications. This session will explain the basic modes of heat transfer, namely, conduction, convection and radiation. Fundamental mathematical models representing the heat transfer modes will be introduced and applications to engineering problems will be discussed. Principles of operation of heat exchangers will also be explained.
- Heat Transfer modelling of Engineering Systems
    - Mathematical models governing heat transfer processes will be explained in detail. This includes one, two and three-dimensional steady and transient conduction, natural and forced convection and radiation. Numerical models for solving heat transfer problems in engineering systems will be discussed and the use of CFD and FE models will be discussed.

- Introduction to Turbomachinery
    - This session will introduce the basic operating principles of turbomachinery, their range of applications with comparative performance study with other forms of machinery. Fundamental operation principles will be explained including thermodynamic cycle analysis, methods for accounting for component losses, combined cycle and cogeneration systems. Principles of operation of axial and radial flow compressors and turbines, combustion systems. Principles of turbomachinery sizing for engineering applications will also be considered.
- Introduction to CFD
    - Computational Fluid Dynamics (CFD) is becoming an essential tool in engineering design an analysis. This session will give an overview of the different levels of mathematical models representing the flow. The transformation of the flow governing differential equations to algebraic equations will be discussed by introducing the principles of discretisation. Mesh generation methods. Temporal discretisation, convergence criteria, validation and interpretation of CFD results will be also discussed.
- Transient heat transfer
    - Many engineering and practical applications involve temperature varying as a function of time and this can be modelled by means of transient heat transfer methods. Transient conduction will be discussed through lumped capacitance method. The applicability of the lumped mass model will be explained and its limitations will be highlighted leading to the generalised capacitance analysis. Plane wall and radial systems exact solutions and approximate solutions will be introduced together with convection. Semi-infinite solids and multidimensional solutions will also be explained by means of simplified and practical models.
- Introduction to turbulence modelling in CFD
    - The large majority of flows are turbulent in nature. Resolving all turbulence length and time scales is not practicable for most engineering applications. Turbulence modelling is universally used to represent the effects of turbulence on the mean flow field thus enabling the prediction of flows for engineering purposes. This session will introduce the Reynolds Averaged Navier-Stokes (RANS) equations, the different levels of turbulence models. Their applicability range and their limitations. An introduction to Large Eddy Simulation (LES) and Direct Numerical Simulation (DNS) will be given to highlight differences with the turbulence modelling approach via RANS
- TRIZ tools
    - A powerful technique/methodology called the Theory of Inventive Problem Solving (TRIZ) will be introduced in this session along with several of the key tool sets forming part of this approach. This tool has been widely publicised for effectively solving and addressing problems in engineering. TRIZ provides users with effective ways, drawn from science and technology, especially patents, to help solve problems.
- Energy auditing
    - Energy, its production and use, is a key subject area in business and society. The ability to assess whether a particular product, system or process is using energy as effectively as possible is a valuable skill. Energy auditing refers to the methods used to break down the energy consumption in a product, process or application into components. This can be applied to products, buildings or industrial processes. This session will introduce various methods and instruments used in energy auditing and how these can be used to prescribe appropriate energy saving technologies. Energy management issues also will be discussed.
- Advanced topics in heat and mass transfer
    - The modelling of practical applications involving heat and mass transfer can require advanced technical skills. Topics to be discussed are boiling and condensation, Heat exchangers, types, overall heat transfer coefficient, heat exchanger analysis and methods for heat exchanger calculations. Diffusive mass transfer physics,

mixture composition and Fick's law of diffusion, mass diffusion without chemical reactions. Convective mass transfer.

CV profile of series facilitators

Abdulnaser Sayma FIMechE, FHEA, MRAeS, CEng is Professor of CFD at the University of Sussex and was appointed in 2006. Previously, he was a Senior Lecturer in Computational Mechanics at Brunel University and a Principal Research Fellow at Imperial College London. He was also the Rolls-Royce Research Fellow at Imperial College and held a senior research fellowship from the Royal Academy of Engineering. His research interests focus on the development and application of unstructured-mesh CFD methods to turbomachinery problems with special emphasis on mesh generation, turbulence modelling and large-scale aeroelasticity modelling. His main areas of expertise are unsteady aerodynamics, aeroacoustics, cavity flow and forced response. He has been working on aerodynamics and aeroelasticity problems since completing his Ph.D. from UMIST in 1994 and is the author of over seventy refereed publications. He was winner of the Best Technical paper award from Structural Dynamics Committee, ASME Turbo Expo 2006.

Christopher Long FIMechE, CEng is Director of the TFMRC and a Reader in Mechanical Engineering at the University of Sussex. He lectures undergraduate and postgraduate courses in heat transfer, fluid mechanics and space propulsion systems. He completed his D.Phil. in 1984, was appointed a Lecturer in the School of Engineering in October 1994, and Reader in 2000. His main research interests are in the fields of experimental heat transfer and fluid flow measurement. He is the author of a successful textbook on heat transfer. He has been actively involved with gas turbine internal air systems research for almost thirty years and has published some fifty journal and conference articles in this field. He has been principal investigator or co-investigator on four EPSRC and two BRITE-EURAM funded research projects. In particular, Dr. Long has developed expertise in the application of optically based measurements in gas turbine engine applications including Laser Doppler anemometry (LDA) and particle image velocimetry (PIV).

Nick Atkins Mem.ASME, AIMechE Formerly a Junior Research Fellow, New College, Oxford, based at the UTP in Heat Transfer and Aerodynamics at the Osney Laboratory. He negotiated and managed a collaborative research project, funded by Rolls-Royce and based at the University of Oxford, modelling the heat transfer and aerodynamics in the blade tip region of a transonic HP turbine. This extended work important for Rolls-Royce relating to the severe thermal loading of both shorudless blade tips and the turbine casing. Previously he achieved a European-first with the development of techniques for high resolution turbine efficiency measurement in transient turbine test rigs. The new technique enables the simultaneous study of turbine performance and heat-transfer.

Peter Childs FIMechE, FRSA, FHEA, MIED, Mem.ASME, CEng is Professor of Engineering Design at the University of Sussex, Director of the Rolls-Royce University Technology Centre for Aero-Thermal Systems and Director of InQbate, the Centre of Excellence in Creativity. He has published over seventy refereed papers since his doctorate in 1991, and a number of books including five monographs on temperature measurement and rotating flow, and a text book on mechanical design. His main research interests are energy concepts, fluid flow, heat transfer and design. He has been involved in research and development contracts for Alstom, Ford, Rolls-Royce plc, Snecma, DaimlerChrysler, Airbus, Volvo, Johnson Matthey, Siemens, Fiat, the EPSRC and the EU and has been principal or co-investigator on contracts totalling over £12 million. In 1999 he was the winner of the ASME – IGTI John P. Davis award for exceptional contribution to the literature of gas turbine technology.

Host Organisation

The Thermo-Fluid Mechanics Research Centre (TFMRC) is a dedicated research laboratory specialising in energy concepts and technology, rotating flow and heat transfer. A particular focus is flow and heat transfer research in prime movers such as gas turbine engines and other rotating machinery applications as well as large and small scale research programmes on flow, heat transfer, computational fluid dynamics and energy concepts. The TFMRC has received research

grants in excess of £10 million over the last 10 years from the Research Councils, major engineering companies (Rolls-Royce plc, Alstom, Bowman Power Systems, Siemens, Snecma SAFRAN Group, Turbomeca Groupe SAFRAN, Toyota-Aisin Seiki, Avio, Airbus, Volvo Aero, MTU, Rolls-Royce Deutschland) and the European Union. The TFMRC is also the Rolls-Royce supported University Technology Centre for Aero-Thermal Systems. The expertise available within the group in heat transfer and fluid flow and energy solutions enable us to tackle a wide range of energy concepts with applications ranging from domestic combined heat and power units for companies such as Bowman Power and Aisen Seki to industrial units for companies such as Siemens and Alstom. A speciality of the TFMRC is non-invasive instrumentation including pyrometry and thermal imaging, particle image velocimetry (PIV), Laser Doppler anemometry (LDA) and particle data anemometry (PDA). We are the Dantec Centre of Excellence in non-invasive instrumentation with this relationship providing a direct route for the development and application of non-invasive measurement capability. The recent Appointment of Professor Sayma to the TFMRC brings more than 14 years experience with Computational Fluid Dynamics (CFD) and Aeroelasticity to the research group.

Fees
£100+VAT per person for non-IMechE members
£60+VAT per person for IMechE members
£50+VAT per person for IMechE young-members

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