Uncertainty Quantification & Management Special Interest Group

UQ&M SPECIAL INTEREST GROUP HVM

Study Group Information Pack

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Organisers:

KTN the Knowledge Transfer Network

We work with Innovate UK

UNIVERSITY OF LIVERPOOL | Institute for Risk and Uncertainty

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Problems posed by:

1 Welcoming Statement

It is a pleasure to welcome delegates to the Study Group on Uncertainty Quantification and Management taking place at the Liverpool University Institute for Risk and Uncertainty, co-sponsored by the Knowledge Transfer Network, and Innovate UK.

The Institute, founded in 2011, exists to address the need for personnel trained to PhD level, capable of tackling global problems that cross the boundaries of the traditional disciplines; possibly crossing engineering, the environment, public health, finance, and policy and decision making in government.

In 2013 the Institute was awarded the 'EPSRC and ESRC Centre for Doctoral Training (CDT) in the Quantification and Management of Risk and Uncertainty in Complex Systems and Environments'. The CDT spans the three Faculties of the University with over 50 members of staff and around 90 PhD students currently in training. A special feature of the CDT is that every PhD student has two supervisors from different disciplines and has at least one on-site placement with an industrial partner.

The emphasis of the CDT is strongly placed on industrial problem solving and in February this year the CDT held its first Stakeholder Workshop on 'Addressing Industrial Need'.

It is hoped that the connections made between academics from different institutions and the industrial participants will lead to new partnerships, improved understanding of complicated problems, and solutions that have an impact on methods and processes used in industry.

There are also personal rewards in the form of friendships made through problem solving together - I hope there will be many of these.

Professor John Mottershead
Director of the Liverpool Institute for Risk and Uncertainty
July 2016

2 Study Group Information

The Study Group is an opportunity for industry to gain access to UK excellence in the fields of mathematics, statistics, engineering, and computer science. The structure of the Group allows for this to be done in a structured, intense session over three days.

2.1 Background

This Study Group with Industry is being run by the Institute for Risk and Uncertainty, and the Knowledge Transfer Network (KTN). In the KTN, the Uncertainty Quantification and Management (UQ&M) Special Interest Group (SIG) looks to draw together a UQ&M community and provide a structured meeting space where all the players can share their aspirations, knowledge and expertise.

The SIG was founded in 2014 by the late Prof. Tony Hutton at Airbus Operations Ltd. The SIG is a joint venture between KTN, Innovate UK, Government, industry, and academia. Our First Year Report highlights progress to date. It is expected that much tangible value will be created, such as:

- Collaborative groupings that identify real benefit in working together,
- The development and refinement of challenges and aspirations,
- The emergence of a clutch of industry pulled projects that make significant advances against the wider challenges within given industrial High Value Manufacturing (HVM) sectors,
- An increasingly statistics-savvy engineering design and assessment community,
- A highly visible joined up and holistic UK based UQ&M capability that can respond positively to end-user aspirations and requirements.

This Study Group represents a vital part of the SIG's progress in identifying state of the art approaches to deal with industry problems and identify where there are UK strengths and weaknesses. It is expected that the outputs of the Study Group will be of great use to the industries posing specific problems, but also in the approaches generated, wider industry can get a sense of 'good practice' in an industrial context.

2.2 Who will be attending?

The Study Group will consist of researchers from various fields, including, but not limited to mathematics, statistics, computer scientists, and engineers. As well as university researchers, we strongly encourage registrations from Ph.D students, postdoctoral researchers and early-stage researchers.

As well as these researchers, the Study Group will be attended by industrial representatives limited to those offering problems to the group. **We are not accepting registrations from any industry not directly involved in the problems.**

In addition to these attendees the Study Group will host a number of Public Sector representatives from the Research Councils, Department of Business Innovation and Skill and the Government Office for Science.

We expect to host around 60 people to this Study Group from across these sectors. Attendees can be found in Section 4.

2.3 How does it work?

The format of the Study Group will be following the highly successful European Study Groups with Industry. Industry present their problems on the morning of the first day to the Group. The researchers ask questions and choose which group they may be able to help with.

The groups (aiming for 10 - 15 researchers per group) will move to their own working space. An academic Project Lead will be nominated. They will discuss with the group what aspects of the problem should be addressed, and how these may be approached. It is likely that the group will subdivide, but this will depend on the problem.

It is expected that the industry representatives will be on hand (preferably physically, although virtually would be acceptable) to answer questions, provide access to codes, data and generally ensure that the problem context is clear throughout the Study Group.

Conversations often continue during the evening, and as such the Study Group provides dinner for all delegates. This often provides an environment for cross-fertilisation of ideas between groups and disciplines.

Group work continues during the second day until a break half way through. This break is to informally present back to the larger Study Group progress and plans. These will be challenged, and groups may change as a result. Following this discussion, group work continues until meeting again on the final afternoon for final presentations. It is likely that the Project Lead will provide these presentations.

Following the Study Group, the industry presenters will receive a report detailing what was done during the three days. Again, the Project Lead will coordinate this and draw on assistance from members of their team. The Project Lead will aim to get this report to the industrialist by the end of September.

After review from the industrialist, we wish for this report to be made public as the Sponsoring parties have a responsibility to distribute good practice to the wider community. Thus, it is important for the industrialists to check for sensitive outcomes to be redacted within a month of receiving their report.

2.4 Agenda

<table>
<tr><th></th><th>Sunday 17th</th><th>Monday 18th</th><th>Tuesday 19th</th><th>Wednesday 20th</th></tr>
<tr><td>08:30</td><td rowspan="8"></td><td>Registration</td><td rowspan="3">Group Work</td><td rowspan="3">Group Work</td></tr>
<tr><td>09:00</td><td>Introduction
(Organisers, Ken Badcock)</td></tr>
<tr><td>09:10</td><td>Industry Problems</td></tr>
<tr><td>11:00</td><td colspan="3">Tea and Coffee</td></tr>
<tr><td>11:30</td><td>Group Work</td><td>Review Session</td><td>Group Work</td></tr>
<tr><td>13:00</td><td colspan="3">Lunch</td></tr>
<tr><td>14:00</td><td>Group Work</td><td>Group Work</td><td>Final Presentations
(+ EPSRC and Innovate UK)</td></tr>
<tr><td>15:30</td><td colspan="3">Tea and Coffee</td></tr>
<tr><td>16:00</td><td rowspan="2">Group Work</td><td rowspan="2">Group Work</td><td rowspan="6">Finish</td></tr>
<tr><td>17:00</td><td rowspan="5">Arrival</td></tr>
<tr><td>19:00</td><td rowspan="4">Dinner</td><td rowspan="2">Arrive at Dinner + Group Photo</td></tr>
<tr><td>19:30</td></tr>
<tr><td>20:00</td><td>Pre-Dinner Talk
(Colin Armstrong)</td></tr>
<tr><td>20:15</td><td>Conference Dinner</td></tr>
</table>

2.5 Do I need to pay?

The sponsoring parties (Institute for Risk and Uncertainty and the Knowledge Transfer Network) are pleased to cover for **all** delegates accommodation on the 17th - 19th July, including breakfast and lunches. We do ask however that researchers and industrialists cover their own costs for travel to and from the venue

2.6 Pre-Study Group Actions

To make sure the group progresses well, it is important that researchers read and study the problem statements provided by industry prior to the Study Group. It would be helpful for the researchers to have ideas on how they might approach **all** of the problems and be willing to work in any of the groups in case adjustments need to be made to balance capability and numbers in each group.

2.7 Computer Access

Access to the servers at the Institute will be granted to industrial participants, and group leaders. Also, there will be plenty of space in our facilities to meet, talk and discuss the challenge problems. However,

desktop workplaces are limited and we **strongly recommend participants to bring and use their own laptops wherever possible**.

2.8 Check-in, Accommodation and Dinners

The organisers have arranged for a number of rooms to be held for Study Group members, for the Sunday, Monday and Tuesday nights (Blue Circle on the Map in Section 4) - requests for these should be indicated at Registration. These (en-suite) rooms include breakfast. Buffett lunches will be provided at the Institute, a buffet dinner will be available on the Monday night, and a conference dinner will be held on he Tuesday (below).

For those traveling down on Sunday, there will be a reception in the evening starting at 6;00 pm where drinks and light snacks will be available. It will also be a good opportunity to discuss research ideas and how problems may be addressed in an informal manner. Check-in time on the Sunday is 16:00 and delegates should go to the Crown Place accommodation (Blue Circle on the map in Section 5) - if there is a problem, please find us at the Institute for Risk and Uncertainty, and someone will be able to help you.

2.9 Conference Dinner

The dinner on Tuesday will be held at The Old Blind School (green square on the Map in Section 4). There is no dress code, and no cost associated with the dinner. We would ask that people arrive promptly by 7:30 pm (for a 8:00 pm start). Additionally, if you have not indicated to the organisers in your registration any allergies, we request that you do so as soon as possible.

Government Office for Science

We are delighted to have a pre-dinner talk by Colin Armstrong. Colin is the Head of International Resilience at the Government Office for Science. He was previously Head of Science and Policy Advice for SHED at UKCDS, where he was responsible for the co-ordination of two expert groups - a Risk and Horizon Scanning Expert Group and a Humanitarian Emergency Expert Group - designed to inform Ministerial decisions on emerging international risk and emergencies. These groups, chaired by the Government's Chief Scientific Adviser, aim to make a real difference to the way that the UK prepares for and predicts humanitarian emergencies and disasters.

Colin previously worked at the Department of Health where he was responsible for the development of a £ 2 million research programme for pandemic influenza. During the 2009 'swine flu' pandemic, Colin supported the Scientific Advisory Group for Emergencies, which provided scientific and technical advice to UK Government. He also project managed the development of a national policy document outlining the UK strategy for pandemic influenza preparedness.

The Government Office for Science is the home of science and engineering across government and exists to support the Government Chief Scientific Adviser, Sir Mark Walport. The key role of the GCSA and GO-Science is to ensure that all levels of government, including the Prime Minister and Cabinet, receive the best scientific advice possible, and to enable the many science-using departments across government to create policies that are supported by strong evidence and robust arguments.

3 Problems

3.1 Climb-Cruise Engine Matching

Presenting Institution: Airbus Operations Ltd.

Problem Presenter: Sanjiv Sharma

Abstract (Technical Topics and Desired Outcomes):
Background: Consider a use case in the context of a 24-hour operation aircraft; a key implication is that aircraft can operate within noise curfews. Then, using a Set-Based Design approach, explore a multitude aircraft configurations with respect to their climb out Noise Levels, the Cruise Performances and Gaseous Emissions, under uncertainty.

Objectives: The basic concept is to generate data for a set of representative single aisle aircraft configurations by combining a multitude of airframes with a multitude of engines. Specific noise measurement criteria in terms of the location of the measurement system and the type of noise level need to be deduced. Then, using coupled analyses 'plug-ins', derive the performance models that enable an architect to explore the sensitivities amongst three exemplar measures of aptness. For this use case these are:

- Noise Levels (lower is better); conversely, Noise Level **Margin** (higher is better)
- Cruise Fuel Consumptions (lower is better)
- Gaseous Emissions (lower is better); conversely Gaseous Emissions **Margin** (higher is better)

This provides a multi-dimensional challenge for determining, visualising and acting on the uncertainties that propagate through the analyses to these measures of aptness. The main objective is to narrow the set of possible aircraft configurations to a set of feasible ones using uncertain, multi-dimensional decision criteria. The process is then repeated, using analyses models closer to the laws of nature, to narrow the set of feasible aircraft configurations to a set that provides competitive advantages.

UQ&M Aspirations: The UQ&M analyses will be used for:

- robust design-making to narrow a set of possible aircraft configurations
- discovering the parameters that strongly contribute to the variations in the measures of aptness
- managing key parameters to drive reliably towards the desired properties and behaviours

Resources Available for this Problem:

- Simulation experts from Airbus
- Data generated through CONGA project to support analysis for a multitude of airframes with a multitude of engines (provided in `.csv` format).
- Access to AirCADia environment - an interactive tool for the composition and exploration of aircraft computational studies at early design stage.

References:

1. Full problem details can be found here: Climb-Cruise Engine Matching. A presentation will be given on the first morning of the Study Group.

3.2 Ride Optimisation Considering Vehicle Mass Property Variation


Presenting Institution: Jaguar Land Rover

Problem Presenter: Jacqui Morison, Pete Newbury (Andy Richardson, Steve Robinson, Claire Freeman)

Abstract (Technical Topics and Desired Outcomes):
Background: At Jaguar Land Rover the ultimate objective of the Vehicle Dynamics Team is for the vehicle to be 'signed off' by the Vehicle Evaluation Team as meeting customer requirements for Ride, Steering & Handling character in line with the brand DNA. Due to the cost of prototypes the sign-off process has its limitations in that it is focussed on a discrete number of vehicle variants. It does not fully consider the performance variability that exists across the full range of variants and/or specification levels. Each individual vehicle will have different mass and inertia properties affecting the ride performance. Therefore it is currently difficult to optimise the ride performance of the vehicle across the entire variant/specification range of a vehicle programme.

Objectives: To optimise the ride performance of the vehicle to achieve the ride targets for the programme, within programme assumptions.

UQ&M Aspirations: Since it is not understood how the variation in mass properties affect the distribution of ride from vehicle to vehicle and because only a discrete number of prototypes are available for tuning, current ride tuning does not fully optimise all possible variants/specifications.

- Determine a process to optimise vehicle ride performance for all potential customer vehicle variants & option specifications. Improved prediction of ride variation to minimise the number of component variables required to achieve desired ride performance across the programme.
- Is there a better method to optimise ride performance across a range of uncertain mass properties?

Resources Available for this Problem:

- Simulation experts from JLR
- Response surfaces relating input parameters to outputs of interest as proxy for full multi-body model
- Input, output distributions and sales data for real vehicle variant class.
- Data formats in `.xls` format

References:

1. Full problem details can be found here: Ride Optimisation Considering Vehicle Mass Property Variation. A presentation will be given on the first morning of the Study Group.
2. Presentation on use case, given 30th June 2015: Ride Optimisation Considering Vehicle Mass Property Variation

3.3 Increasing Certainty in Offshore Wind Energy

Presenting Institution: Zenotech Ltd.

Problem Presenter: David Standingford

Abstract (Technical Topics and Desired Outcomes):
Background: Wind turbine array wake analysis leads to uncertainty reduction and better wind farm layouts and control strategies. This (i) reduces costs, thus enabling a displacement of fossil fuels thereby (ii) cutting carbon emissions and (iii) reducing dependence on insecure imports. Offshore wind farm design based on improved wake modelling to reduce wake losses will result in at least 0.2% reduction in the Levelised Cost of Energy (LCoE).

Objectives: The use of numerical simulation techniques for a-priori design of wind turbine array layout and control strategies is highly desirable - if the simulation results are accurate. Underlying models for the use of CFD in aerospace, automotive and civil engineering have been well validated. This is not the case for wind energy.

Turbulence parameters for turbine wakes have been lifted directly from standard aerospace-scale models without great consideration of the tuning that has been applied - or in some cases the formal bounds of applicability. The industry is now inserting LIDAR and other direct measurement systems into large wind farm arrays to provide in-situ and in-service data feeds, but integration with design simulation models is virtually non existent.

The performance of the overall array is assessed in terms of the LCoE - a formal framework from the Department of Energy and Climate Change (DECC). LCoE includes operational, capital and risk of the array over its life. This provides a solid model for assessing the impact of uncertainty reduction. The model explicitly includes the cost of financing as a function of output power uncertainty over the lifetime of the turbine array.

The physical parameters to be included as input to the simulation process include location, layout, type and control laws for the turbines. More detail is included in the location and wind / sea characteristics; turbine model and definition - blade / section types, power curve and control laws; layout; simulation parameters (turbulence model, boundary conditions - atmospheric profiles). These parameters are all subject to uncertainty on input. The qualitative characteristic definition of many of these input uncertainties is not mature.

UQ&M Aspirations: Uncertainty in the pre-construction energy predictions for offshore wind farms can be reduced with accurate CFD-based wake analysis.

Resources Available for this Problem:

- Raw wind-tunnel data as a surrogate for wind farm data
- A technical reference guide for the CFD solver zCFD, and
- Access to zCFD

Potential Tools of use:

- Tools for time-series analysis

References:

1. Full problem details can be found here: Increasing Certainty in Offshore Wind Energy. A presentation will be given on the first morning of the Study Group.

4 Participants

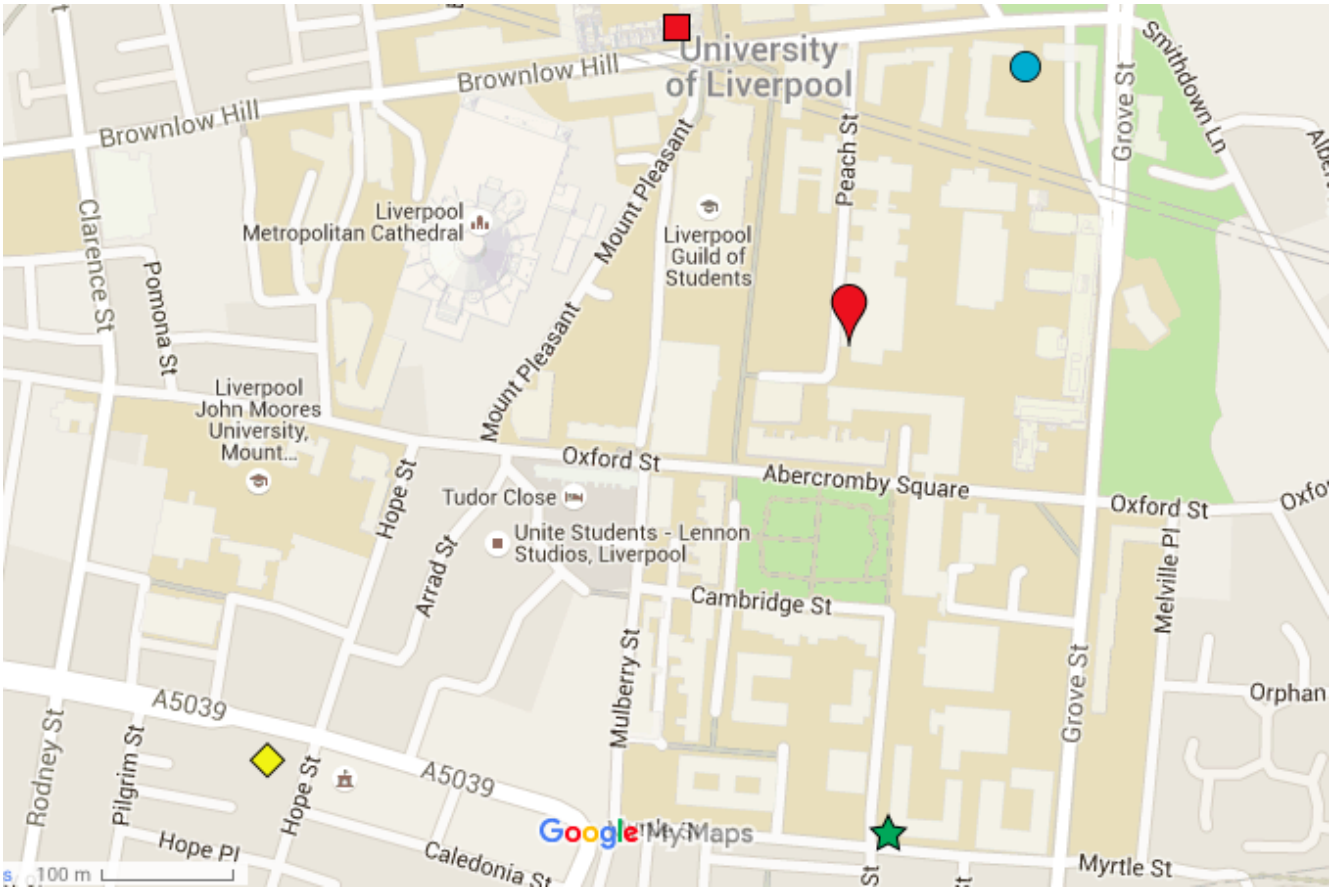
Surname	First Name	Institution	Capabilities
Adhikari	Sondipon	Swansea University	Physics based uncertainty propagation, dynamics, random matrices
Alitieri	Domenico	University of Liverpool	Civil engineering, structural reliability analysis, optimisation problems
Armstrong	Colin	Government Office of Science	Natural hazards
Badcock	Ken	University of Liverpool	Executive Pro-Vice Chancellor, Science and Engineering
Bates	Ron	Rolls-Royce PLC.	Robust Design
Brommer	Peter	University of Warwick	Computational materials physics: hierarchical multiscale simulations (DFT->MD) with quantified uncertainty and propagation across scale boundaries. Long-timescale evolution of defect populations. Application of Bayesian methods beyond materials: Structural health monitoring (civil engineering), health monitoring data feature extraction and health outcome prediction (biomedical engineering). General HPC expertise.
Butchers	Matt	Knowledge Transfer Network	Organiser
Byrnes	Paul	University of Liverpool	Risk and Uncertainty
Chen	Xin	Cranfield University	Uncertainty Quantification, Sensitivity Analysis, Visualization
Danashkha	Alireza	University of Warwick	I am using Gaussian process, particularly, deep Gaussian process for uncertainty quantification and sensitivity analysis of the complex industrial systems.
Darwish	Motasem	Newcastle University	Extreme precipitation events and its uncertainties
De Angelis	Marco	University of Liverpool	Organiser, uncertainty propagation, metamodeling, fuzzy and interval analysis, sensitivity analysis
Deshpande	Amogh	University of Liverpool	Probability, statistics, PDE techniques , data assimilation to industrial problems.
Diaz De la O	Francisco Alejandro	University of Liverpool	Organiser, Bayesian methods, calibration, reliability analysis, metamodelling.
Downing	Roger	STFC Hartree Centre	Big Data analytics
Dyer	Ronald A. D.	University of Liverpool	Project Risk Management
Elsheikh	Ahmed	University of Liverpool	Head of the School of Engineering
Farmer	Chris	University of Oxford	Interest and experience in UQ & experience of study group format meetings. Algorithms for statistical inverse problems, stochastic control, uncertainty propagation, forecast evaluation.
Filepe	Fontanela	Imperial College London	I have been working with uncertainty quantification in structural dynamics for almost 4 years now. My main research focus on reduced-order models for uncertainty quantification and their respective parameters identification based on experimental results.
Garbuno	Alfredo	University of Liverpool	Machine Learning, Statistics, Applied Mathematics

Surname	First Name	Institution	Capabilities
Georgiou	Georgia	University of Liverpool	Ground vehicle dynamics, multi-body systems modelling, numerical simulation, design optimisation and uncertainty quantification.
Gong	Zitong	University of Liverpool	History Matching
Goulart	Paul	University of Oxford	Control engineering, robust optimsation, embedded systems
Hancock	Philip	University of Surrey	Experimentalist. Aerodynamics
Hristov	Peter	University of Liverpool	CFD, Gaussian process emulation
Huajian	Ouyang	University of Liverpool	Mechanical and Vehicle Engineering, VIBRATION ANALYSIS OF ATOMISING DISCS, Friction-induced Vibration, Vibration in centrifugal atomisation, structural dynamics in engineering
Hutahaean	Junko	Heriot-Watt University	Assisted history matching, multi-objective optimisation, and uncertainty quantification within Bayesian framework
Icardi	Matteo	University of Warwick	Uncertainty quantification: polynomial chaos and multilevel Monte Carlo techniques, applications to complex flow problems and computational fluid dynamics
Innocente	Mauro	Coventry University	Mathematical Modelling Numerical / Evolutionary Optimisation
Kawabata	Emily	Edinburgh University	I use Bayesian techniques to quantify uncertainty in earthquake parameters.
Kermode	James	University of Warwick	Computational materials science. Multiscale materials modelling (quantum mechanics/atomistic levels). Uncertainty quantification and propagation
Kigezi	Tom	University of Sussex	Control system design (optimal and robust control)
Kundu	Abhishek	Cardiff University	Stochastic reduced order modelling, Bayesian inference, Structural dynamics, control
Li	Ming	University of Liverpool	Scour around offshore wind turbine foundations, coastal process, sediment transport. Model tools for scour around offshore structure and large scale modelling tools to examining structure wake in seawater.
Loxham	Joseph	Cranfield University	PhD is: Uncertainty quantification & management in multidisciplinary design optimisation
Madinei	Hadi	Swansea University	Uncertainty analysis based on Monte Carlo simulation
Mannis	Adam	University of Liverpool	Science and Engineering
Maskell	Simon	University of Liverpool	Big Data Analytics, High Perfromance Computing, Bayesian Statistics, Particle Filters.
McGregor	Lynne	Innovate UK	
Meimaris	Antonios	University of Liverpool	Mathematics
Metya	Subhadeep	University of Swansea	Uncertainty Quantification, System Reliability Analysis
Molina-Cristobal	Arturo	Cranfield University	Uncertainty Quantification, Sensitivity Analysis, Visualization
Montomoli	Francesco	Imperial College London	NIPC and Stochastic Collocations
Mottershead	John	University of Liverpool	Uncertainty analysis in Structural Dynamics
Morison	Jacqui	Jaguar Land Rover	Virtual Method Validation, Virtual Capability Improvements

Surname	First Name	Institution	Capabilities
Newbury	Pete	Jaguar Land Rover	Vehicle Dynamics MBS Modelling
O'Hagan	Anthony	Prof. A. O'Hagan Ltd.	Uncertainty modelling, elicitation, UQ, model discrepancy.
Obisesan	Abayomi	University of Aberdeen	I have carried out experimental and statistical studies to investigate and characterise the influence of ship structural material,geometric and load uncertainties on ship response during collisions. I developed scripting codes to automate the pre-processing and post-processing capabilities of deterministic finite element models using Python programming language.
Overstall	Antony	Glasgow University	My area of research is on the interface of statistical modelling and design of experiments. I have developed methodology to find optimal designs taking into account the objective of an experiment and all known sources of uncertainty. This has been applied to real applications involving physical models from the biomedical and engineering sciences, and engineering.
Patelli	Edoardo	Institute for Risk and Uncertainty. University of Liverpool	Reliability and uncertainty quantification
Pant	Raghav	University of Oxford	Risk analysis, Computational tools
Pronios	Nikos	Innovate UK	Cyber-physical systems & robotics and autonomous systems
Pryse	Sion Eilir	University of Swansea	I'm currently studying for a PhD at the College of Engineering, Swansea University where my work is based on reduced order models and error estimates for systems containing uncertainties. Previously: Graduated with an MSc (Distinction) from Cardiff University in 'Operational Research and Applied Statistics'. The course contained a wide variety of problem-solving techniques which were used to build mathematical and statistical models. Prior to this I graduated with a BSc Mathematics (First Class) from Aberystwyth University. These experiences would allow me to bring analytical skills, numerous ways of thinking and different methods to tackle real problems.
Pura Arri	Sandhi	Imperial College London	My specialisation is CFD. I conducted several CFD simulation of industrial case using commercial package (ANSYS). For my bachelor thesis, I developed Adaptive Mesh Refinement code in MATLAB environment. Now at Imperial, I am working on my thesis titled "Optimisation of Controlled Aeroelastic Systems". It is multidisciplinary topic consists of structural dynamics, aerodynamics, control, and optimisation. I am developing it using MATLAB language. For study group I will bring MATLAB, Python, C++, and OpenFOAM.
Qiao	Yujun	University of Cambridge	I do inverse problems, mainly working on regularisation. I program in Matlab. I also work on medical application such as elastography.
Sadeghi	Jonathan	University of Liverpool	Metamodels, interval predictor models, theoretical physics
Sarlak Chivaee	Hamid	University of Coventry	Wind energy, CFD
Seshadri	Pranay	Cambridge University	Uncertainty Quantification, Turbomachinery Aerodynamics, Optimization Under Uncertainty

Surname	First Name	Institution	Capabilities
Shaheen	Muhammad Arsam	Airbus UK	Overall Aircraft Design
Sharma	Sanjiv	Airbus UK	Cruise-Climb Engine Matching
Shi	Yuanfeng	University of Liverpool	Bayesian system identification, structural dynamics
Standingford	David	Zenotech	Increasing Certainty in Offshore Wind Energy
Tartaruga	Irene	University of Bristol	My areas of expertise are Uncertainty Quantification, Sensitivity Analysis and Nonlinear Dynamics. I would like to present the SVD based methodology I developed to propagate uncertainty and an optimisation strategy based on evolutionary algorithm's principles
Traiger	Elizabeth	DNV GL	Expertise: Wind Energy Industry, Statistics, Data Analysis
Visavadia	Rhia	EPSRC	
Waite	Tim	University of Manchester	Expertise: statistical design of experiments. I am currently developing methodology to find designs for physical experiments that are maximally informative about the unknown calibration parameters in a computer model/simulator.
Wang	Qiongli	University of Liverpool	Uncertainty quantification; meta-modelling, Gaussian Process
Wang	Shifeng	Newcastle University	Energy systems
Wang	Weizhuo	Manchester Metropolitan University	Inverse problems. Solid & Structural Dynamics. Computational Model Validation & Updating
Woods	David	University of Southampton	Statistical design of experiments and uncertainty quantification, including physical and computer experiments for the calibration of potentially misspecified empirical and mechanistic models.
Yuan	Jie	Cranfield University	Uncertainty quantification Structural dynamics. Aircraft wing design Fan bladed disc system

5 Maps and Directions - Click Here for Interactive Version



Legend	Activity	Label
Red Marker	Institute for Risk and Uncertainty	Institute for Risk and Uncertainty
Blue Circle	Accomodation at Crown Place	Accommodation
Yellow Diamond	Conference Dinner - Tuesday	Old Blind School
Red Square	Breakfast for Crown Place guest at the Victoria Café	
Green Star	Monday Dinner for Crown Place guests	

Legend

	Muspratt Lecture Theatre	Presentations (Mon-Tue)
	Seminar Room G70c	Group Work #1
	Seminar Room G70b	Group Work #2
	Staff Room G59	Group Work #3
	Staff Room G60	Group Work #4
	Spare Room	Other activities
	Corridor	Lunches, Tea and Coffee
	Toilets	

6 Supporting Organisations

6.1 Knowledge Transfer Network

KTN Connects people. To speed up innovation, solve problems and find markets for new ideas. Established to foster better collaboration between science, creativity and business, KTN has specialist teams covering all sectors of the economy - from defence and aerospace to the creative industries, the built environment to biotechnology and robotics. KTN has helped thousands of businesses secure funding to drive innovation. And we support them through their business cycle to see that investment through to success.

Contact(s): Matt Butchers
Website: http://www.ktn-uk.co.uk

6.2 Institute for Risk and Uncertainty, University of Liverpool

A centre for research and education. The University's Institute for Risk and Uncertainty is dedicated to helping people and organisations create a safer world. Large scale funding totalling £ 21 m has been secured to establish an EPSRC and ESRC Centre for Doctoral Training (CDT) on Quantification and Management of Risk & Uncertainty in Complex Systems & Environments within the Institute for Risk and Uncertainty.

Contact(s): Francisco Alejandro De La O, and Marco De Angelis
Website: https://www.liverpool.ac.uk/risk-and-uncertainty/