Stakeholder Workshop on Meeting Industrial Needs

An important annual event for the EPSRC and ESRC Centre for Doctoral Training in Risk and Uncertainty is the Stakeholder Meeting, held this year on Wednesday 16 March. Different from previous years, the meeting took the form of a workshop with active industrial involvement and a focus on addressing industrial needs. Thus the Stakeholder Workshop with the theme of “Meeting Industrial Needs” was held in the newly refurbished Chadwick Building on the University of Liverpool campus. The workshop was aimed at defining industrial requirements and identifying academic colleagues with the necessary skills and experience.

About the workshop: The workshop was attended by Dr Chris White of EPSRC (Senior Portfolio Manager for Mathematical Sciences, and Complexity Science) As well as by Professor Ken Badcock (PVC for Science and Engineering). Several industrial partners were invited to provide a description of an industrial challenge related to Risk and Uncertainty - see following pages for details. The tasks to be completed at the workshop were based on these descriptions and each of the invited industrial partners gave a brief explanatory talk. Selected academic colleagues gave presentations on available research skills and facilities as they relate to major multi-disciplinary themes of the CDT. This was followed by group discussions, each chaired by an industrial partner, with the purpose of together preparing draft projects to be worked up over the following months as potential CDT PhD proposals. The meeting re-convened towards the afternoon to summarise the achievements made.
Industrial Challenges

Definitions of Design Fire Loads
Robert English and David Sanderson, MMI Engineering

MMI Engineering has previously performed numerous Fire Integrity Analysis (FIA) and Passive Fire Protection (PFP) optimisation studies for a variety of clients in the offshore oil and gas sector. The studies comprise two main stages, namely: 1) Fire Risk Assessment (FRA) to determine the Design Accidental Load (DAL) for the fire hazards on the facility; 2) Structural assessment and progressive Fire Collapse Analysis (FCA). At present there is no commercially available software for performing probabilistic (i.e. risk-based) FRA. Some of these methodologies perform Fire Consequence Modelling (FCM) using Computational Fluid Dynamics (CFD) and produce a risk-based DAL in terms of specific 'real' fire scenarios; others perform FCM using correlations and phenomenological methods, producing a design fire scenario that does not correspond to a 'real' scenario, but is rather determined by an evaluation of the fire risk at multiple different times into the fire event. The CFD based methodologies are generally regarded to be the least conservative, and therefore offer the greatest potential to minimise PFP requirements.

MMI Engineering would like to obtain a greater understanding of this, and to determine whether there are any reasonable modifications that could be made to the methodologies in order to reduce conservatism without being potentially non-conservative. There are a large number of inputs to the FRA studies, including process conditions, event trees, corresponding nodal probabilities and event frequencies. There are uncertainties associated with these input parameters; however studies are typically performed using a single set of values or only a small number of sensitivities. MMI would like to gain a better understanding of the relative sensitivities of the design fire loads to these inputs within the uncertainty range for each input.

Challenges of Design Optimisation under Uncertainty
Andrew Pike, Senior Engineering Tools Scientist, GE Power

GE Power designs and manufactures a complete portfolio of turnkey power plants, sub-systems and components. At each level of this hierarchy, Design Optimisation Under Uncertainty (DOUU) is required. Three key industrial needs related to DOUU are as follows:
1) The requirement for effective numerical methods to locate the optimal design within the uncertainty space. 2) The requirement to quantify the risk associated with plant/sub-system/component guarantees. 3) The requirement to utilise the available computing resource effectively to obtain results within commercial time-frames. A number of technical issues need to be considered within an industrial DOUU project. These include (e.g. with reference to a Gas Turbine (GT) design): The propagation of uncertainty within a hierarchy of interacting subsystems (e.g. blade performance uncertainty \(\rightarrow\) compressor performance uncertainty \(\rightarrow\) GT performance uncertainty); Uncertain boundary conditions (e.g. ambient conditions); Manufacturing tolerance (e.g. on dimensions of GT casing); Lack of knowledge of model parameter uncertainty (unlikely to know full distributions, perhaps most likely value and upper and lower limits), numerical and meta-model error (convergence tolerance, discretisation error), as well as new design challenges, such as handling design innovation performance uncertainty (e.g. for a new blade design that does not exist in the fleet of operating engines).

The development of state-of-the-art DOUU strategies that are successful within industrial design projects is a challenge that can only be met by effective collaboration between the academic research community and industry.
Approaches for the Qualification of Exhaust Solutions for DEMO-class Devices

Simon McIntosh, Culham Center for Fusion Energy

Plasma exhaust is a critical aspect of DEMO-class devices, so there needs to be confidence that it will work. The methodology to establish confidence in potential solutions will be considered, drawing on approaches inside and outside fusion including evolving high power computing tools - these approaches could also help find improved solutions. One of the challenging aspects of step from ITER to DEMO-class devices is the qualification of the scientific, technological and engineering solution to a level that justifies to stakeholders the strategic and financial investment, given that a full scale precursor test is not feasible, almost by definition. Most other fields have/had immediate exploitation (the Space Shuttle programme had several craft) and clear risk/benefit arguments for full scale tests. Therefore a traditional Technology Readiness Level approach cannot be used at the final stage.

Plasma exhaust is a good example of the general challenge. It encompasses complex plasma & neutral gas physics, advanced engineering, design and use of materials and components in extreme environments, and measurement and control in this same environment. Crucially, the elements need to be integrated into an overall solution that accommodates significant behaviour uncertainties. The reference approach is to take the best available design, with uncertainties and unknowns, and implement margins and risk mitigation strategies. We explore a complementary approach based on models for the final step which aims performance and uncertainty range.

This work has been funded by the RCUK Energy Programme [grant number EP/I501045]

Making the right Decision given Large Uncertainty

Jonathan Carter, E-On

We have a reservoir that has been producing oil for 36 months, it has now started to produce water as well. Should management spend a large amount of money to shut-off those parts of the well that are producing water, and which sections should be shut.

The model is a simple vertical cross section through a reservoir. On the left hand side there is an injector, and on the right hand side is a producer. Mid-way between the wells is a fault as shown in the figure. The geology is an alternating sequence of good and poor quality sand. The data available consists of 108 measurements of oil production rate, water production rate and water injection rate, and there are three uncertain parameters that need to be determined from the data: permeability in each of the two sand types and the fault throw.

The challenges are:

1. Build a good proxy model of the reservoir behaviour
2. Perform a probabilistic inverse problem to determine most likely intervals for the three parameters.
3. Make a recommendation for the best management action and predict the performance over the next year.

The model is known as the IC Fault Model and can be found at this link.

In addition to the technical questions described above we have two human interaction issues related to this work: 1) What is the best practice to obtain realistic prior information about the uncertainty from our subject experts. 2) What are the most appropriate techniques to communicate the uncertainties to senior decision makers who have no training in probabilistic forecasting and may be hostile to non-deterministic modelling.
Financial Market Interdependencies
Kimmo Soramäki, Financial Network Analytics

Covariance is a common measure for interdependency between financial assets. In risk management often a single covariance matrix, recalculated periodically, using long time series is used for modelling how a system of assets would be affected by shocks. As a more recent alternative, methods to detect covariance regimes have been developed addressing the empirical observation that interdependencies are stronger when the system is stressed - we speak of "correlations going to one" or of "risk-on" and "risk-off" periods. However, going one step further it would be useful to consider the covariance matrix as a variable that is, in addition to the time period also dependent on the shock type and magnitude of shock modelled. These 'conditional' factor vectors could be used to better model interdependencies in portfolio stress testing.

A related question is identifying the pathways by which these shocks cascade in the markets. A shock to an asset (say oil) will first cause price adjustments to assets that are 'close' to oil, say emerging market bonds (as many emerging markets are high cost oil producers). The emerging market bond price adjustment will cascade to assets close to them, say high yield bonds. The price adjustment to high yield bonds will affect many financial stocks, etc. These price adjustment processes are not immediate as it takes time for information to cascade in the markets. The ability to measure these processes, their main pathways and their speed would enable better market risk management and a better understanding on the market interdependencies.

Development on Flood Plains, picking up the Costs of Flooding?
Gareth Jones, Ribble Rivers Trust

Winter 2015 brought an unprecedented level of flooding for the Ribble catchment. Amongst the worst hit areas was Whalley (population 3,629 (Office for National Statistics, 2011)) which received 600mm (EA pers corres, 2016) more flood water than had been previously recorded. Repairs to properties and the displacement of people will not be rectified for months. Not only do these currently flood but they will further reduce the porosity of the surrounding land. This creates a conflict between the public need for more housing and locations/opportunities to introduce flood storage measures. Over the last 256 years Todd et al. (2015) established that rainfall records for Carlisle reflect wetter winters were more frequent suggesting that a revision of flood frequencies and magnitudes is warranted. To address these concerns within a flood management context, there is a requirement for a more integrated approach to be adopted by impacted local councils core development plans. For those lacking core plans, the inclusion of flood storage measures within the decision-making process is more unclear.

The Ribble Rivers Trust is a charity that promotes and undertakes sustainable water resource management practices. It delivers river restorative techniques through working with landowners, farmers and volunteers using green infrastructure. How the Risk Institute could assist in tackling:

- Appraise the cost of flood repairs to residents in light of the winter floods.
- Consider how green infrastructure is and could be considered within Core Plans.
- Where core plans don't exist, where within the planning application process should consideration be given.
- Assessing and scoring blocks of land in terms of its propensity to provide flood risk management
- Measure the flood risk benefit of the land given the introduction of a preferred flood storage option(s) over and above that for development. This should incorporate an ability to combine blocks of land and also consider options for mitigation.
- Contrast the costs to home and business owners against the profits made by developers.
Group Meetings and Discussions

Discussion groups were held in staff offices. Each group led by an industrial partner and an academic chair. The aim of these meetings has been to discuss an industrial problem, identify academic staff with suitable skills/expertise, design a preliminary PhD programme. Findings and outcome of these meetings were subsequently summarised and presented back in the Seminar Room to all the participants of the workshop.

The group meetings were as follows:

**Definitions of Design Fire Loads;**
*Industry partner:* MMI Engineering, Robert English and David Sanderson;
*Chair:* Volfango Bertola and Peter Green.

**Challenges of Design Optimisation under Uncertainty;**
*Industry partner:* GE Power, Andrew Pike;
*Chair:* Alejandro Díaz De la O.

**Approaches for the Qualification of Exhaust Solutions for DEMO-class Devices;**
*Industry partner:* Simon McIntosh;
*Chair:* Bruno Merk.

**Making the Right Decision given Large Uncertainty;**
*Industry partner:* E-On, Jonathan Carter;
*Chair:* Edoardo Patelli.

**Financial Markets Interdependencies;**
*Industry partner:* Financial Network Analytic, Kimmo Soramäki
*Chair:* Athanasios Pantelous.

**Development on Flood Plains, picking up the Costs of Flooding;**
*Industry partner:* Ribble River Trust, Gareth Jones;
*Chair:* Neil Macdonald.

**Challenge Project Title;**
*Industry partner:* Unilever, Timo Giesbrecht;
*Chair:* Andrej Stancak.
Strategic Risk Communication of Nuclear Projects

Nuclear industry is carrying some big burdens from past events and therefore people sometimes have irrational fears which can make deployment of new power plants difficult. The current Government commitment to a significant expansion in new nuclear in the UK stating that nuclear power, alongside renewable energy sources, will ensure UK has enough low-carbon electricity in the future.

A new concept of nuclear power plants - Small Modular Reactors (SMRs) - was introduced and it is looking for its place in the energy market. SMRs are smaller, modular and with more passive safety features, they offer several other advantages such as reduction in transmission losses, zero CO2 emissions, district heating or better financial viability. Public acceptance or opposition to new technologies is related with the perception of possible risks or benefits this new technology can bring to society or individuals. Public attitudes are known to be more sceptical towards nuclear power then towards renewable sources; this is especially because of higher perception of risks from nuclear power than of risks from other sources. To successfully communicate risks related to SMRs it is necessary to understand how public perceive risks rising from use of nuclear power and small energy generation.

The industrial partner involved in this project is National Nuclear Laboratory (NNL). Cooperation with NNL on this project will help to understand the nuclear industry concerns and work being done in the field of public engagement of nuclear power by industry so far. Their team is currently developing the Strategic Project on Public Engagement in collaboration with Welsh Government and Sellafield Ltd. I am currently at placement with NNL and I have joined the team working on this project. The project main aim is getting a feedback on nuclear new build from public as new power plants are planned to be built in Cumbria and Anglesey. Public will be given information about new build in the UK on two workshops in two different locations in a form of a public dialog. The dialog is aiming to understand people concerns, answer their questions and find what the best to approach wider public is.

About Petra:
After graduating in 2013 with distinction at Brno University of Technology in Risk management of Chemical technologies, I moved to the UK and decided to deepen my knowledge about nuclear technologies and nuclear safety. I successfully completed a Postgraduate Course in Nuclear Safety at University of Central Lancashire in Preston. My artistic background should be helpful when trying to tackle with ways of how to communicate nuclear power issues using info-graphics and visualising uncertainties.

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3Professor and Head: Institute for Computer Science in Civil Engineering, Leibniz University Hannover, Germany
4Scientist at National Nuclear Laboratory Ltd
Reliability Analysis and Surrogate Modelling of Biodiesel Filters

Peter Hristov, PhD Student, year two
Supervisors: Alejandro Diaz De la O, Krzysztof Kubiak and Umer Farooq

The current project focuses on improving the process of separation of water from biofuels using non-woven fibrous filters. Biofuels have a number of advantages, some of which are renewability and carbon neutrality. However, because of its chemical composition, biofuels are very prone to water contamination. The majority of the water can be separated using different mechanical devices.

However, the problem of separating water droplets on the microscopic scale is a more challenging endeavour. Since the process concerns liquid-liquid separation, many factors need to be taken into consideration. This work is sponsored by the School of Engineering and by an industrial partner.

Due to the fact that there are so many possible configurations of different parameter values, the use of a computer model is necessary to avoid physically testing all of them, which would be impractical and expensive. This code, also known as a simulator, is essentially a function of its inputs, but with unknown explicit form. Once written, the code can be used to perform different simulations to suit the relevant requirements.

The used simulation method is Lattice Boltzmann modelling (LBM). Given the complex nature of the process being simulated, it is expected that the simulator will be very computationally expensive. This is a problem, since various tests and validation processes require thousands of runs of the simulator under different input combinations. Therefore, an extensive use of emulation (Gaussian process emulation, in particular) is used in this project. Emulation is a powerful technique for creating a statistical approximation of the output of the expensive code. Once constructed and validated, the emulator can be used independently of the simulator, thus saving an appreciable amount of time and allowing different analyses of the original model to be performed.

Examples of these are: sensitivity analysis, where the most important parameters are identified; history matching, where values for the parameters used to pre-calibrate the model are identified; and calibration, where experimental data is used to learn about the unknown parameters of the model; reliability analysis, where the probability of failure of the system under consideration is estimated.

About Peter:
I have a Bachelor’s degree in Aerospace Engineering from the University of Liverpool. I have worked for a number of small engineering and aeronautical companies in Bulgaria, including a position as an editor of a physics and mathematics textbooks for aircraft technicians. My research interests lie in the domain of aerial vehicle design and especially fluid dynamics. I am also interested in simulation techniques for fluid flows as well as dealing with the analysis of expensive computer codes.

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7Senior R & D Scientist at Parker Hannifin
Training Activities
EPSRC & ESRC Centre for Doctoral Training in Risk & Uncertainty:
Easter School - April 2016

“Systems Approaches to Risk Assessment and Management”

Ioannis Stratis National University of Athens, Greece:

- Mathematical Framework for Systems Analysis
- Systems of Linear Ordinary Equations (ODEs)
- Advanced Topics: Semi-group Approach and Controllability of Linear ODEs

Mike Poole Radioactive Waste Management Ltd, Oxford, UK:

- Strategies of Uncertainty: Geological Disposal of Radioactive Waste
- Total Systems Modelling: Solutions in Radioactive Waste Management
- Quantification of Uncertainty by Expert Judgement: RWM Methods

Nicola Pedroni University Centrale Paris / Supelec, France:

- Risk, Vulnerability and Resilience Assessment
- Complex Systems Applications: Cases in Networked Infrastructures
- Vulnerability / Risk Assessment: Use of Non Probabilistic Approaches
Uncertainty Quantification Training Course on HPC with COSSAN software, 4th - 6th May 2016:

The Institute for Risk and Uncertainty in collaboration with Hartree Centre, is organising a three-day training course on:

“Uncertainty Quantification using COSSAN Software on High Performance Computing”

Each day focuses on a specific topic. This allows the participation to attend a specific training day.

- The first day is dedicated to an introduction of general concepts of stochastic and probabilistic analysis and the fundamentals for accessing and using the fantastic HPC facilities of the Science and Technology facility Centre. The Virtual Engineering Centre, UK’s leading centre of Virtual Engineering technology, will show the latest scientific and technological infrastructure solutions for industrial and commercial applications.
- The second day is dedicated to COSSAN-X software, a cutting-edge software to quantify, mitigate and manage risk and uncertainty in many fields. Our teachers will show the performance of UQ tools using COSSAN-X. The easy-to-use graphical interface of COSSAN-X allows to perform stochastic analyses in few simple steps.
- The third day, will concentrate on the OpenCossan software. Our demonstrators and developers will reveal the secrets of our UQ tools by showing the OpenCOSSAN software.

Learning outcomes:

- Understand the importance of Uncertainty in computer simulations;
- Learn the main tools and techniques for quantify and manage uncertainties;
- Gain familiarity with modern tools for actually carrying out the computations in a HPC context.

When:

- Start Date: Wednesday, 4th May 2016;
- End Date: Friday, 6th May 2016

Where:

The training course will take place at the Science and Technology Park (Daresbury Innovation Centre) in Daresbury, Cheshire. Each day of training will be dedicated to a specific topic focusing attention on HPC, and advanced methods for dealing with uncertainties.

There is a limited availability of spaces. Do not miss this opportunity. Reserve your seat now. More information and Registration.
CDT Summer School, 9th - 10th June 2016, Rhodes Greece:

The summer school this year will take place in beautiful island of Rhodes within the 2nd symposium on Quantitative Finance and Risk Analysis (QFRA2016).

The symposium provides a multi-disciplinary forum for the exchange of knowledge and expertise in the area of Quantitative Finance, Risk Analysis and Management. The event is aimed at specialised and synergetic developments in both theory and practice. Find out more [here](#).

The objective of this symposium is to bring experts and decision makers from different disciplines but working on similar problems together to share information on current and emerging developments and to initiate advancements towards a solution to our challenges through cross-fertilisation. This symposium and subsequent publications will help transition intellectual discussions into robust frameworks for handling emerging vulnerabilities and risks, and provide the leadership and initiative required to respond to national and international financial crisis.

A copy of the programme will be available May 15th. Registration to the Summer School is now open. In order to register please click [here](#).

“Japan Nuclear Human Resource Development Network”. International Short Course, September 2016, Liverpool UK:

The Risk Institute will be hosting a small group of postgraduate students and staff from University of Tsukuba, Japan for a short course in nuclear risk, disaster response and environmental radioactivity. The opportunity exists for a small number of Risk Institute-associated PhD students to join this course. Costs for the full programme of events, including overseas visits, will be in the region of £1750 per person and should be discussed with Risk CDT supervisors. Priority will be given to those with projects related to the nuclear industry. The course is an excellent opportunity for international networking and skills development.

The programme will involve:

- 1-day field course in West Cumbria involving sampling near Sellafield and tour of the Dalton Cumbrian Facility (tbc)
- 1-day radiometry laboratory course and workshop at Liverpool
- 1-day visit to IAEA in Vienna, Austria
- Field visit and/or training course in Chernobyl, Ukraine (details tbc)

Participation in the UK section only is also possible and all Risk Institute students are invited to join the course. Please contact Dr Jon Bridge for more details and to express interest.

LIDASP IV, “International Advanced Course in Liquid Interfaces, Drops and Sprays.” Brighton, UK, 30th Aug - 2nd Sept 2016:

International Course Directors: A. Amirfazli, V. Bertola, M. Marengo

The knowledge of the physics of liquid drops is essential for many applications, especially in Risk mitigation of fire accidents. The mathematical study of stability theories for hydrodynamic interfaces also aids the process of numerical modelling of complex phenomena triggered by unexpected circumstances, such as tsunami and landslides.

The course objective is to provide the participants with today's knowledge on the physics of drops and sprays based on recent research results and the most updated methods for the prediction of dynamic outcomes, heat transfer, wettability effects, and its applications to technological and industrial areas.

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Symposia in International Conferences

**EMI2016 & PMC2016.** Vanderbilt University, Nashville, Tennessee.

**Symposia:**

- **EMI-MS-01:** Structural Identification and Damage Detection  
  Eleni Chatzi, ETH-Zurich;  
  Costas Papadimitriou, University of Thessaly;  
  Siu-Kui Au, Risk Institute, University of Liverpool.

- **PMC-MS-01:** Advanced simulation-based approaches to uncertainty quantification and reliability analysis  
  Michael D. Shields, Johns Hopkins University;  
  Siu-Kui (Ivan) Au, Risk Institute and Centre for Engineering Dynamics, University of Liverpool.

SIAM Conference on Uncertainty Quantification, SIAG/UQ.  
SwissTech Convention Center, EPFL Campus, Lausanne, Switzerland.

**Symposium:**

- **Uncertainty Quantification with Vague, Imprecise and scarce Information organized**  
  Edoardo Patelli, Risk Institute, University of Liverpool, UK.
- **Learning Parameters from Data: Calibration, Inverse Problems, and Model Updating**  
  Alejandro Diaz, Risk Institute, University of Liverpool, UK.

**ECCOMAS 2016,** Crete Island, Greece.

**Symposia:**

- **MS 1302:** Advanced Simulation Methods for Probabilistic Analysis  
  Edoardo Patelli, Risk Institute, University of Liverpool, UK;  
  Konstantin Zuev, Risk Institute, University of Liverpool, UK;  
  Enrico Zio, Ecole Centrale Paris LGI-Supelec, France & Politecnico di Milano, Italy.

- **MS 1303:** Analysis and Design of Safety Critical Systems Under Uncertainty  
  Edoardo Patelli, Risk Institute, University of Liverpool, UK;  
  Michael Beer, Leibniz University Hannover, Germany;  
  Matteo Broggi, Risk Institute, University of Liverpool, UK;  
  Francisco Alejandro Diaz De la O, Risk Institute, University of Liverpool, UK.
Asian-Pacific Symposium on Structural Reliability and its Applications.

**APSSRA 2016**, 28-30 May 2016, Shanghai, China.

**Symposia:**

- **MS-1:** *Epistemic Uncertainties in Engineering: Modeling, Methods and Applications*
  Wei Gao, UNSW Australia;
  Hao Zhang, The University of Sydney, Australia;
  Michael Beer, Leibniz University Hannover, Germany;
  Vladik Kreinovich, University of Texas at El Paso, US.

- **MS-3:** *Imprecise Probabilities*
  Michael Beer, Leibniz University Hannover, Germany;
  Edoardo Patelli, LIRU, University of Liverpool, UK;
  Matteo Broggi, LIRU, University of Liverpool, UK;
  Kok-Kwang Phoon, National University of Singapore;
  Ser Tong Quek, National University of Singapore.

- **MS-4:** *Reliability of Large Systems and Structures*
  Konstantin Zuev, California Institute of Technology;
  Michael Beer, Leibniz University Hannover, Germany;
  Athanasios Pantelous, LIRU, University of Liverpool, UK;
  Matteo Broggi, Risk Institute, University of Liverpool, UK.

- **MS-5:** *Perception, Calculation and Communication of Risk under High Uncertainty*
  Sara Waring, Risk Institute, University of Liverpool, UK;
  Michael Beer, Leibniz University Hannover, Germany;
  Enrico Zio, Politecnico di Milano, Italy and Ecole Centrale Paris LGI-Supelec, Paris, France
  Terje Aven, University of Stavanger, Norway.

- **MS-7:** *Surrogate models for structural reliability analysis*
  Francisco Alejandro Diaz De la O, Risk Institute, University of Liverpool, UK;
  Sondipon Adhikari, Chair of Aerospace Engineering, Swansea University.

- **MS-8:** *Uncertainty Modeling & Propagation in Nonlinear Stochastic Dynamics: Current Status & Future Challenges*
  Ioannis A. Kougioumtzoglou, Columbia University, US;
  Michael Beer, Leibniz University Hannover, Germany;
  Jianbing Chen, Tongji University, Shanghai;
  Pol D. Spanos, Rice University, US.

- **MS-11:** *Numerical design for advanced engineering structures*
  Wolfgang Graf, TU Dresden, Germany;
  Michael Beer, Leibniz University Hannover, Germany.

- **MS-12:** *Risk Assessment of Complex Infrastructure Networks*
  Konstantin Zuev, California Institute of Technology;
  James Beck, California Institute of Technology;
  Enrico Zio, Politecnico di Milano, Italy and Ecole Centrale Paris LGI-Supelec, Paris, France
  Athanasios Pantelous, Risk Institute, University of Liverpool, UK.

- **MS 13:** *Reliability And Performance-Based Design Of Complex Structural Systems*
  Hector Jensen, University of Chile;
  Marcos Valdebenito, University of Chile;
  Michael Beer, Leibniz University Hannover, Germany;
  Edoardo Patelli, Risk Institute, University of Liverpool, UK.
**RMetS NCAS** Conference 2016, Wednesday 6 July 2016 - Friday 8 July 2016 - University of Manchester, University Place, Oxford Road, Manchester.

Session: **High Impact Weather and Climate**
Neil Macdonald

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Keynote lecture:
**Floods Working Group: Cross community workshop on past flood variability**
Niel Macdonald

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**IMAC-XXXV** A Conference and Exposition on Structural Dynamics.

**Session on Big Data**
Peter Green

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**SaRS2016** - Safety and Reliability Society, 6th October 2016, Buxton

Don’t stop thinking about tomorrow: tools and techniques for managing an uncertain future
will be hosted by HS’s Foresight Centre at the Health and Safety Laboratory in Buxton on the 6th October 2016. The aim of SaRS2016 is to demonstrate how futures techniques, whilst they can’t predict the future, can provide you with the necessary foresight to anticipate and prepare for it.

Nicola Stacey

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**SaRS2016** - Safety and Reliability Society, 17th May 2016, Manchester

The Dependability Case 17th May 2016, Manchester
IEC 62741 is an international standard which has been published in 2015. This standard provides a description of the principles of the Dependability Case and guidance on its content and application in systems engineering.

Nicola Stacey

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**SaRS2016** - Safety and Reliability Society, 16th June 2016, London

Big Projects, Big Problems? Technical Seminar
The UK faces challenges in delivering major infrastructure projects to improve transportation and energy systems.

Nicola Stacey

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ICASE Awards: Available PhD Studentships

Robust Design under Uncertainty ICASE Award

Principal Investigator: Dr. Alejandro Diaz

General Electric Power and the EPSRC and ESRC Centre for Doctoral Training in Quantification and Management of Risk & Uncertainty in Complex Systems & Environments are delighted to announce an ICASE supported PhD. The position targets the development of uncertainty quantification techniques applied to engineering design problems.

The goal of engineering design is to create technological systems that satisfy specific performance objectives and constraints over a period of time. Usually, there exist many feasible designs that satisfy the required objectives. For this reason, it is desirable to choose an optimal design according to some criterion. Modern engineering systems are inherently complex. This complexity means that endogenous (geometry, material properties) and exogenous (loads) information is never complete. This lack of information can be captured by modelling uncertainties as random variables, whose distributions can in principle be obtained from expert opinion, literature or test data. The objective of performance-based design is therefore to determine the optimal design that minimises an expected loss function which depends on both the characteristics of the design space and the model parameters that encode the characteristics of the system under study.

This PhD project is an excellent opportunity to develop highly sought-after skills in uncertainty quantification. It is expected that the student will be focused in techniques such as surrogate modelling, computational Bayesian inference and stochastic optimisation. A strong numerical and computational background is required, and a background in probability and statistics is highly desirable. The position is available from the autumn of 2016 and will be based at the Liverpool Institute for Risk and Uncertainty. For further details please contact Dr. Alejandro Diaz.

Liverpool-CCFE ICASE Award

Principal Investigator: Dr. Edoardo Patelli

In southern France, 35 nations are collaborating to build the world's largest tokamak, a magnetic fusion device designed to prove the feasibility of fusion as a large-scale and carbon-free energy source, based upon the same principle that powers our Sun and the stars. Culham Centre for Fusion Energy (CCFE) and the University of Liverpool are offering an exciting opportunity to carry out a 4 year Ph.D., focusing upon modelling the tokamak “edge pedestal” (a comparatively narrow layer of plasma that forms the interface between the hot, dense central plasma and the cooler, more rarefied plasma that lies adjacent to the machine first-wall components). The pedestal is characterised by significantly improved energy confinement compared to the core plasma, leading to a very steep temperature gradient. If its confinement properties can be optimised, then the confinement of the whole plasma will improve, leading to efficient power production. Not surprisingly, given that the desired temperature gradient is of order 100 million Kelvin over just a few centimetres, the region is very challenging to model (and measure), and much needs to be done to increase the reliability of the models.

This PhD is an opportunity to develop highly sought after skills in uncertainty quantification (UQ), as well as a background in plasma dynamics, well-suited to a subsequent career developing tokamaks into a practical and economic energy source. We are seeking applications from candidates with a strong undergraduate degree in a relevant discipline (physics/mathematics/engineering/computer science) and a keen interest in using high performance computing and advanced UQ techniques to solve complex physical problems.

Interested applicants can find out more, including instructions on how to apply, via the CDT website: https://www.liverpool.ac.uk/risk-and-uncertainty/postgraduate/cdt-research-projects-available/

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Research Projects Grants

New H2020-MSCA-RISE Grant Award

*Principal Investigator:* Dr. Jorge Hernandez

Dr. Jorge Hernandez, jointly with Professor Andrew Lyons, Dr. Hossein Sharifi and Dr. Dong Li, who belongs to the Agility Centre from the University of Liverpool Management School jointly with Professor Michael Beer, Professor John Mottershead and Dr. Edoardo Patelli from the Liverpool Institute for Risk and Uncertainty have been awarded a €1.3M **Research Grant** under the H2020 Marie Skłodowska-Curie Actions for Research and Innovation Staff Exchange.

The research will lead to the creation of a validated standard framework for supporting the development of collaborative and Participative Decision Support Systems solutions for enhancing the Agriculture Value Chain Decision-making under high Risk and Uncertainty. This innovative and multi-disciplinary research work involves academics, researchers and industries from seven countries, including: UK, France, Italy, Spain, Poland, Chile and Argentina in the field of Operations & Supply Chain Management, Risk and Uncertainty, Agriculture, Agribusiness Value Chain, Modelling and Optimisation, Multi-Criteria Decision Analysis, Interoperability, Innovation, Knowledge Management, Computer Science and Decision Support Systems. This is a four-year project and is led by the University of Liverpool.

Uncertainty Quantification and Management of Ambient Modal identification EPSRC grant

*Principal Investigators:* Prof Siu-Kiu Au and Prof John Mottershead

How much data do we need? This is always among the first few questions in planning a test campaign or data collection system as it has implications on feasibility and required resources. Clearly it depends on what questions and precision are to be answered by the data. If the questions cannot be answered with 'perfect precision' due to limited information, there will be uncertainty associated with the answer even in the presence of data. This and associated issues become important in modern problems where models adopted to understand data are increasingly complex, paralleled by more demanding questions and accountability.

To address this question one needs to master the relationship between the uncertainty of answer and the information content of data. Concerned with the dynamics (modal properties) of 'giant' structures such as skyscrapers and long-span bridges, this question shall be addressed by a team of researchers from the Liverpool Risk Institute (lead, Professors Siu-Kui Au and John Mottershead) and University of Exeter (Professor James Brownjohn). The project, titled Uncertainty Quantification and Management of Ambient Modal identification, is supported by a recent **£0.8M EPSRC grant**.

*Modal Properties* of a structure include primarily its natural frequencies (related to resonance), damping ratios (related to energy dissipation) and mode shapes (related to vibration patterns). Their information is indispensable for design against dynamic loads (e.g., wind, earthquake, human loads), which is the governing factor for dynamic-prone structures such as skyscrapers, long-span bridges and extended roofs. Uncertainty arises due to lack of knowledge and modelling limitations. This generally reduces confidence in performance, increases project risk and hampers cost-effectiveness when exercising design conservatism.

An effective means to mitigate uncertainty of modal properties is to identify them using data (e.g., velocity, acceleration) from vibration sensors installed on the structure. Traditional means requires artificial forces (e.g., Fig.(a) human jumping, Fig.(b) shaker) to create significant vibration and obtain data under 'controlled' conditions so that it can be explained using deterministic dynamic models. This has implications on budget, logistics and risk management; or may not be even feasible for 'giant' structures.

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Diagnostic tools for human African trypanosomiasis elimination and clinical trials EDCTP award  

*Principal Investigator*: Prof Professor Eric Févre

The project, “Diagnostic tools for human African trypanosomiasis elimination and clinical trials” abbreviated as 'DiTECT-HAT' is a recent project that we are collaboratively working on in West Africa. The project is funded by the Horizon 2020-The EU Framework Programme for Research and Innovation and the European & Developing Countries Clinical Trials Partnership (EDCTP) and has ∼£0.3M UoL component.

The central goal of the project is to validate the performance of diagnostic tools and algorithms for early and rapid diagnosis of Trypanosoma brucei gambiense (HAT), through a series of three parallel studies:

- **Passive case detection**: the study will determine the diagnostic performance and cost-efficiency of RDTs performed in peripheral health centres, and of diagnostic algorithms combining RDTs with serological and/or molecular tests on filter paper performed at regional reference centres.
- **Post-elimination monitoring**: the study will determine the feasibility and cost-efficiency of different diagnostic algorithms with serological and molecular high-throughput tests.
- **Early test of cure**: this study will determine, through therapeutic trials, the accuracy of neopterin and trypanosomal spliced leader RNA detection as an early test-of-cure for HAT. Early treatment outcome assessment will not only speed up the development and implementation of new drugs for HAT, but will also improve management of relapsing patients in routine patient care.

Geomorphic and sedimentary evolution of an extreme event: testing a sediment-based palaeoflood record NERC grant  

*Principal Investigator*: Prof Professor Richard Chiverrell  
*Co-Principal Investigators*: Dr Neil Macdonald and Dr Jeff Warburton (Durham University)

This project, supported by a £51k NERC grant, will use the December 2015 extreme flooding in Cumbria to critically test the integrity and responsiveness of our unique, long (>600 year) lake sedimentary records of flood magnitude and frequency by quantifying the initial sedimentary event. The recent flooding, following previous extreme flood events in 2005 and 2009, has highlighted the inadequacies of flood magnitude / return-frequency models developed using recorded river flows (30-50 year), which are too short to address societal requirements for accurate measures of flood risk and to address questions regarding the role of climate forcing of recent events.

Lake sedimentary archives developed by our research teams at Liverpool and Durham Universities provide the length of record necessary to address this research gap. This includes a sediment magnitude (event particle size) signature at Bassenthwaite that correlates well with river discharges (for 40 years) and identifies that the largest 3 floods in 600 years have occurred in the past decade. More details about the award are available here.

The proposed project will use the unique opportunity afforded by contrasting pre- and post-flood sedimentary records and fluxes to establish the sedimentary signature of one of NW England’s most extreme floods; crucially to engender confidence in the use of our lake sediment records as genuine flood series, thus contributing to calls for enhanced flood records to accurately define flood risk in these and potentially wider UK and world river systems. Our team has existing sediment traps at Brotherswater and Buttermere, together with lake sediment surface gravity cores sampled before the flood (2012-2015) at key sites impacted by the recent events in the Eden catchment (Brotherswater and Ullswater (Glenridding)) and Cocker-Derwent catchment (Bassenthwaite and Buttermere).

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Other Research Grants and Awards

• Congratulations to Prof Yan Lavallee for the project titled: “Assessment of on-going hazards of persistency active volcanoes & understand structural instabilities”, funded by THE DAIWA ANGLO-JAPANESE FOUNDATION. Principal Investigator: Prof Yan Lavallee

• Congratulations to Dr Carmen Boado-Penas for the project titled: “Linking pensions to life expectancy: A solution to guarantee long term sustainability?”, funded by the Fundación MAPFRE. The general aim of this project (£15k) is to investigate whether the recent reforms on pension policy based on linking benefits to life expectancy are sufficient to guarantee the financial stability in the pensions systems. Principal Investigator: Dr Carmen Boado-Penas

• Congratulations to Dr Karl Tuyls for the project titled: “Game Theoretic Analysis of the Space Debris Removal Dilemma”, Ariadne grant awarded from ESA. Principal Investigator: Dr Karl Tuyls

• Congratulations to Dr Ryan Judge, who has established, within the School of Engineering of the University of Liverpool, the Blast and Impact Research Centre. See leaflet http://www.liructd.org/wp-content/uploads/2016/04/UoL-Blast-Impact-Flyer-V3.pdf for more details.

• Congratulations to Dr Mike Jump and Dr Jacqueline Wheatcroft for the project titled: “A Toolkit to Measure Accuracy and Decision Confidence in Human-Machine Interaction Across States and Decision Danger in the Operations Room”, funded by DSTL and related to Air Warfare capability. The project is across disciplines being 50/50 Psychology/Engineering. Principal Investigator: Dr Mike Jump (Engineering) Co-PI: Dr Jacqueline Wheatcroft (Psychology).

• Congratulations to Dr Roberto Ferrero, who in December 2015 was awarded the University Interdisciplinary Network fund to establish an interdisciplinary research centre for advanced monitoring of electrochemical power sources. This centre involves the Risk and Uncertainty Institute, as measurement and model uncertainties play a key role in monitoring of electrochemical devices.

• Congratulations to Dr Konstantin Zuev, who was elected Chair of the Committee on Probability and Statistics in the Physical Sciences, which is a part of the Bernoulli Society for Mathematical Statistics and Probability.

• Congratulations to Dr Edoardo Patelli, who was elected Chair of the Technical Committee on Simulation for Safety and Reliability Analysis, which is part of European Safety and Reliability Association.

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The next Risk Institute Meeting will take place Friday afternoon May 20th, in our Seminar Room of our newly refurbished building in the Chadwick Building. All of the academic members of the Institute are invited to participate and contribute. Some of the key topics touched at the previous meeting, held past January 26th, were:

• Appointment of Risk CDT Manager;
• CDT Themes and Steering Group;
• Easter School;
• Training - Hartree Centre;
• CDT Projects Selection;
• Grant Applications and Awards;
Cohort 3: List of Selected Projects

The projects will commence October 2016.

- **Addressing the Risk of Food Security and Antimicrobial Resistance via Advanced Monitoring Techniques;** *Student:* Jodie Barber (Microbiology). *Supervisors:* Prof Rasmita Raval (50%), Chemistry; Dr Daimark Bennett (25%), Integrative Biology; Heather Allison (25%) Biological Sciences;
  *Industry Partner:* Croda

- **Stigmergy-based mapping of indoor hazardous environments;** *Student:* James Butterworth (Computer Science). *Supervisors:* Prof Karl Tuyls (60%), Computer Science; Dr Paolo Paoletti (40%), Engineering;
  *Industry Partner:* National Nuclear Laboratory

- **Living and Future Tools for Risk Assessment: An Examination of the Possibilities for Fusion;** *Student:* Atousa Khodadadyan (Risk Management). *Supervisors:* Professor Gabe Mythen (50%), Sociology; Dr Hirbod Assa (30%), Mathematical Sciences; Beverley Bishop (20%), Health & Safety Executive;
  *Industry Partner:* Health & Safety Executive

- **Neural mechanisms of effort-based decision making;** *Student:* Adam Byrne (Psychology). *Supervisors:* Dr Andrej Stancak (60%), Psychological Sciences, Dr Athanasios Pantelous (40%), Mathematical Sciences;
  *Industry Partner:* Unilever

- **Rapid Screening Mass Spectrometry for Detection of Marine Toxins in Aquatic Food;** *Student:* Barry Smith (Electrical Engineering). *Supervisors:* Dr Simon Maher (90%), Electrical Engineering & Electronics; Dr Iain Young (10%), Integrative Biology;
  *Industry Partner:* Q-Technologies

- **Training & Learning Evaluation Frameworks: Monitoring Skills & Knowledge Audits;** *Student:* Darren Cook (Psychology). *Supervisors:* Professor Laurence Alison (35%), Psychology; Professor Simon Maskell (35%), Electrical Engineering; Dr Michael Humann (30%), Psychology;
  *Industry Partner:* National Counter Terrorism Unit, London Fire Brigade, Merseyside Fire & Rescue

- **Big Data Adaptive Dynamic Route Planning for High-Sea Transportations;** *Student:* Noémie Le Carrer (Physics). *Supervisors:* Dr Jeyan Thiyagalingam (80%), Electrical Engineering & Electronics; Dr Peter Green (20%), Engineering;
  *Industry Partner:* Hartree - STFC, Lloyds Register

- **Automatic Balancing Mechanisms in Public Pension Systems: A Solution to Face Demographic and Economic Risks?** *Student:* Maria Ferrer Fernandez (Mathematics). *Supervisors:* Dr Carmen Boado Penas (70%), Mathematical Sciences; Professor Brendan McCabe (30%), Management School;
  *Industry Partner:* Swedish Pension Agency

- **Farming in transition in East Africa: financial risk taking and agricultural intensification;** *Student:* Eleanor Balchin (International Development). *Supervisors:* Professor Eric Févre (50%), Dr Rob Christley (10%), Institute of Infection & Global Health; Professor Jude Robinson (40%), Sociology;
  *Industry Partner:* Financial Sector Development Programme

- **Testing the robustness of base-lined data required to assess and mitigate flood risk in lacustrine environments using multi-proxy evidence;** *Student:* Hazel Phillips (Engineering). *Supervisors:* Dr Neil Macdonald (40%), Physical Geography; Professor Richard Chiverrell (40%), Physical Geography, Dr Jonathan Bridge (20%), Environmental Engineering, School of Engineering;
  *Industry Partner:* Environment Agency, NERC

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