

# Research Newsletter

The School of Mechanical, Aerospace and Civil Engineering

Issue 2 - Autumn 2011

## Spotlight on:

- Smart Boundary Conditions
- A Small Step or a Giant Leap
- Big Ideas for the Future

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# Editorial



It is already time for our second newsletter. The content shows the breadth of research and outreach internationally while emphasising the climate change, environment and green energy theme.

Major grants have been awarded on the resilience of electricity networks to climate change, on autonomous systems in aerospace and on long-term coastal sediment systems. Research grants involving computational fluid dynamics for marine turbines for the Energy Technologies Institute and on thermal hydraulics for Magnox are being extended as a result of their success. The use of High Performance Computing is important in MACE where we have 950 parallel processors for internal use and access

to an order of magnitude more externally, notably through collaboration with EDF. The Modelling and Simulation Centre provides a hub for this activity in solid and fluid mechanics with open source code-ASTER and code-SATURNE.

It is pleasing to report the appointment of six new staff; clearly we are able to attract people of the highest quality. Bob Ainsworth FRS will head the Nuclear Research Group in MACE. I should also mention the expansion of a Management Masters programme at the Nanyang Technological University, Singapore, with the support of Rolls Royce who are also encouraging joint research efforts.

*Professor Peter Stansby, FEng  
Head of School*

## CLIMATE RESEARCH NEWS

### Tyndall Manchester

#### Tyndall in a nutshell



The researchers in Manchester work on a variety of topics, from stakeholder responses to new energy technologies, including finding out why NIMBY is such an unhelpful term, to technical assessments of shipping emissions. There is also a close working relationship with colleagues in the Sustainable Consumption Institute, which has awarded grants to Tyndall researchers to develop scenarios of the food system, exploring aspects such as the production of wheat and bread in a climate constrained world.

[www.tyndall.manchester.ac.uk](http://www.tyndall.manchester.ac.uk)

[www.sci.manchester.ac.uk/research/climatechange/mitigation/](http://www.sci.manchester.ac.uk/research/climatechange/mitigation/)

#### Friends with Fudan University



Tyndall Manchester is an interdisciplinary research centre based in MACE with work focusing on energy systems and greenhouse gas emissions. It is part of the wider Tyndall Centre that was initiated in 2000 by EPSRC, NERC and ESRC, with seven other partner institutions across the UK.

Over time it has diversified its funding sources and has recently been joined by Fudan University in China. Prof Kevin Anderson blogged about this important partnership and also his epic train journey to Shanghai.

[www.tyndall.manchester.ac.uk/public/index.html#beyond](http://www.tyndall.manchester.ac.uk/public/index.html#beyond)

#### What's in the pipeline ?

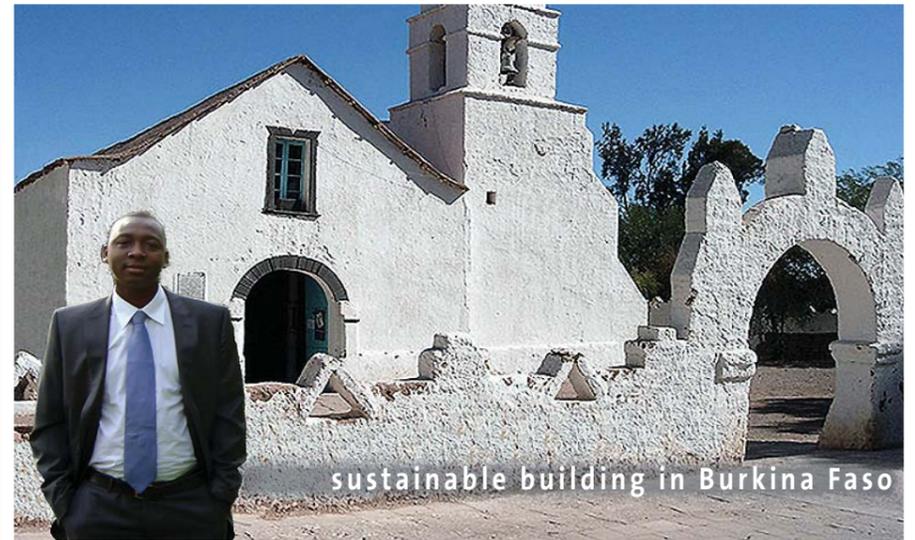


Tyndall Manchester's Clair Gough (MBS) and Dr Sarah Mander (MACE) have recently been awarded a grant by The National Grid. Their aim is to assess the social impacts, and public perceptions of, the transport of CO<sub>2</sub> in pipelines to storage sites, as a component of the Carbon Capture and Storage (CCS) process. There are thousands of miles of underground pipeline which transport many different types of fluids and gases across the UK. Apart from the risk of having a pipeline, public perceptions of a CO<sub>2</sub> pipeline will be influenced by a lack of familiarity with the technology, belief in climate change or opposition to fossil fuel developments. This research will unpack all these elements and will try to provide reassurance to the public as to the safety of CO<sub>2</sub> transport and will facilitate the deployment of a CO<sub>2</sub> pipeline network.

*Further information:*

[www.tyndall.manchester.ac.uk/research/carbon](http://www.tyndall.manchester.ac.uk/research/carbon)

### A House in the Sun



sustainable building in Burkina Faso

Bachir Ismael Ouedraogo, a third year Civil Engineering PhD student, won a scholarship to travel to Bryn Mawr College in the US and took part in a two week summit on climate change this summer. This follows his contribution to the Copenhagen Climate Change Conference in 2009 as part of Burkina Faso delegation, where he met President Barack Obama.

His PhD is focused on the financial impact of energy saving in buildings and climate change mitigation in Burkina Faso and is sponsored by the Sustainable Consumption Institute. In Bachir's view the impact of climate change is felt more keenly in the poorer countries of the world because they neither have the resources nor the funds to adapt to their changed environment. He is committed to helping his country to come up with solutions to the problems that are caused by climate change.

#### La Voute Nubienne (VN)

Building sustainable shelter for Burkina Faso's 15 million inhabitants is such a challenge. Bachir's favoured solution to the problem of timber scarcity in Burkina Faso is the use of vaulted earth bricks in a now well-proven technique: la Voute Nubienne (VN).

The VN technique is a simplified, standardised adaptation of traditional methods which originate from the Nubian region of Egypt. It is still relatively unknown in West Africa but it is gaining in popularity. The earth bricks – a readily available, free, resource that can be made on-site with local labour, can provide a large scale and sustainable improvement in housing conditions in Africa.

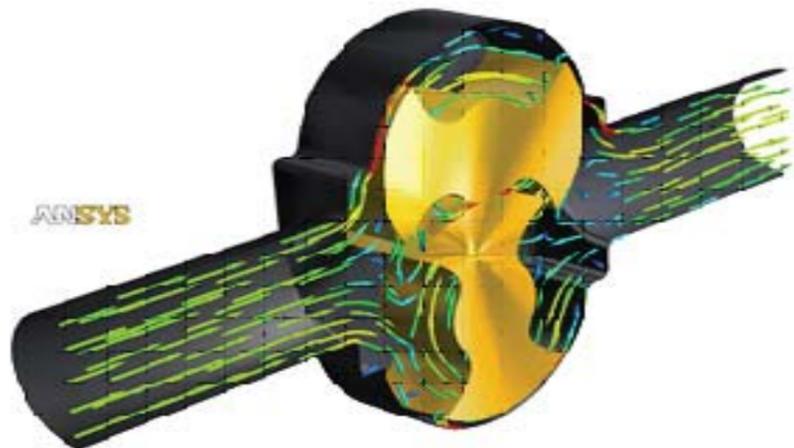
*Further information:*

[www.lavoutenubienne.org/?lang=en/](http://www.lavoutenubienne.org/?lang=en/)

[www.sci.manchester.ac.uk/postgraduate/ourstudents/bachirismael/](http://www.sci.manchester.ac.uk/postgraduate/ourstudents/bachirismael/)

# SPOTLIGHT ON

## Smart Interface Boundary Conditions



In engineering and scientific calculations, a boundary value problem is a differential equation together with a set of additional restraints, called the boundary conditions. A solution to a boundary value problem is a solution to the differential equation which also satisfies the boundary conditions. In computational mechanics, to simplify the calculations, complex domains are often divided into sub-domains whereby the boundaries are defined by overlapping sub-domains.

Dr Sergey Utyuzhnikov has developed a new method to define smart artificial boundary conditions. His new high-performance algorithm allows us to avoid 'sub-domain overlapping' by defining accurate smart interface boundary conditions. Then calculations for each sub-domain can be carried out independently. As a result, the overall physical process is described by a compounding effect of all sub-domains.

There are numerous applications for this new technique, from aerospace flow modelling to describing the blood flow through arteries. The method is most effective in design optimisation where multiple calculations are required.

Further information: [www.mace.manchester.ac.uk/research/groups/aerospace/UtyuzhnikovSmartInterface.pdf](http://www.mace.manchester.ac.uk/research/groups/aerospace/UtyuzhnikovSmartInterface.pdf)

## A small step or GIANT LEAP?

Dr Lei Ren has been awarded an EPSRC grant with the title "A Large-Scale Predictive Musculoskeletal Model to Simulate Human Walking". Walking is our most fundamental and widespread mode of transportation and is recommended for a healthy lifestyle.

We walk automatically without the need for conscious attention. However, this seemingly simple task requires very complex control between our body segments, joints and muscles, working together to provide highly adaptable and energy efficient forward movement.

What are the basic mechanisms underlying human walking? What are the fundamental control strategies governing human walking. There are still many unsolved questions toward the fundamental understanding of human walking.



Most of experimental studies have been descriptive in nature as they are based on measurements, and by its very nature tell us what happens but not why it happens. While mathematical models, which can predict human walking without the need of measurement data, has the capacity to tell us why it happens because the reasons for particular model behaviours can be examined.

The aim of this research project is to develop a novel computer model to predict human walking using an advanced computational approach, which has great potential for the simulation of large-scale systems and has not yet been fully explored.

Further information:  
[lei.ren@manchester.ac.uk](mailto:lei.ren@manchester.ac.uk)

## Big ideas, small particles

The new super-resolution optical microscope developed by staff in MACE has been included in the RCUK's "Big Ideas for the Future" report. The report highlights research in the UK that is expected to have an impact on our future. "The UK needs to investigate, discover and exploit new sectors for growth" writes Lord Bilimoria in his foreword.

Prof Lin Li's and Dr Zengbo Wang's work is expected to make such a contribution.

See page 34 of the Report

[www.mace.manchester.ac.uk/research/groups/manufacturing/BigIdeas.pdf](http://www.mace.manchester.ac.uk/research/groups/manufacturing/BigIdeas.pdf)



## MEXICAN RESEARCH technologies for the petroleum industry



The School has recently been awarded a number of research grants from the Instituto Mexicano del Petróleo (Mexican Institute of Petroleum). The Instituto Mexicano del Petróleo (IMP) is a centre dedicated to undertaking and facilitating basic and applied scientific research in order to develop technologies applicable to the petroleum industry.

IMP provides support to Petroleos Mexicanos (Mexican Petroleum) in finding hydrocarbons and new oil fields and in the improvement of the exploitation of these resources. The three research grants, which together total in excess of £ 1M over three years were awarded to Dr Teresa Alonso Rasgado and are being undertaken in collaboration with the schools of Chemical Engineering and Analytical Science (CEAS) and Earth, Atmospheric and Environmental Sciences (SEAES).

The projects are concerned with developing new compounds for use as corrosion inhibitors in oil carrying ducts and basin design for regions in the south of Mexico and are being supported by the Petroleos Mexicanos (PEMEX) and the Consejo Nacional de Ciencia y Tecnología (CONACyT) of Mexico.

Further information:

<http://www.mace.manchester.ac.uk/aboutus/staff/academic/profile/index.html?staffId=250>

# Appointments



Dr Hossam Abuel-Naga joined the University in August 2011 as a Senior Lecturer in Geotechnical Engineering. His research interests include ground improvement and geosynthetics engineering, geoenvironmental engineering, and Thermo-hydro-mechanical behaviour of geomaterials.



Dr Lee Cunningham joined the University in October 2011 as a lecturer in Structural Engineering. He has worked in industry for the past 11 years where he has gained experience in the design and construction of a wide variety of building and civil engineering structures. His research interests include reinforced concrete design and computational modelling, maritime and coastal defence structures, structural timber and fibre reinforced polymer composites.



Prof Bob Ainsworth joined the School in March 2011 as a Professor of Structural Integrity, after over 35 years in the UK electricity supply industry. There he was heavily involved in development of structural integrity assessment procedures, in particular the defect assessment procedure R6 and the high temperature assessment procedure R5. He is a Fellow of The Royal Society, The Royal Academy of Engineering and the Institution of Mechanical Engineers.



Prof Paul Mummery joined the School as Professor of Nuclear Materials in October 2011. Paul's work has focussed on the relationships between microstructure and mechanical behaviour of materials, primarily fracture. He is particularly interested in the development and application of novel experimental techniques to characterise damage. He is using x-ray tomography to develop microstructurally-faithful models of material behaviour.



Dr Alice Bows joined the School in August 2011 as a Senior Lecturer in Energy and Climate Change and Sustainable Consumption Institute (SCI) Senior Research Fellow. Her research interests focus on the scope for mitigating climate-related emissions in energy, transportation and food systems whilst considering the future impacts of climate change. Alice is based in Tyndall Manchester.



Dr Zhenjun Yang joined the University in October 2011 as a Senior Lecturer in Structural Engineering. His expertise is in computational solid mechanics using finite element method and scaled boundary finite element method, and application to design and analysis of engineering materials and structures subjected to quasi-static and dynamic loadings.



## FUEL EFFICIENCY of motor vehicles



### Fuel efficiency of motor vehicles equipped with sports flags

Dr Antonio Filippone studied the effect on the aerodynamics and therefore the fuel efficiency of cars that are adorned with sports flags and reported on this in the newspaper "The Province" based in Vancouver and the Canadian Broadcasting Corporation (CBC).

The results showed that an average car with two flags attached burns an extra litre of fuel per hour at an average of 70mph. The extra fuel consumption is caused by the flags creating drag. The extra drag generated by these flags can reduce a car's fuel economy by up to 3% during a one-hour journey. This may not seem a significant increase but if half a million cars are flying these flags we could see up to 1.22 million litres of extra fuel burned unnecessarily. Something to bear in mind for the 2012 Olympics.

## Manchester spectacular

Dr Antonio Filippone has been shortlisted for the best photo in environmental research photography competition Manchester Spectacular.

*Further information:*

<http://www.mace.manchester.ac.uk/aboutus/staff/academic/profile/index.html?staffid=102>



# Grants &

## iCOAST: Integrated coastal sediment systems



A consortium of nine institutions and companies was awarded a total of £ 2.8M by the Natural Environment Research Council (NERC) to address the need for new methods to characterise and forecast long term coastal geomorphic system evolution. UK coastal areas are at great risk of flooding and degradation of their geomorphic systems, sediment starvation and/or climate change could greatly exacerbate these risks. Recently developed methods for system-level analysis of coast, estuary and off shore landform behaviour provide probabilistic assessments of coastal change at a regional scale.

The iCOAST consortium will exploit these emerging insights to improve the current ability to analyse geomorphic changes. Professor Peter Stansby and his group will primarily be involved with process-based modelling for waves, currents and sediments linking these various items.

*Further information:*

[http://gotw.nerc.ac.uk/list\\_split.asp?awardref=NE%2FJ005614%2F1](http://gotw.nerc.ac.uk/list_split.asp?awardref=NE%2FJ005614%2F1)

## GAMMA GROWING AUTONOMOUS SYSTEMS MISSION MANAGEMENT APPLICATIONS



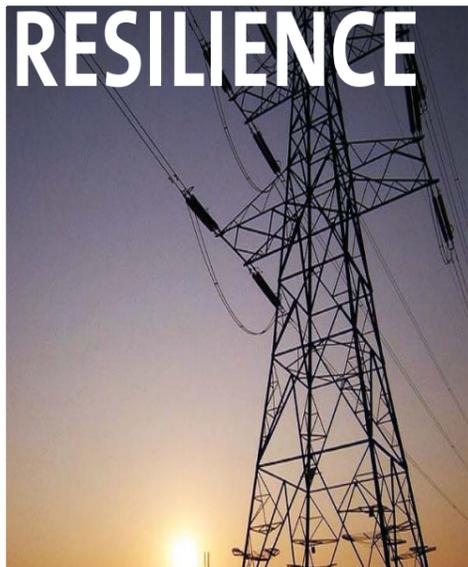
GAMMA (Growing Autonomous Systems Mission Management Applications) is a technology and next generation supply chain development programme led by the North West Aerospace Alliance in partnership with BAE Systems and North West Universities Manchester, Liverpool, Lancaster, Salford, Central Lancashire and the National Nuclear Laboratories. Dr Bill Crowther led the Manchester contribution to GAMMA's successful bid for funding to the Regional Growth Fund in the North West.

GAMMA will examine user requirements for civil applications and develop technology needs road maps for applications in the area of autonomous systems. It will further identify small and medium sized companies with relevant technologies to this emerging market and help them to develop and grow their workforce. It is envisaged that incubation facilities in the region's academic and science institutions will assist with setting up new companies.

*Further information:*

<http://www.mace.manchester.ac.uk/aboutus/staff/academic/profile/index.html?staffid=68>

## RESILIENCE of the UK electricity grid



In September, Tyndall started another major project funded by a £1m grant from EPSRC to examine the resilience of the UK electricity grid to climate impacts. This is in partnership with Prof Ian Cotton in EEE and Dr Richard Dawson at Newcastle University.

Much of Tyndall's work has substantial policy and commercial relevance, with Tyndall Manchester's profile especially high in the areas of emissions accounting, aviation and shipping. This has led to consultancy contracts from the Welsh Assembly Government, The Cooperative Bank and Friends of the Earth, amongst others, and a series of policy briefing notes and submissions to the House of Commons and House of Lords committee inquiries.

In future Tyndall Manchester will be able to expand this income stream through the award of an EPSRC Knowledge Transfer Fellowship to Dr John Broderick and an industrial secondment for Dr Conor Walsh.

## AWARDS

### Griffith Medal & Prize

Prof David Hayhurst FREng FIMMM was awarded the Griffith Medal and Prize at the Institute of Materials, Minerals and Mining awards ceremony in June. Prof Hayhurst is renowned for his understanding of the mechanics of materials and for pioneering techniques that led to the study of computational continuum damage mechanics being recognised in its own right.



### First ARBRIX Prize from RICS

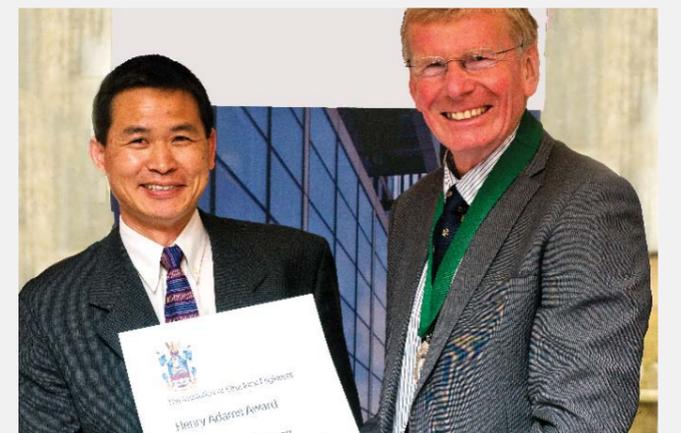
Dr Peter Fenn, a Fellow of the Royal Institution of Chartered Surveyors and a Trustee of the Chartered Institute of Arbitrators has been awarded the First ARBRIX & Royal Institution of Chartered Surveyors Education Trust Prize for his proposal for work entitled: "Uncertainty of the Cost of Conflict and Disputes: Towards a Predictive Model for Appropriate Dispute Resolution".



### ISE Henry Adams Award

Professor Yong Wang and Professor Colin Bailey were awarded a Henry Adams Award by the Institution of Structural Engineers for the best research paper published in The Structural Engineer in 2010.

The paper "The safety of common steel beam/column connections in fire" was published in the 2 November 2010 issue. The paper was based on the outcome of an EPSRC-funded collaborative research project with the University of Sheffield on "Robustness of joints in steel framed structures at elevated temperatures".



*Further information:*

[www.mace.manchester.ac.uk/aboutus/news/index.html](http://www.mace.manchester.ac.uk/aboutus/news/index.html)

*Further information:*

[www.tyndall.manchester.ac.uk/projects/resnet/](http://www.tyndall.manchester.ac.uk/projects/resnet/)

# The bigger picture

## Invited lecture at Fraunhofer ILT



Professor Lin Li, was invited by Fraunhofer Laser Institute (ILT) and RWTH Aachen University, Germany to give a seminar on advances in laser processing at the Colloquium for Laser Technology in Aachen earlier this year.

The presentation highlighted the recent research achievements by the Laser Processing Research Centre (LPRC) at The University of Manchester, led by Professor Li. The Colloquium was attended by staff and research students (laser processing) at the ILT and RWTH Aachen University. Technical

discussions were made at the Colloquium following the presentation.

Fraunhofer ILT is a world leading organization in laser processing research and applications, with a focus on new technology development and practical industrial implementation (TRL4-6) with close interface with university fundamental research at TRL1-3. This is a successful model for knowledge transfer.

[www.ilt.fraunhofer.de/](http://www.ilt.fraunhofer.de/)

## CPD

Continuing Professional Development

### Smoothed Particle Hydrodynamics (SPH)

2nd-3rd February 2012

SPH is a meshless computational method for potentially highly violent fluid flows where there is very large deformation with arbitrarily complex moving boundaries. Manchester can rely on extensive know-how built up whilst researching SPH, with expertise in both compressible and incompressible methods.

This 2-day course is aimed at professionals and students in areas of engineering fluid mechanics including coastal and shallow water hydrodynamics, ballistics, nuclear flows, marine, structures, fluid/structure interaction and other flows. The course is led by Dr Ben Rogers.

Further information:

[www.mace.manchester.ac.uk/business/cpd/courses/sph/](http://www.mace.manchester.ac.uk/business/cpd/courses/sph/)

## CARDC Aerospace Workshop in China



In June Dr Tim Craft, Prof Hector Iacovides, Prof Kostas Kontis, Prof Brian Launder and Dr Sergei Utyuzhnikov attended a 3-day workshop organised by CARDC, the Chinese counterpart of NASA. 100 researchers from different leading aerospace centres and universities took part in the workshop.

The MACE delegation gave talks that covered various aspects of turbulence modelling, experimental supersonic aerodynamics and multi-objective optimisation. The presentations were followed by

an impressive programme of excursions around CARDC's aerodynamic experimental laboratories. Both sides showed a strong commitment to long term collaboration.

The trip was organised by Prof Kostas Kontis as an outcome of a CARDC delegation visiting UMARI last year. The next meeting will take place in Manchester.

Further information:  
[k.kontis@manchester.ac.uk](mailto:k.kontis@manchester.ac.uk)

### Introduction to Maintenance Engineering & Asset Management

1-3 May 2012

A 3 day CPD course Introduction to Maintenance Engineering and Asset Management includes the key features of the maintenance in plants. A complete spectrum of maintenance process including maintenance system, audit maintenance, turnaround maintenance, design awareness in maintenance, reliability and availability analysis and vibration-based monitoring are covered. This course is an abstract of the MSc course in MEAM.

The course is developed by Dr Jyoti Sinha and KTA team. It is attended by delegates from all around the world. A very positive feed-back has been received from the delegates in 2011.

Further information:

[www.mace.manchester.ac.uk/business/cpd/courses/intro2meam/](http://www.mace.manchester.ac.uk/business/cpd/courses/intro2meam/)

### Maintenance Engineering & Asset Management MSc module by module

The course consists of nine modules: Maintenance Strategy, Maintenance Organisation, Maintenance Systems, Condition Based Maintenance, Maintenance Awareness in Design (M&R), Auditing Maintenance Systems, Turnaround Management, Reliability, Maintainability and Risk, Machinery Vibration Monitoring & Analysis. Each module can be offered as a CPD short course toward a Masters Degree in Maintenance Engineering and Asset Management.

To arrange a course, please contact:

**Course Administrator** Mrs Carol Heath  
tel. +44 (0) 161 275 4393  
e-mail: [carol.heath@manchester.ac.uk](mailto:carol.heath@manchester.ac.uk)

Further information:

[www.mace.manchester.ac.uk/business/cpd/courses/meam/](http://www.mace.manchester.ac.uk/business/cpd/courses/meam/)

## Thematic Conference



## COUPLED PROBLEMS 2011

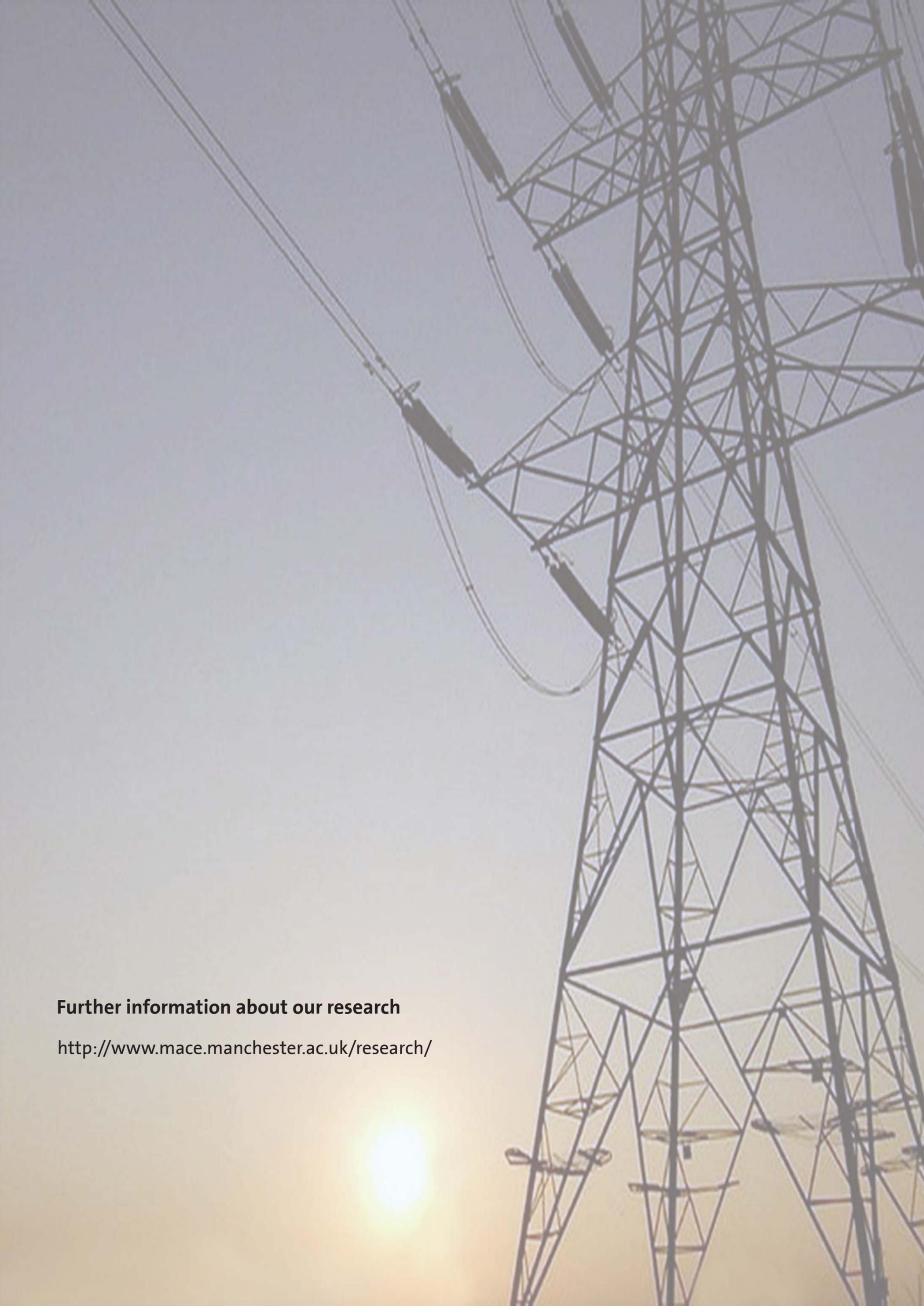
An IACM Special Interest Conference

2011, KOS Island, Greece

Professor David R. Hayhurst delivered a plenary lecture: "Coupling of Damage Mechanisms in the Prediction of Creep Failure of a Welded Branched Header Pipe" at the fourth International Conference on Computational Methods for Coupled Problems in Science and Engineering, held in Kos, Greece June 20-22, 2011. The conference was organised in the framework of Thematic Conferences of the European Community on Computational Methods in Applied Sciences (ECOMAS) as a special interest conference of the International Association for Computational Mechanics (IACM).

Further information:

<http://www.mace.manchester.ac.uk/aboutus/staff/academic/profile/index.html?staffid=127>



**Further information about our research**

<http://www.mace.manchester.ac.uk/research/>

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