Coventry University

Research Review

Winter 2017

Faculty of Engineering, Environment and Computing

Coventry University

Welcome

I am delighted to introduce this publication, the first Research Review for Coventry University's Faculty of Engineering, Environment and Computing.

The Faculty of Engineering, Environment and Computing has a long and proud history of vibrant, innovative and impactful research, applying our knowledge and expertise to benefit businesses and society all over the world. Our world-class research teams, supported by excellent facilities, and working in collaboration with global partners, are providing the scientific and engineering advances that underpin the development of new technology for wealth creation, sustainable development, and improved safety and security in people's personal and professional lives.

Organised into four over-arching and multidisciplinary Faculty Research Centres, our research benefits from an impressive, ever-growing network of commercial, academic and government partnerships here in the UK, throughout Europe, and across the globe. I hope you enjoy reading more about some of the exciting projects we have undertaken in 2016/17. Our ambition is to increase the volume, scope and impact of our research even further, and I look forward to sharing our progress with you in the future.

Some highlights are:

- We have invested a further £1 for every £1 external funding received
- Total income awarded in 16/17 was over five times larger than 15/16
- We have tripled the number of active Faculty researchers since 2014
- Over 150 staff involved in research
- 77 PhDs awarded in the past two years

Professor Michael Fitzpatrick, Pro-Vice-Chancellor (Engineering, Environment and Computing)

Michael holds the Lloyds Register Foundation Chair of Structural Integrity and Systems Performance and is a partner in the International Joint Research Centre on Nuclear Safety, funded by the Lloyd's Register Foundation and led by Lancaster University.

His research centres on the application of advanced experimental methods to materials engineering applications, particularly in the nuclear power and aerospace industries.

He has published over 200 research papers, collaborating with partners in industry and government around the world, including Airbus, Alcoa, and the US Air Force Research laboratories.

Michael has been a user of the international neutron and synchrotron X–ray facilities for over 20 years, for the study of internal stress and damage development in metallic materials and components.

A Chartered Engineer and Chartered Scientist, Michael is a Fellow of the Institute of Materials, Minerals and Mining, and a Member of the Institute of Directors. He received The Lidstone Medal from The Welding Institute in 2009 for his contribution to the advancement of welding technology. His active research includes laser shock peening for life enhancement of aerospace and marine structures. Michael is a Non–Executive Director of Diamond Light Source Ltd, the UK's synchrotron X–ray facility.

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Local impact, global reach

Our innovative research benefits individuals and businesses here in Coventry, up and down the country and throughout the world.

Partnering industry

Practical and relevant, our technological and scientific breakthroughs are maximising productivity and profits for the businesses we work with.

Centre for the Built and Natural Environment

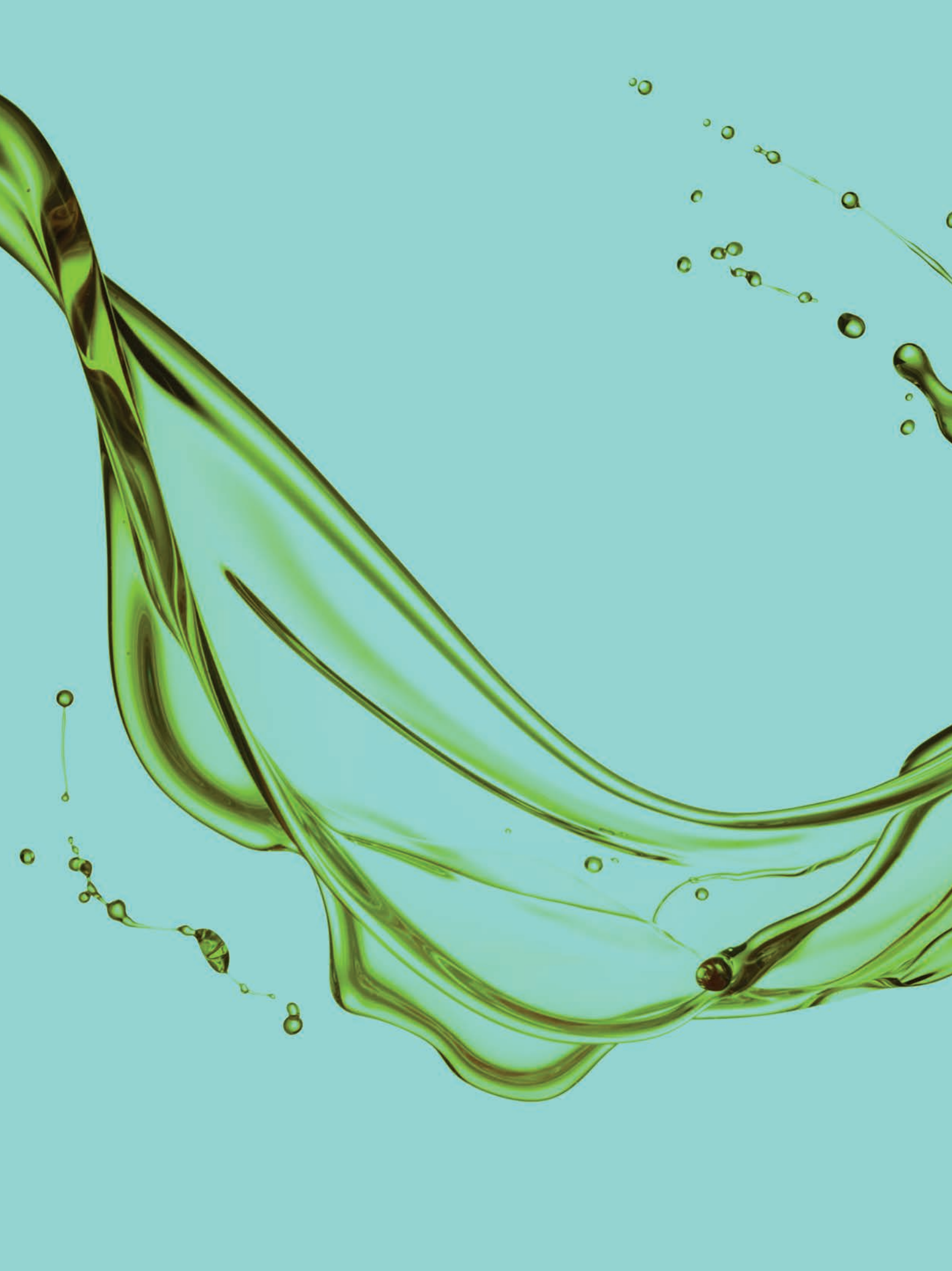
We study the effects of human-environment interactions to unearth new ways to protect the environment, conserve natural resources and improve our living and working conditions.

Centre for Mobility and Transport

We are developing inclusive, sustainable and safe forms of movement and transport within four overarching themes of design, safety and security, autonomy and low carbon.

Our people

Learn more about some of the researchers behind the discoveries and how, by sharing new knowledge, discussing and debating key issues, we hope to be the catalyst for further change for development.



Research Review

Winter 2017

Changing lives for the better

01

From revolutionising manufacturing processes and inventing new ways to use liquids, materials, machinery or technology, our cutting-edge research is tackling some of society's greatest challenges.

The research we conduct across the engineering, environment and computing disciplines goes way beyond knowledge transfer; it is already making a real difference to our personal and professional lives. Not only are we enhancing business productivity and economic regeneration through scientific and technological breakthroughs, but we are also improving working conditions and home environments too.

In an uncertain world of volatile markets and unprecedented climate change, ensuring we have access to a resilient future energy supply is one of the planet's greatest concerns. Managing the transition to a low carbon economy requires a shift to non-fossil fuel based energy sources and increased energy efficiency.

> **"Significant environmental impact, fuel savings and reduced operator costs can be achieved through the Gyrodrive project."**
>
> **Project Lead Jesper Christensen, Coventry University**

Back in 2014, we joined forces with GKN Land Systems, S&S Windings and Alexander Dennis Limited, Britain's biggest bus and coach manufacturer, to adapt and update the energy recovery technology used in motorsport to a mass transit application, namely city buses. The two-year project, valued at £16 million, received £7.5 million funding from the UK's Advanced Propulsion Centre.

The **Gyrodrive System** has been designed to save the braking energy of a bus as it slows for a stop, using it instead to accelerate back up to speed. It uses a high-speed flywheel made of carbon fibre – originally developed for Formula 1 and designed by Williams – to recycle the energy that would usually be lost as heat into rotational kinetic energy. Coventry's role in the project was to develop bespoke modelling techniques and software to conduct system health and performance monitoring, full vehicle energy modelling, vibration and endurance testing. The system, which can be installed during build or retrofitted, is predicted to cut fuel consumption by as much as 20% and save up to 14 tonnes of CO_2 per bus each year.

The built environment is a significant contributor to CO2 emissions and energy consumption. UK building stock contributes around 40% of all UK carbon emissions."

Project Lead Ashish Shukla, Research Fellow, Coventry University

Within the construction industry, we are also making major inroads in maximising energy efficiency. The **Active-LIVing Envelopes (ALIVE) project**, due to be completed in November, has developed and tested a low impact design for 'building envelopes', which is climate responsive and able to adapt to local climate conditions. Funded by the Engineering and Physical Sciences Research Council (EPSRC) as a first grant proposal, the project has involved collaboration with the Sustainable Building Envelope Centre (SBEC), TATA Steel and Phase Change Material Products Limited.

Building envelopes – essentially the 'outer shell' which physically separates the interior of the building from external conditions such as temperature, humidity or noise – play a vital role in the energy efficiency of buildings. Optimising the materials and design by utilising solar energy and passive ventilation could potentially reduce heating and cooling energy demands in all types of domestic and non-domestic buildings by approximately 30-50%. This would have a direct impact on greenhouse gas emissions from buildings, as well as reducing utility bills, increasing air quality and creating a mould free living space.

Elsewhere, the Centre for Flow Measurement and Fluid Mechanics is participating in a joint research project to enable the large-scale roll-out of liquefied natural gas (LNG) and liquefied biogas (LBG) as a transport fuel. LNG implementation would enable the stringent pollutant emission limits of future EURO VI standards to be met more cost-efficiently as compared to conventional fuels. LNG fuelled truck engines generate around 25% less carbon dioxide (CO2) compared to diesel engines and 85% less nitrogen oxides (NOX). They also produce far less noise than diesel-operated engines and are becoming the preferred choice for deliveries in urban areas, especially in the early morning or late at night (when avoiding peak traffic.

The current alternatives to diesel are limited and LNG and LBG are particularly suited for long-distance road and water transport. Their utilisation as a transport fuels is one of the pillars of the European clean fuel strategy, which aims to reduce the emissions of greenhouse gases, nitrogen oxides, sulphur dioxide and particles."

Project Lead Professor Andrew Hunt, Executive Director of Centre for Flow Measurement and Fluid Mechanics, Coventry University

This Joint Research Project (JRP), which combines expertise from industry, instrument manufacturers and research institutes in nine European countries, will run for the next three years. It has received £1.7 million as part of the European Metrology Research Program (EMRP), jointly supported by the European Commission and the participating countries within the European Association of National Metrology Institutes.

An essential part of the project is the development of measurement traceability for heavy duty LNG transportation and transfer. For billing purposes and to comply with regulations, measurements of flow and composition need to be underpinned with a clear and accountable metrological infrastructure, incorporating properties important for fuel usage, such as density and proportion of methane (the methane number). To address this, the project will establish the necessary test facilities and validation methods to develop written standards for the industry to promote good practice.

Modern society depends on sophisticated products and engineering systems whose failure can lead to catastrophic consequences. The complexity of these products and systems is increasing exponentially. This applies to large-scale systems such as transport networks, safety-critical infrastructure such as nuclear power plants, and applications in maritime and offshore sectors that are subject to challenging environments. It also affects consumer products such as mobile phones, GPS trackers and game consoles, which rely more and more on both electronics and mechanical devices to deliver improved functionality and performance.

When assessing the safety of a system there are different scales at which failures can occur: starting at the level of individual components; then assemblies of components that combine into structures, equipment and systems; also failures in operating and safety procedures and errors made by the individuals working in the system. At the core of assessing systems performance is the desire to make systems as safe, functional and reliable as possible, which is dependent upon robust research and accurate underpinning data. Parts of a system may be subject to rigorous legislation, but it is often difficult, if not impossible, to provide workable legislation that can assure the safety of the system as a whole.

Structural integrity is concerned with designing and operating products that are safe, incorporating a thorough and complete understanding of the loading and the environment they will encounter, underpinned by complete knowledge of the mechanisms by which the materials concerned can fail if their limits are exceeded. Structural integrity is a fundamental part of the overall concept of product performance, reliability and quality. It focuses on the performance of a physical part or component within a system.

In 2015, Faculty Pro-Vice-Chancellor Professor Michael Fitzpatrick, who sits on the Lloyd's Register Foundation Advisory Council, was commissioned to produce a '**Foresight Review of Structural Integrity and Systems Performance**', which highlighted the impact the Foundation could make by funding high-quality research which has a real impact on the safety of life and property. His report, which has exceeded 1860 printed copies and downloads, identified key safety challenges in structural integrity and systems performance, recommending five priorities for future research and development.

These were: ensuring the safe uptake of 3D and 4D printed parts; advancing the state of the art in engineering science challenges; developing an economic whole-system approach to demonstrate safety and integrity; data-centric engineering; and minimising the risks associated with maintenance and inspection.

"Structural integrity is concerned with designing and operating products that are safe, incorporating a thorough and complete understanding of the loading and the environment they will encounter, underpinned by complete knowledge of the mechanisms by which the materials concerned will fail if their limits are exceeded. Structural integrity is a fundamental part of the overall concept of product performance, reliability and quality. It focuses on the performance of a physical part or component within a system."

Professor Michael Fitzpatrick, Pro-Vice-Chancellor, Coventry University

Now thanks to funding provided by the Lloyd's Register Foundation, Coventry University is working as a collaborative partner with the National Structural Integrity Research Centre (NSIRC), a state-of-the-art postgraduate engineering facility managed by structural integrity specialist TWI, for which Lloyd's Register Foundation was a founder sponsor, along with BP.

In its first open peer-reviewed research call in 2016, NSIRC awarded Lloyd's Register Foundation sponsorship to 12 PhD research topics – three of which are at Coventry University, the only university to have this level of success. Two of the PhD projects are focused on assessing structural integrity in additive manufacturing ("3D printing"), another investigates the use of acoustic emission sensors – as a simple, non-destructive test for in-situ monitoring – to provide a diagnosis of high levels of residual stresses. The University has recently been awarded funding for a further three PhD studentships in the 2017 NSIRC research call, including cutting-edge research into selective-laser-melting (SLM), an outstanding new production technology that allows for time-efficient fabrication of highly complex components from various metals; and the use of state-of-the-art neutron and synchrotron X-ray methods for quality assurance of the powders used in metal or additive manufacturing processes.

We are grateful to the Lloyd's Register Foundation for funding in support of our research programmes, and for permission to reproduce text from the Foresight Review of Structural Integrity and Systems Performance. The Lloyd's Register Foundation is a charitable foundation helping to protect life and property by supporting engineering-related education, public engagement and the application of research.

ABB 8 Axis‘ Flexible Robot Welding Cell


阿拉伯海
印度
孟加拉湾
中华人民共和国
印度洋

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Local impact, global reach

02

From Coventry to Kathmandu, our research has international impact. Our collaborative projects are bringing economic and social benefits in a growing number of developed and developing countries.

In sharing our expertise in science and technology with researchers and developers all over the world, we not only help them to access our knowledge so that they can apply it to local problems, but we also learn from each other. Often, our work leads to new business ventures and job opportunities, improving local prosperity.

We are working with displaced communities in Africa and Asia on a major £1.13 million initiative to leverage new technologies for the implementation of safe and sustainable energy solutions. In partnership with Oxford University, Practical Action and Scene Connect, the **HELP (Humanitarian Energy for Displaced Populations in Refugee Camp and Informal Settlements)** project will first assess energy needs and current provision in areas such as lighting, electrification, cooking, heating, cooling, water and sanitation, then engage a range of energy stakeholders to implement improvements. Funded by the EPSRC, it focuses on the Kigeme, Nyabiheke and Gihembe refugee camps in Rwanda, as well as the Tibet and Bhutan refugees and Kathmandu climate change refugees in Nepal.

“Ultimately, we hope to shift the way refugees see themselves. Instead of 'beneficiaries' dependent on handouts, they will be able to ‘HELP’ themselves – to choose, produce, consume and take part in the running of their own communities.”

Professor Elena Gaura, Associate Dean (Research), Coventry University

The natural solar resource available in developing countries means cost effective energy solutions often concentrate on solar energy, delivered by microgrids and hybrid energy supply systems, which can be supplied quickly and efficiently in humanitarian emergencies. This three-year Coventry-led project, however, will test the feasibility and potential of the many alternatives, such as renewable biomass and biogas, wind generators, micro-hydro, geothermal, liquid petroleum gas (LPG) and waste recycling. It will also investigate whether low-cost, remote monitoring wireless systems could manage and pre-empt operations and maintenance issues of energy infrastructure.

When it comes to energy, China consumes more electricity than any other country in the world. Despite being the world's biggest solar energy producer, it remains heavily dependent on coal – 66% of total energy demand compared with 1% for solar energy – which contributes to the well-publicised air pollution problems. Since 20% of China's primary energy consumption is the result of building energy, on the rise due to rural urbanisation in the central and western regions, the National Energy Administration has called for greater energy control and efficiency through the introduction of sustainable technologies and alternative energy sources. Now, academics from Coventry are teaming up with the Xi'an University of Architecture and Technology to bring together experts from both countries to share research in low impact building technology, renewable energy and energy management in residential and commercial buildings. The project will capitalise on the UK's well-established technology experience, as many buildings are already under renovation to meet low impact buildings standards.

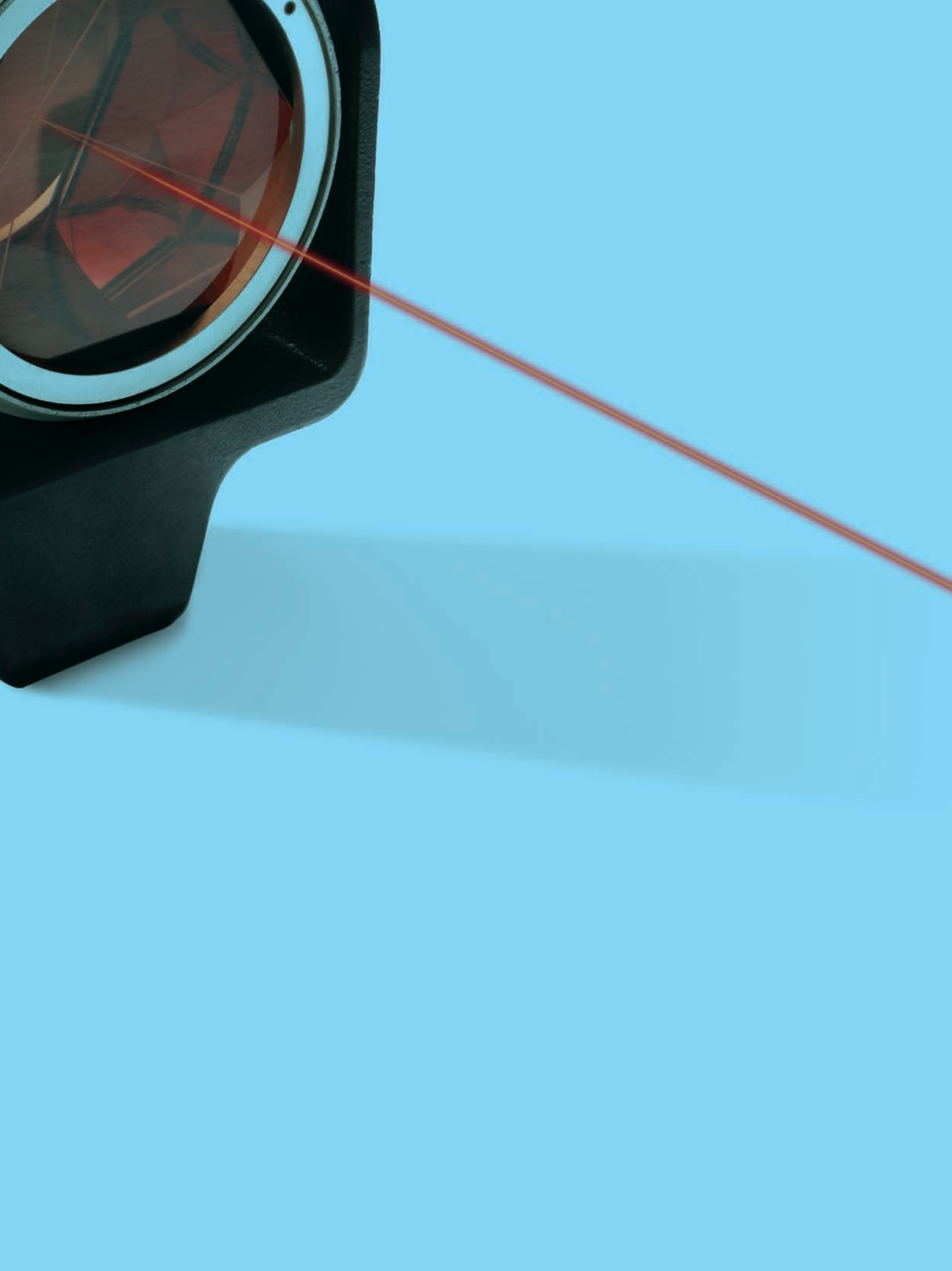
Under the **Researcher Links Scheme**, offered within the Newton Fund and British Council, we are organising a workshop for researchers, representatives, planners and policy makers to address recent advances in energy conservation for buildings in the UK and China. As well as showcasing the latest technologies and developments in areas such as solar energy, wind energy and ground source energy, it is hoped the event, to be held in China this August, will provide opportunities to explore new research opportunities and promote a new interdisciplinary energy research agenda between two partner countries.

Another sustainability themed project, led by Coventry, is the Horizon 2020 funded **SUITS (Sustainable Urban Integrated Transport Systems)** initiative. This €4 million project seeks to increase the capacity of small to medium-sized local authorities to develop and implement sustainable, integrated transport in urban areas. Launched in December 2016, the four-year project brings together a consortium of academic, local government, business and research partners from 11 different countries to understand, provide and disseminate resources and training to local authorities via a series of toolsets, online resources, webinars and workshops.

"Clear evidence is emerging across Europe that greener transport solutions are linked to safer streets, neighbourhoods and cities. If more sustainable transport systems are introduced, urban environments could undergo significant positive changes."

Project Lead Professor Andrée Woodcock, Coventry University

Meanwhile, the Centre for Manufacturing and Materials Engineering is tackling the problem directly at its source – developing a new lightweight exhaust system which could save 325M tonnes of CO2 each year. The £1.59 million **InnEx project**, led by Unipart and due to be completed in May 2018, brings together expertise from the University, Jaguar Land Rover, Johnson Matthey Plc and The Welding Institute. Focusing on the development of new and innovative material processes for the catalytic hot-end of the exhaust system, the goal is to halve the current mass of exhaust systems for diesel and gasoline automotive vehicles. The team will not only provide innovative solutions to the manufacturing challenges associated with down-gauging exhaust components in terms of jigging, forming, joining and metrology, as well as the overall design methodology, but also deliver cost-effective materials and manufacturing technology, including metrology and computer-aided engineering methods.



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Partnering industry

03

Innovation and knowledge exchange are vital to the UK economy: our breakthroughs in, for example, green energy, material science or Big Data, can create new jobs, commercial products and services.

The breadth and volume of our research partnerships with commercial, professional body, academic and government organisations is expanding year-on-year. The Faculty of Engineering, Environment and Computing works with companies of all sizes – from multinationals such as GE Aviation, Intel and Shell to national service providers like the National Health Service (NHS), the UK Oil and Gas Industry or the Highways England Company Ltd local. We have also assisted dozens of small to medium-sized enterprises (SMEs), for instance, providing sustainable buildings guidance to help Stratford-upon-Avon Chartered Architect Richard Davis grow turnover by 30% and doing what/for what other local businesses.

We are proud to be proactively shaping the future of major industry sectors in collaboration with the Automotive Council UK, InnovateUK, TUV-NEL, Department for Transport and Department for Business, Energy and Industrial Strategy, to name just a few. Nowhere is this more evident than our £32m **Institute for Advanced Manufacturing and Engineering (AME)** – the 'world's first faculty on the factory floor' – part-funded by Government in collaboration with Unipart Group and based at the Unipart Powertrain Applications company site in Coventry.

In September 2016, an AME project beat off stiff competition to win best 'Technology Innovation' at the **2016 Cotswold Life Engineering Manufacturing Innovation (EMI) Awards**. The project developed a manufacturing process to provide a lightweight exhaust system for Aston Martin that is half the weight of traditional alternatives. Judges were impressed with the way Unipart had tapped into the R&D facilities and knowledge of the University and praised AME's ability to 'rewrite the rule book when it comes to commercialising new technology and ensuring the economic value and jobs remain in the UK'.

> **"The combination of The Unipart Way with advanced technical knowledge, through research and development at AME, is enabling us to win new contracts and get recognition around the world in terms of quality, technical excellence and precision engineering."**
>
> **Chairman and Group Chief Executive John Neill, Unipart Group**

The Institute also secured Local Enterprise Partnership (LEP) funding to help Unipart (the supplier of Fuel Rails for the Ford Sigma Engine) research and develop the next generation of fuel systems.

The team successfully redesigned the fuel rail to meet the functional and cost targets, and for ease of manufacture – removing 15% of the cost from the original design of the fuel rail, while maintaining the highest standards of performance and quality. Unipart Manufacturing has subsequently been nominated by Ford/Continental for the volume production of the Ford Fox Fuel Rail (over 1.4m units between 2017-2023). Supply begins in 2018 and will mean a 50% increase in production at the Coventry site and 40 new jobs. For Unipart to compete on such a global scale requires the highest levels of productivity, use of the most advanced technologies and continual development of staff. Meanwhile, the goal for AME is to further develop into a UK Centre of Excellence for Fuel Rails Engineering, targeting the 2.5m engines assembled in the UK, as well as export business.

Meanwhile, April 2017 saw the launch of a brand new automotive research centre dedicated to developing intelligent, connected vehicle technology. In collaboration with engineering and test teams at Horiba MIRA, a team of up to 20 academic staff and doctoral research students at the **Centre for Connected and Autonomous Automotive Research** will support the growing global intelligent mobility sector and addresses future transport needs in the area of connected autonomous vehicles (CAV).

> **“The Centre will provide a hub for rapidly expanding the scope of engineering and test services we offer clients; an environment where we can ensure new services are tailored to their needs in this fast-evolving technology area.”**
>
> **CEO Dr George Gillespie OBE, HORIBA MIRA**

Located at the MIRA Technology Park in Nuneaton, this latest strategic investment builds on existing collaborative activity, including work with other leading industry players to test connected vehicle technology in real-world conditions, as well as doctoral research exploring, among other things, technologies that make journeys safer, cleaner and smarter.

Another of our key partners is former UK Government Laboratory NEL, with whom we launched the Centre for Flow Measurement and Fluid Mechanics in 2016. We recently helped NEL, a leading provider of consultancy, measurement, testing and calibration, secure £16 million in funding for a new **Centre of Excellence (CoE) for subsea development** in Scotland. We researched, co-wrote and co-presented the initial £4.9 million bid, which led to NEL’s parent company, TÜV SÜD AG, agreeing to invest a further £11.1 million in the project.

> **“Coventry University was instrumental in securing the £4.9 million Scottish Enterprise development grant that has allowed the development of the CoE. We look forward to working with our colleagues at the University to make full use of the CoE’s potential.”**
>
> **Managing Director Brian Millington, NEL**

Designed to provide a new, best-in-class, high pressure multiphase flow test facility, with a test range beyond anything currently available anywhere else in the world, the CoE will provide opportunities for company-led industrial projects, development work with SMEs and hands-on training for the industry and academic research. Focused predominantly on the £50 billion per year global oil and gas sector, it will also offer potential benefits to companies in other sectors such as nuclear power, food and drink, aerospace and renewable energy.

Renewable energy continues to be one of the Faculty's core themes across all areas of research; this summer marks the completion of a four-year €13.7m Energy Efficiency Buildings European Initiative. The **REtrofitting Solutions and Services for the enhancement of Energy Efficiency in Public Edification (RESSEEPE) project** was led by UK-based Integrated Environmental Solutions Ltd and involved 25 partners in 10 different countries, including Coventry-based engineering and technology provider Exergy and Coventry University. It was designed to technically advance, adapt, demonstrate and assess innovative building retrofit technologies with the aim of halving energy consumption.

Existing public buildings have a huge impact on the total energy use in Europe, for example, in France the hospitals alone represent about 11% of the total service industry's energy consumption. The potential for energy savings is therefore important at national and European level, creating demand for new technologies and specialist expertise to design, construct and manage new buildings or renovate existing buildings.

"Exergy has worked very closely with Coventry University over the past four years; we have worked together to identify and contribute to the development of research proposals. We are looking forward to maintaining this collaboration by supporting any efforts of mutual interest in the future."

Technical Coordinator Kassim Caratella, RESEEPEE project

Coventry University provided the test site for the implementation and testing of innovative technologies to demonstrate energy reduction achievable through low-energy retrofit, using an optimised mix of active and passive technologies. To both conserve energy and covert solar energy into direct current electricity using semiconducting, we studied the impact of LED lighting, solar panels, efficiency glazing, vacuum insulated panels and cladding materials with integrated photovoltaic cells.

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Collaborating with communities

04

Engaging communities near and far in our academic research is essential to identify the needs, behaviour and problems facing modern society, so we can discover workable solutions together.

For centuries, universities have played a major civic role in developing the new knowledge which has generated or contributed to social, economic and political change. Community-based participatory research (CBPR) not only benefits our researchers, by equipping them with a far greater understanding of different communities, but also ensures that the 'actual' needs of communities are considered, empowering people to share their ideas and concerns about the subjects under investigation.

In response to the challenge of sustainability, we are conducting research to promote low carbon lifestyles, lower greenhouse gas emissions, decrease finite fossil fuel consumption and reduce reliance on imported energy, not just here in the UK, but all over the world. These projects demonstrate the widespread advantages such academic-community collaboration can bring.

Responsible for 22% of energy-related greenhouse gas (GHG) emissions worldwide, transport emissions are increasing at a faster rate than any other sectors. Here at Coventry, we are working with organisations at home and abroad to improve vehicle emissions and fuel efficiency across personal, public and goods transportation to mitigate climate change and improve air quality and human health. Part of the challenge is to achieve a change in culture so that transport managers and travellers are more willing and able to use electric vehicles (EVs) or choose other low carbon alternatives, such as public transport.

> **"Current vehicle climate control systems control temperature rather than thermal comfort. They also tend to be energy hungry, which is of concern when considering electric vehicles. An example of the problem is where noise from a fan is so disturbing that even if a high setting keeps you cooler, you adjust it lower."**
>
> **Project Lead, James Brusey, Coventry university**

In June 2017, €5.1 million funding was awarded under the Horizon 2020 European Green Vehicles Initiative to optimise energy use in EVs, while keeping user comfort and safety needs central. The three-year DOMUS project – **Design and OptiMisation for efficient EVs based on a USer-centric approach** – is being led by Spanish automotive design and test organisation IDIADA in collaboration with the Kansei engineering group from Toyota Brussels. Here in Coventry, researchers from the Faculties of Engineering, Environment and Computing; Arts and Humanities; and Health and Life Sciences will conduct driving simulator trials to model user perceptions of cabin heating and cooling systems – the car's largest auxiliary load. Their research trials will be used to update existing human comfort perception models to include things that are important but not normally considered a priority, such as the effect of acoustic noise and lighting. It will establish what comfort and safety requirements can be met and at what energy cost.

After transportation, buildings account for 40% of the total non-transport energy consumption both in UK and EU. Four million UK householders spend more than 10% of their income on energy bills; all paid retrospectively, long after they could have managed or modified their energy consumption or that of non-bill payers, such as children.

The Coventry-led £1 million **Smarter Households project**, funded through the EPSRC's £6 million Transforming Energy Demand in Buildings through Digital Innovation (BuildTEDDI) initiative, presents householders with real-time energy consumption data to improve their ability to intelligently manage energy consumption and subsequent bills. Launched in 2013, the five-year project is being run in collaboration with E.ON, one of the UK's top energy suppliers, and the Coventry-based Orbit Group housing association, as well as Birmingham, Edinburgh, Aston and Portsmouth universities.

SMARTER HOUSEHOLDS
Intelligent digital networks for low carbon lifestyles

"Smarter Households helps households manage their energy use according to their own priorities, whether to save money, help the environment or simply feel more comfortable at home. We want to develop practical ways to link lifestyle choices with electricity and gas bills."

Project Lead Professor Shuli Liu, Coventry University

An Integrated Meter and Sensor System (IMSS) has been installed in 20 trial homes in Coventry, Warwickshire, Northamptonshire and Worcestershire to record electricity and gas consumption, alongside environmental conditions, such as internal and external temperature, relative humidity and carbon dioxide levels. Information is displayed on an in-home 3D 'energy dashboard' mobile app and household members can compete against each other playing a Virtual Energy World Game (VEWG) to manage their energy use in a fun and interactive way.

"When fully developed, microgrids supplied by renewable energy will increase energy security, enhance efficiency, place control of the energy supply with the local community, provide economic growth and poverty reduction."

Senior Lecturer in Humanitarian Engineering Dr Anh Tran, Coventry University

Elsewhere, in Brazil, we are working with the Universidade Federal do Amazonas (UFAM) and local Amazonian riverside communities to support the Brazilian government's target of 23% of energy from renewable sources by 2030. In 2014, only 9% of the country's total energy supply was powered from solar, wind and biomass. The isolated riverine communities face challenges with limited opportunities for business and cottage industries, as well as poor access to communication, education and health services.

The link with UFAM was established as part of UNESCO's University Twinning and Networking (UNITWIN) in Humanitarian Engineering programme, for which Coventry is the global lead institution. The recently launched **Star Energy project**, funded by the British Council, aims to develop a sustainable and replicable off-grid renewable energy system suitable for Amazonian riverside communities. The two-year project will involve an initial baseline survey of 15 riverine communities to investigate the current energy context, from which we will select one community to pilot a renewable energy system that will be instrumented for monitoring of energy generation, consumption, aspiration, socio-economic and health indicators for one year. A core aim is to develop economically viable business models that are scalable and can be replicated, for example, developing a private sector in renewable energy supply infrastructure of rural energy entrepreneurs who can market, install and service the systems. We will also design and trial energy awareness education programmes for the local communities and workshops for early career researchers and academics at UFAM to build the local research knowledge base.

Working with academic communities all over the world

Collaboration with the academic community has been an integral part of research for many years. Our research is conducted in partnership with other institutions; we also learn from each other by sharing research findings through publications, conferences, guest lecture programmes and scientific committees. The increase in interdisciplinary – often multi-agency collaboration of academia, industry and government - has encouraged the development of innovative and ground-breaking investigations and discoveries.

Professor in Materials Physics Alexander Chroneos has given three invited speeches across Europe in recent months to share the results of his research into materials for nuclear energy (funded by the Lloyd's Register Foundation), nanoelectronics, batteries and solid oxide fuel cells, which offer high efficiency for energy conversion in a clean way. In May, he joined colleagues from Erasmus partner universities at the Technological Educational Institute (TEI) of Crete in Greece for its 4th Erasmus Week on Modern Topics in Electronics and Applications. The following month, he spoke at the 21st International Conference on Solid State Ionics in Padua, Italy. In July, he was invited to give a 'Converging Technologies Keynote Lecture' at the 5th Helenic Forum for Science Technology and Innovation at the Demokritos National Centre of Scientific Research in Athens, Greece.

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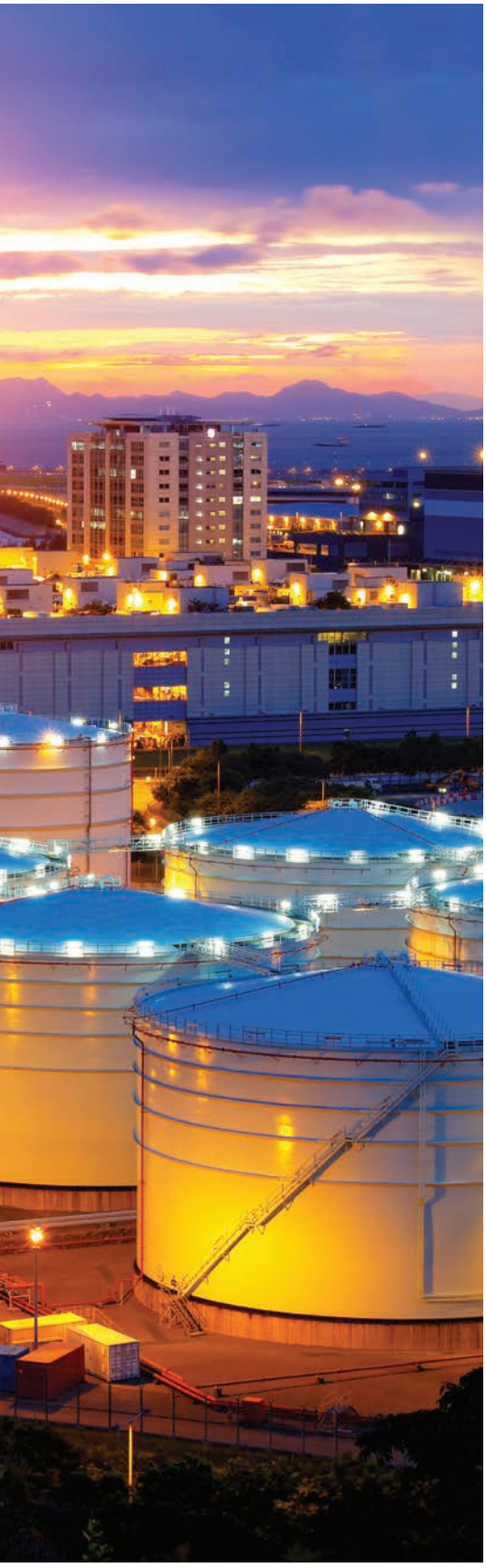
Centre for Flow Measurement and Fluid Mechanics

05

Fluid mechanics is fundamental to our existence: from the air we breathe, the fuel to heat and feed us or the Earth's molten liquid core, generating the magnetic field that protects against the Sun.

The Centre combines unique specialist expertise and facilities from Coventry University and Glasgow-based NEL, holder of UK's national standards for flow measurement. Our research is leading advances in instrumentation and modelling processes involving the flow of complex mixtures of gases and liquids across the energy, manufacturing and process industries, including oil and gas, aerospace, food, water, nuclear and automotive. For businesses selling high value commodities like petrol, a move from traditional techniques of 'forecasting' with historic data to 'now casting' using real-time data will save millions of pounds by improving the accuracy of measurements. By studying the behaviour of liquids and gases, we can do many things: optimise performance, for example, propellant flow in a zero-gravity environment to sustain longer periods of space exploration; identify more sustainable energy sources, such as waste biomass; and minimise negative side effects – anything from tidal erosion to the storage of unwanted carbon underground.



Flows occur in all fields of our natural and technical environment. The motion of liquids and gases plays a pivotal role in maintaining the high standards of our everyday lives: ridding us of pollutants and waste; providing most of our energy and transport; and powering much of the processes responsible for the multitude of products we rely on. Research in fluid mechanics aims to improve our ability to predict, control and optimise these situations.

Our internationally renowned expertise in flow measurement led to the University being chosen to deliver a ground-breaking **Engineering Research Doctorate (EngD) programme** of high impact, industry-focused research in partnership with NEL, the former National Engineering Laboratory and now part of the TÜV SÜD Group.

Part of our ongoing collaboration, the doctoral programme is currently supporting 10 EngD studentships. Their work includes research into one of the latest techniques of multiphase flow imaging using Electrical Capacitance Tomography (ECT) coupled with particle filtering computations. This could allow the accurate visualisation of oil and gas flows at the wellhead, which would be a major game-changer for industry. Such technologies could allow enhanced real-time control that would optimise and increase production and reduce safety related and flow assurance issues. Other research involves flow meter diagnostics and is aimed at providing an improved flow characterisation from existing flow-meter measurements. This could have a major bearing on the push to develop self-calibrating flow meters, which would help solve the maintenance and calibration challenges associated with remote installations.

As you might expect, energy is a major focus of our research and, increasingly, the search for more sustainable sources. In one such project, Senior Lecturer in Aerospace Engineering Jonathan Nixon is investigating **energy recovery from waste biomass** in the Sindh region of Pakistan.

Heavily dependent on import of oil due to limited resources of oil and gas and non-utilisation of coal, Pakistan is currently experiencing a severe energy crisis: electricity and gas shortages are causing economic and social hardship. Producing power from biomass, such as crop residues, animal manure and municipal wastes, offers a promising and safer energy alternative. Being an agrarian economy, more than 60% of Pakistan's population is involved in agricultural activities and around 26,280,000 hectares of land is under cultivation. The country already produces substantial quantities of biomass, but, so far, the uptake of bioenergy has been largely limited to inefficient technologies and practices. The consumption of biomass in inefficient cook stoves in rural and semi-urban areas, for example, degrades the indoor air quality, posing a significant health risk. High exposure to indoor air pollutants (IAP) causes about 100,000 premature deaths annually in Pakistan and has resulted in acute respiratory infections, chronic obstructive lung disease, tuberculosis, blindness and lung cancer, especially in women and children.

The efficient use of biomass would increase energy independence, advance domestic economies, improve the health of women and children, and reduce air pollution emissions. Industry will profit from the rising demand for biomass conversion and utilisation systems, while the community at grass-roots level will benefit from the use these technologies economically."

Project Lead Dr Jonathan Nixon, Senior Lecturer in Aerospace Engineering, Coventry University

The main aim of the project, run in partnership with Sindh Rural Support Program (SRSP), a non-governmental organisation (NGO), and Mehran University of Engineering and Technology (MUET) is to explore the biomass potential for clean energy for heating, cooking and other purposes. Methods of efficient direct combustion and biofuel production will be evaluated and tested, together with the design, development and demonstration of prototypes. Equally important, however, is the need to build local capacity and transfer knowledge of clean bioenergy production and utilisation. As part of a range of education and outreach programmes being devised, in November 2016, Dr Nixon delivered a keynote speech and short course on bioenergy at the 4th International conference on Energy Environment and Sustainable Development 2016 (EESD-2016), held at MUET in Jamshoro.

Meanwhile, Professor Alban Pothérat is midway through a five-year project examining turbulence in magnetic fields, after receiving the prestigious **Royal Society Wolfson Research Merit Award** in 2015, which recognises outstanding achievement and potential among UK scientists. Turbulence lies at the heart of an immense variety of natural and industrial processes and causes flows to exhibit intense, erratic fluctuations, which are extremely difficult to predict. Our incomplete understanding of the dynamics of the Lorentz forces from magnetic fields and the Coriolis forces due to planetary rotation currently limits the development of computationally effective models and impedes progress in some of the greatest challenges in physics and engineering.

Professor Pothérat and his international team of collaborators are conducting experiments on turbulence and convection in some of the strongest magnetic fields in the world at the Grenoble High Magnetic Fields Laboratory in France. The project aims at improving our understanding of turbulence and other flows in such extreme conditions. It is hoped that it will lead to deeper insight into the dynamics of the earth core, astrophysical turbulence, and help improve heat extraction from nuclear fusion reactors.

News

March 2017 saw the launch of a Royal Academy of Engineering project in association with Plymouth University and the University of San Carlos, in the Philippines, to develop a **Post-Earthquake Structural Health Monitoring System (PE-SMS)**. Many countries suffer from the threat of earthquakes, but the socio-economic impact is greater in less developed countries where there are fewer qualified engineers and reinforced concrete structures (RCS), highly susceptible to seismic damage, are the most common building archetype. A PE-SMS system deployed quickly could have a significant impact, minimising delays in the damage assessment process, reducing potential loss of life due to building collapse and mitigating avoidable social and economic losses. Lab tests will take place in the UK, alongside field trials in the Philippines, where a recent earthquake will provide a sample of buildings to test the system.

New PhD research announced by the Centre aims to improve our knowledge of coastal defence systems and could ultimately benefit the one billion people worldwide who live in areas at risk of sea-level rise. Coastal flooding is one of the most significant issues in the world today, especially as human populations continue to grow and occupy the coastal zone. The world's changing climate is also causing additional problems, including an increase in the intensity, severity and frequency of coastal storms and surges. The purpose of the research, which will be fully funded for outstanding candidates, is to develop a robust and efficient predictive **modelling tool for coastal defences under extreme climatic conditions**, including wave-by-wave overtopping, over-wash, wave pressure and loads, sediment transport and scouring. Given that industries and consultant engineers have no access to experimental facilities, such tools are vital to evaluate the performance of transformative future technologies in the coastal region.

An EPSRC first grant proposal has been awarded to Dr Bogdan Teaca to facilitate – **understanding and modelling kinetic turbulence in magnetized plasmas**. Magnetic confinement fusion is an approach to generating electrical power from fusion reactions, using strong magnetic fields to confine the hot fusion fuel, which exists as a plasma state of matter, within a device known as a tokamak. Turbulence in plasma represents a key impediment to this objective, as turbulent mixing is known to enhance the transport of particles and heat across magnetic surfaces, leading to the eventual loss of plasma confinement that stops the fusion reaction.

“Plasma physics lies at the core of the UK’s magnetic fusion research programme and is an important pillar of the EPSRC's energy theme. The generation of electrical power via magnetic confinement fusion promises an abundant, inexpensive, clean, safe and reliable source of energy, a viable alternative to fossil fuels.”

Project Lead Dr Bogdan Teaca, Senior Lecturer in Applied Mathematics, Coventry University

Understanding the proper interactions in plasma turbulence, interactions that are captured by kinetic theories in a six-dimensional space will enable predictive models to be developed, which in turn can determine the most efficient operational regime of current machines and improve the design of future tokamak reactors. In the process of building better sub-grid models that account for plasma dynamics at kinetic scales, a series of related questions pursued in the astrophysical community, such as identifying the correct route for the energy dissipation in the solar wind, will also be tackled. This £90K two-year project will support the work of Dr Teaca and his collaboration with partners from the Culham Centre for Fusion Energy in the UK, Max-Planck Institute for Plasma Physics in Germany, University of California in Los Angeles and Princeton University.

French PhD student Kelig Aujogue was the 2017 recipient of the **Royal Astronomical Society’s Patricia Tomkins Prize** for the best PhD thesis defended in the UK during 2016 and relevant to the field of instrumentation for Astrophysics or Geophysics. Kelig received the prize for his work on the experimental model for the liquid core of the Earth using a transparent electrolyte and the large magnets from the high magnetic field laboratory in Grenoble, in the frame of a project funded by the Leverhulme Trust.
In July 2016, his contribution to research developing a new experimental facility, Little Earth Experiment, which is designed to study the hydrodynamics of liquid planetary cores, was published in the Review of Scientific Instruments.

In November 2016, Senior Lecturer in Petroleum Reservoir Management Seyed Shariatipour published an article in **IOP Conference Series: Earth and Environmental Science** on the storage of CO2 in subsurface geological structures as a means of mitigating global warming. The research reported a comprehensive safety and monitoring system of CO2 storage undertaken at the Prinos hydrocarbon field, offshore northern Greece. It concluded that the majority of CO2 generated in the county’s industrial processes could be dealt with at a relatively low cost and the consequences of a leak were limited with no direct negative impacts on marine ecosystems.

As part of his EngD, NEL Flow Measurement Engineer Craig Marshall has developed a new method to improve the accuracy of differential pressure flowmeters for ‘heavy oil’. Around 70% of the world’s remaining oil resources are classed as ‘heavy oil’ and there is a need to improve measurement technology in these applications. Differential pressure flowmeters were never designed to cope with this type of oil and inaccurate measurements are costing the oil and gas industry millions of dollars per year. The new method will help safely control the production processes, optimise recovery and reduce the industry’s financial exposure.

Research
Review
Winter 2017

Centre for the Built and Natural Environment

06

For centuries, man has relied on the environment to protect, shelter and nourish him. As we have come to realise to our peril, everything we do impacts on our surroundings and vice versa.

The Centre for the Built and Natural Environment is conducting cutting-edge research which seeks to restore the natural balance between man and the environment. It aims to minimise the damage caused by global warming, sea-level change, pollution, reduction in biodiversity and the ecological imbalance that has wreaked havoc on the earth's landscape – through flooding, rainstorms, earthquakes, volcanoes, erratic rainfall, heavy winds, disease and crop failures. We strive to provide solutions – from identifying 'greener' building materials and testing alternative energy sources to training construction industry professionals in the latest sustainable energy technologies and developing smart energy meters. More importantly, we also aim to provide a deeper understanding of the root cause of the problem – the human relationship with the environment and the effects of our interactions: from climate change and air quality to growing populations, advanced technology and urbanisation.

The amount of natural resources extracted to produce goods and services is steadily increasing. At around 60 billion tonnes each year, humans extract and use about 50% more than only 30 years ago. Global environmental and energy concerns have led to increasing scrutiny of the construction and maintenance of private and public buildings – as a major user of these resources – both here in the UK and throughout the world. Our researchers are not only helping to identify new techniques and technologies, but are also shaping the future standards to regulate them.

The University was instrumental in establishing a series of international conferences on **Sustainable Construction Materials and Technologies**, first launched in 2007, in partnership with the University of Wisconsin Milwaukee Center for By-products Utilization in the United States. In August 2016, founding committee member and organiser Essie Ganjian, Professor of Civil Engineering Materials, shared his research into reusing and recycling end-of-life materials at the fourth international conference, held at The University of Navada in Las Vegas.

His research led to the development of a cost-effective cement replacement using recycled gypsum from waste plasterboard and a range of mineral wastes, which was successfully tested in low-medium strength concrete mixes for the foundations of minor roads and car parks. Over 2.5 million tonnes of plasterboard are manufactured and used each year within the UK construction industry for forming partitions, lining walls and ceilings. Wasteful design, off-cuts, damaged boards and over-ordering leads to around 300,000 tonnes of plasterboard waste, most of which ends up as landfill.

Another highly successful UK-US partnership has been to showcase the future potential of bamboo as a widespread building construction material, most recently in Indonesia at the **2017 International Symposium on Bamboo in the Urban Environment**. The annual conference, now in its third and final year, is one of many legacies of a two-year research project, one of only 14 across the world to win funding through the joint UK-US government Global Innovation Initiative. The original $220K project brought together experts in bamboo and sustainable design from Coventry, the University of Pittsburgh (US), International Network for Bamboo and Rattan (China), Bogor Agricultural University (Indonesia) and the Indian Institute of Technology Delhi (India) to engage in cutting-edge analysis and testing of bamboo as a safe construction resource.

“Bamboo is one of the world’s oldest construction resources, dating back thousands of years, but we haven’t come close to fully exploiting its potential as a sustainable alternative to current industry materials and techniques. If we can go some way towards empowering the next generation of engineers, architects and builders to use bamboo to meet the demands of the 21st century, then the project will have been a success.”

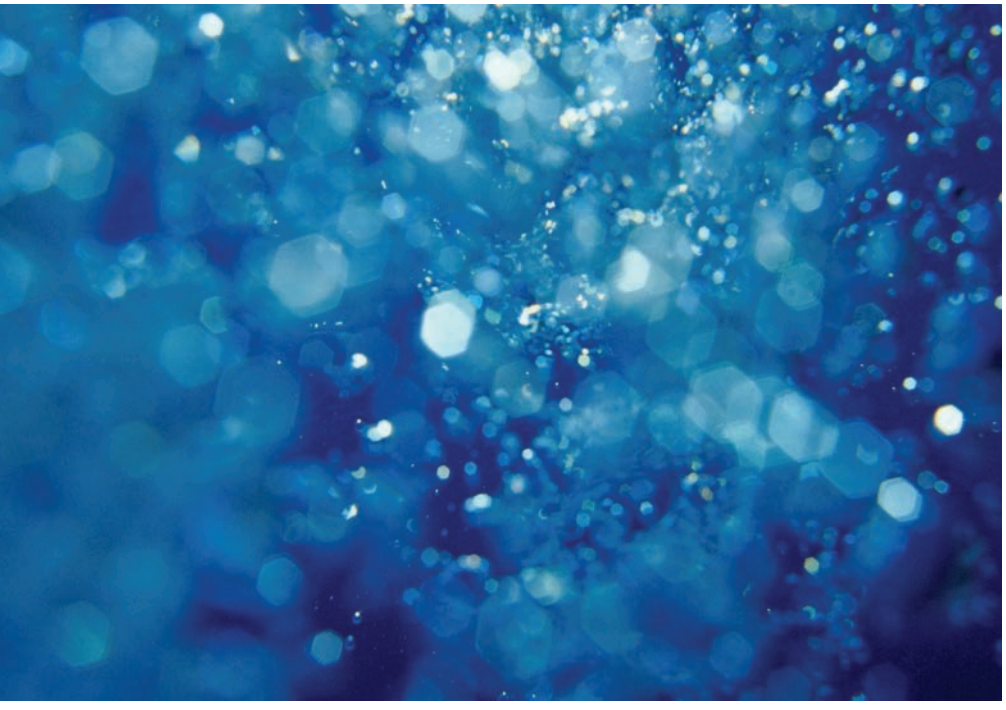
Project Lead David Trujillo, Coventry University

With continued population growth, especially in developing and lagging countries, together with urbanisation and the need for greater resilience in the face of natural hazards and climate change, there is a pressing need for a sustainable yet safe and strong construction material. The researchers have been championing the role that bamboo can play in the provision of safe, affordable housing and for emergency shelters. In May 2016, they launched the 'Pittsburgh Declaration' – a global call to action to increase international recognition of the benefits of bamboo with recommendations to more effectively harness the plant as a building material. Led by Senior Lecturer in Civil Engineering David Trujillo, the latest research, due to be completed next year, aims to develop an international grading methodologies and standards for bamboo, on a par with those that exist for timber. It is expected that in September 2017 two international ISO standards will be approved as the culmination of this effort. The ambition is that this is simply the beginning of an ever growing, joint international effort to develop standards for bamboo.

Research Fellow Azadeh Montazami, a leading expert on the thermal performance of buildings and committee member of the UK Indoor Environments Group (UKIEG), has provided counsel on several energy efficiency standards, including Passivhaus. She is currently serving on a Department of Education Advisory Board to revise guidelines – for the first time in over 10 years – on ventilation, thermal comfort and indoor air quality in schools, known as '**Building Bulletin BB101**'. Some of her works have been taken on board by the DoE in their revisions of the existing school design guidelines.

With the ambition of making Britain's schools among the best in the world by 2020, the Government is increasingly conscious of the direct link between the attainment of children at school and ambient conditions in classrooms, as well as the effect of exposure to air pollution on their mental and physical development. Raised CO2 levels and temperature have been proven to have a negative effect on the cognitive performance of children – impacting concentration, productivity and attention. The 2017 publication, which supersedes an earlier 2006 edition, reflects the increased importance now being given to maintaining good indoor air quality in schools. It sets out regulations and recommendations on the design and construction of school buildings to provide good indoor air quality and thermal conditions.

Dr Montazami's own research revealed that children's threshold comfort temperatures are at least 3°C lower than adults: teachers, who invariably adjust internal comfort conditions to meet their own preferences, may not necessarily deliver the most effective learning environments for their pupils. She has subsequently developed an algorithm to predict children's thermal dissatisfaction rate, which is being used to help designers and teachers deliver and control classroom environments in a way that maximises educational performance. Her most recent work, published in the Building and Environment journal, demonstrated that the socio-economic background of children is likely to influence their perceptions of comfort in primary school classrooms and the behaviour that they adopt to adjust their individual comfort. In particular, thermal experiences at home are likely to be reflected in their thermal perception in the classroom. The outcome of this study is of interest to architects, teachers, engineers, school administrators and policy makers.

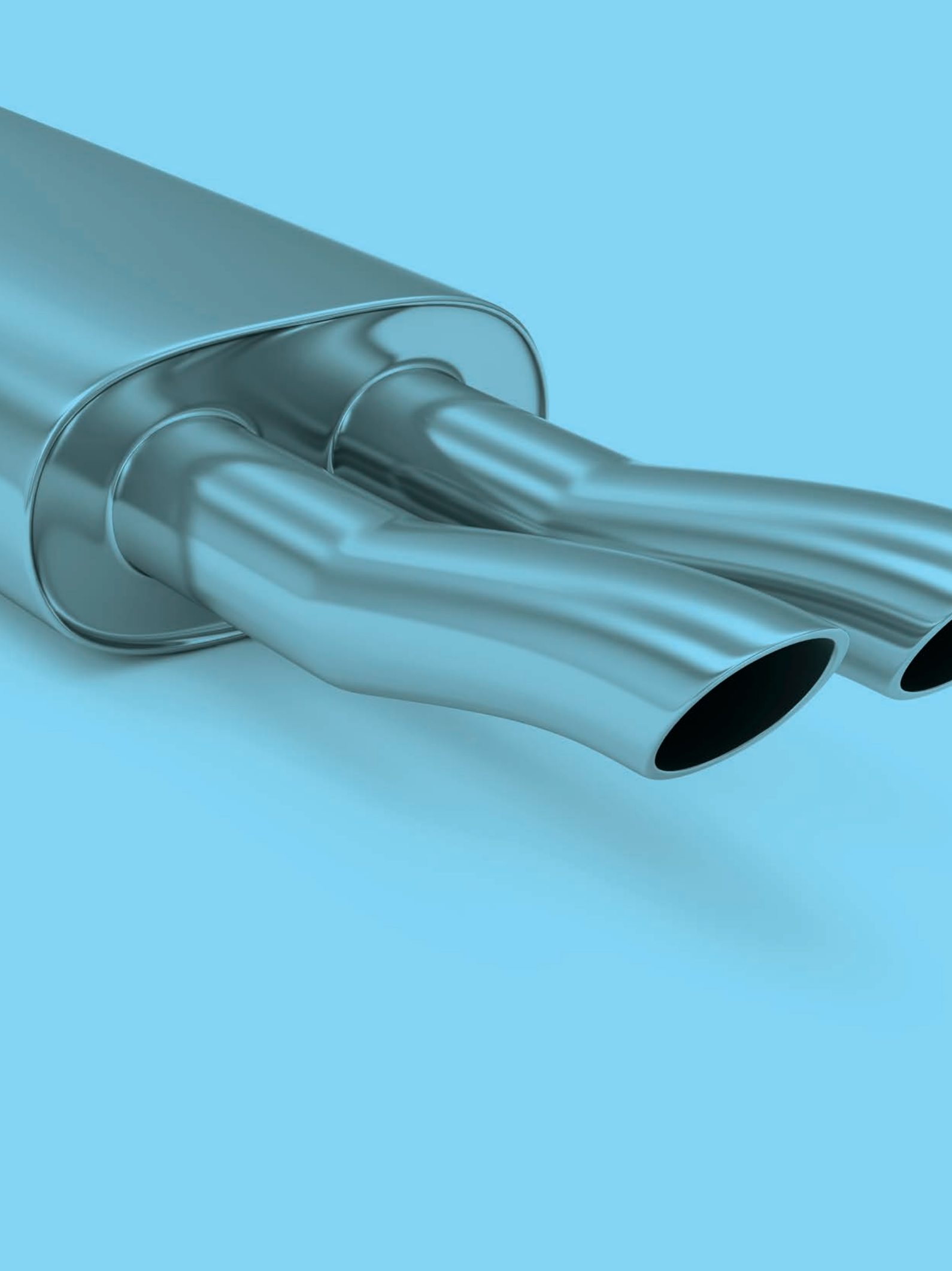


News

In May 2017, Lecturer in Environmental Hydraulics **Soroush Abolfathi** was appointed to the UK Leadership Team for the International Association of Hydro-Environment Engineering and Research (IAHR). IAHR is a worldwide independent member-based organisation of engineers and water specialists working in fields related to the hydro-environmental sciences and their practical application. Soroush, who joined Coventry in 2015, is a committee member of the Institute of Civil Engineers for Coventry and Warwickshire. His PhD at Warwick, studying pollution transport mechanisms in the nearshore region due to the combined effects of wave-currents, received the prize for best oral presentation at the 10th Young Coastal Scientists and Engineering Conference 2014 (YCSEC).

As the Professor in Sustainable Construction Engineering, James Yang has been spearheading pioneering research on multi-scale experimental characterisation and microXCT-image based numerical modelling of complicated fracture in concrete and fibre reinforced composites, previously funded by Royal Society, EPSRC, US Air Force and various industrial collaborators. He has published over 70 high-impact journal papers in related areas, one of which is currently ranked among the top 1% of all the papers published between 2013-2017 in the Engineering discipline by ESI (Essential Science Indicators). Prof Yang's works in this area have attracted over 1000 citations since 2015 according to Google Scholar (total citations over 1980 with H index 27), reflecting their worldwide fast-increasing impact. This has recently attracted external funding from the worlds' oldest agriculture research institute Rothamsted, to collaborate on cutting-edge multidisciplinary research of multiscale fluid-soil interaction problems.

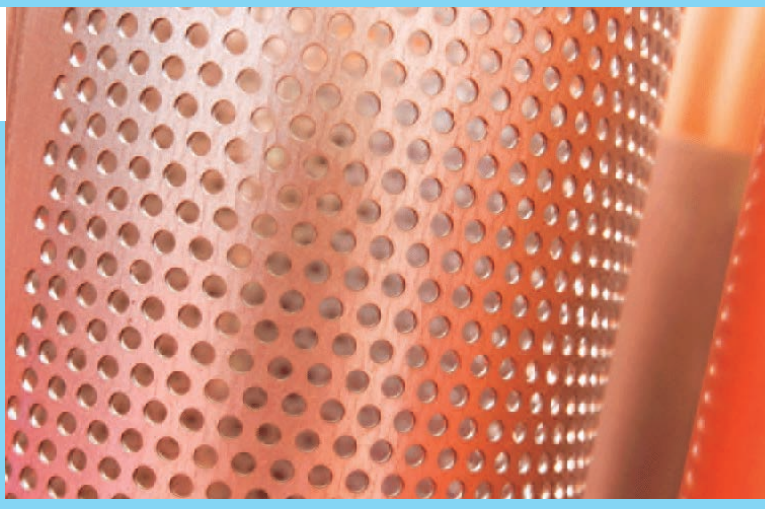
In May 2017, SMEs in Coventry and Warwickshire were invited to the first in a series of free workshops to encourage adoption of sustainable and low carbon technologies. Funded by Coventry and Warwickshire Green Business programme, the free two-day workshop – **Sustainable Techniques for Refurbishment and Construction** – was organised by Lecturer in Building Araz Agha. Targeted at those in the property development sectors, construction, landlords and manufacturers, it provided an introduction into techniques and technologies for energy efficiency refurbishment, as well as guidance on how to incorporate energy efficiency into all business operations.

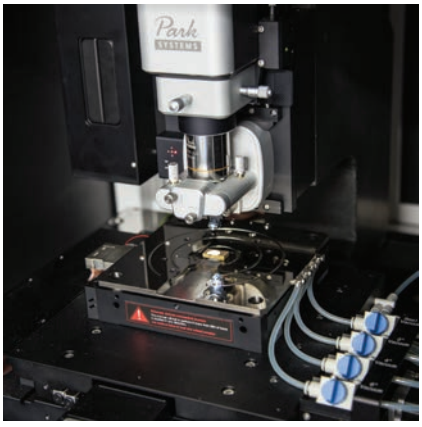


Research Review
Winter 2017

Centre for Manufacturing and Materials Engineering

07





Our research is revolutionising industry: from pioneering cutting-edge processes like laser peening to taking advantage of digital manufacturing technology and precision measurement using fine gems.

The performance of materials is one of the most critical factors in the integrity of a manufactured component or structure. As materials continue to evolve and increase, and they are required to withstand more complex, more challenging, and more aggressive environments, accurate performance data is essential. Underpinned by our mastery of metrology – sought out by the likes of Rolls-Royce, Ford, BMW, Nikon and Airbus – our research supports the full manufacturing lifecycle to maximise productivity and product quality. It focuses on seven distinct areas: functional materials; structural integrity; laser processing; metrology; materials and mechanics; future manufacturing; and welding, joining and 3D printing. We examine the properties and functions of a range of materials, developing novel ways to improve specific qualities, such as strength, weight or durability, or assessing alternatives. Our ground-breaking research explores the latest technologies, surface laser treatment, robotics, sensor technology and the data capture required to capitalise on Industry 4.0, to name just a few.

The Centre brings together fundamental and applied research supported by state-of-the-art facilities and in collaboration with practical manufacturing services to accommodate all levels of technology readiness. Our research is driving future industry trends and improving the UK's competitiveness with the greater productivity achieved from digital manufacturing technologies. Strategic partnerships – like the Institute for Advanced Manufacturing and Engineering (AME) run in collaboration with Unipart – not only ensure close alignment with current industrial and national skills challenges, but also provide clear and immediate impact to help improve productivity and quality.

Recognised as one of the world's leading research groups in measurement and analysis of residual stress, we have been working with Airbus for over a decade and additionally, for the last five years, with the United States Air Force Research Laboratory (AFRL) to refine a laser surface treatment – known as laser shock peening (LSP) – which increases the resistance of materials to failure mechanisms such as fatigue and stress corrosion cracking.

The technique, which uses short laser pulses with high power density, is primarily used commercially to improve aircraft integrity, mainly for jet engine turbine components, and is now being considered in other sectors, such as marine and medical applications. As an example, when the US Air Force encountered design issues with the Lockheed Martin F-22 Raptor, its all-weather stealth tactical fighter aircraft, LSP proved to be the only technological solution which could ensure the safety of the fleet. Tests proved it not only reduced the risk of cracks in the aircraft's thick titanium structure, but also slowed down their appearance and growth.

Coventry's research has advanced our fundamental understanding of how the laser peening process interacts with aluminium alloys, so enhancing the predictive capabilities of our simulation models. The Coventry team has significantly advanced our ability to accurately predict laser-peening-induced residual stresses, which is a critical step in transitioning the technology to our airframes. Our current programs are further developing our understanding of the mechanics of how cracks interact with laser peening stress fields, and how that understanding can be integrated into our predictive models."

Dr Kristina Langer, Technology Advisor, AFRL/RQVS

Led by Pro-Vice-Chancellor Professor Michael Fitzpatrick, the research team has worked on multiple international projects to model, assess and refine the technology readiness level of the treatment, so that it can be deployed in aircraft structures for repairs, or at the point of manufacture to improve overall future performance. The Coventry team has been working with AFRL on a portfolio of research worth over $1 million, in collaboration with Columbia University and the Universidad Politécnica de Madrid, to provide fundamental understanding of the effect of the laser treatment on the material properties, and to improve models for optimising the application of the method in practice. This will help companies like Airbus implement the method in both manufacturing and repair operations, and provide methods for life extension of military aircraft, some of which are now being forecast to have over 100 years of operating life, creating new maintenance challenges the older they become.

Coventry University is also set to play a significant role in H1PERBAT, an ambitious project that will look to realise a unique flexible battery technology for the global automotive sector.

The Centre is part of a consortium led by Williams Advanced Engineering and including key partners Aston Martin Lagonda, Unipart Powertrain Applications, Warwick Manufacturing Group, National Composites Centre, Aspire Engineering and Productiv. The aim is to pool respective expertise and capabilities to address the need for high performance electric vehicle (EV) batteries by establishing a UK pilot facility and creating battery technology with unrivalled module/system performance.

Williams Advanced Engineering is delighted to be working with Coventry University on this pioneering project. By using partners with specific competencies, such as Coventry University's skill set in the area of joining and material engineering, we believe we will be well placed to develop one of the largest independent battery manufacturing facilities in the UK. We also hope that this relationship will help with learning and skills development that can be transferred to students of the future and support bridging the skills gap in this new technology sector."

Senior Commercial Manager Tony Booth, Williams Advanced Engineering

The H1PERBAT project takes an integrated full life cycle approach to remove constraints on capacity, energy density and thermal management of EV batteries at module and system level to realise a step-change in performance for demanding EV applications. The novel scalable pilot facility will look to create an unprecedented UK capability in module/system-level R&D/testing and scalability to medium production volumes to flexibly target UK/global EV OEMs.

Validation of technology/production alongside AML's ground-breaking Battery Electric Vehicle programme will show that disruptive EV battery technologies can enable feasible like-for-like zero-emission alternatives to internal combustion engine cars across all vehicle types and applications.

Harnessing R&D capabilities and the knowledge of staff at the Institute for Advanced Manufacturing and Engineering (AME), Coventry University will be leading on joining and metrology, whilst also completing feasibility studies around production scale automation.

In another exciting new academic and industry collaboration – **Project H-AM (Hydrogen production from animal and human waste)** – we are seeking to invent a combined biological and electrochemical process to generate 'green' hydrogen using agricultural and sewage waste from pig farms and sewage treatment facilities. Launched in April 2017, this one-year £300K feasibility study, funded by InnovateUK and the EPSRC, brings together staff from the Centre, colleagues from the University's Centre for Applied Biological and Exercise Sciences, Midland Pig Producers Ltd, Severn Trent Water Ltd, WRK Design and Services Ltd and Green Fuels Research.

"The development and upscaling of renewable hydrogen sources are a prerequisite if the UK is to effectively help solve the energy 'trilemma' of reducing emissions from electricity generation, improving security of supply and reducing costs."

Principal Investigator Dr John Graves, Research Fellow, Coventry University

While hydrogen offers significant potential as an alternative clean energy source to replace polluting traditional fuels, there is an urgent need to identify alternative renewable sources, since 95% of the world's current supplies of hydrogen are derived from fossil fuels. The project will determine if each of the processes involved can be improved sufficiently to produce an economically, environmentally and socially attractive source of renewable hydrogen. If successful, it could lead to significant electricity generation for the end-users involved from abundant, low value, polluting waste streams, paving the way for the technology to be exploited in other overseas markets and additional industry sectors, such as food manufacturing and processing.

News

In November 2016, **The Manufacturer** magazine named Carl Perrin, Director of the Institute for Advanced Manufacturing and Engineering (AME), as an 'Exemplar' and one of the 'Top 20' manufacturing professionals in the country. Carl, a Chartered Engineer and Fellow of the Institute of Materials, Minerals and Mining, has helped establish AME as one of the most trusted R&D centres in the UK, winning over £6m of funded projects, securing Unipart a new fuel rail project for the Ford Fox engine and a lightweight exhaust system for Aston Martin. He is currently judging nominations for The Manufacturer Top 100 2017.

Professor Xiang Zhang, Head of the Structural Integrity research group, has received the **Helmholtz International Fellow Award 2016** for her service to science and long-term collaboration with the Helmholtz-Zentrum Geesthacht (HZG) Centre for Materials and Coastal Research. The Award provides funding of 20,000 Euros to support continuing collaborations across the 18 Helmholtz Centres in Germany. Professor Xiang's most recent visit to HZG, in December 2016, involved joint research on the damage tolerance of 'refill friction stir spot welding' (RFSSW), typically used for difficult-to-weld alloys on aircraft.

In September 2016, PhD student Apostolos Kordatos presented his research into 'Disordered ionic conductors: A machine-learning approach' at a poster display for the University of Bath's **Third Energy Materials Symposium**.

Systems with structural disorder are considered as promising potential candidates in numerous applications for reliable electrical energy storage in future applications such as the next generation of Li-ion batteries and Solid Oxide Fuel Cells. Apostolos' focus is on the investigation of the atomistic phenomena to efficiently determinate the factors that affect the processes of self-diffusion and conductivity.

Lecturer in Materials and Manufacturing Processes Dr Bo Chen travelled around the world to present his research into the lifetime extension of UK Advanced Gas Reactor (AGR) nuclear power plants operating at high temperatures – at the State Key Laboratory for Advanced Metals and Materials at the University of Science and Technology Beijing and at Key Laboratory of High-Temperature Structural Materials and Coatings Technology at Beihang University in December 2016, and at the School of Engineering at Swinburne University of Technology in Australia in April 2017. Modern technological progress, for example, electrical power generation, demands the use of engineering materials at increasingly higher temperatures. As a result of high temperature exposure, there are changes in material internal state. Dr Chen has been studying the effects of these changes on the mechanical strength of Type 316H austenitic stainless steel with the ultimate goal of developing a mechanistic based high temperature lifetime prediction method.

Coventry is participating in a **Royal Academy of Engineering industry-into-academia initiative** to appoint 28 senior industrial engineers as visiting professors at universities around the country. Bob Shanks, a Chartered Engineer and Chairman of the Imagineering Foundation, will enhance student engagement in sustainable manufacture using practice-based supervision. He brings 30 years of experience managing design and production in a commercial environment, many years spent with Halesowen-based Sandvik. In 2000, he launched the Imagineering Foundation to enthuse young people to become engineers.

Research
Review
Winter 2017

Centre for Mobility and Transport

08

Focusing on human centred design for sport, performance, leisure or travel, we aim to make all forms of movement safer, more efficient and accessible.

We take a fresh approach to the challenges confronting society, by bringing together leading experts from art and design, human factors, engineering and computing into one focused research centre. We consider all aspects of mobility, including the design, styling and development of safe, efficient and accessible transport. Building on existing strengths in automotive and aerospace, we are extending our work in human systems integration, vehicle light-weighting, wireless sensing, occupant protection/comfort and cyber security to rail and marine systems.

Faced with accelerating and improving developments in the high-technology fields of connected and highly automated vehicles and the rapid move away from traditional combustion engines and fuel systems, we have developed impressive new research facilities, including car and aircraft simulators, control engineering laboratories and electrical motor test bench. They complement our existing real-world testing of advanced vehicles – everything from hydrogen fuel cell road vehicles, to flight decks and cabins of the future and next generation super yachts. Among many others, we have previously worked with Jaguar Land Rover to develop 30% lighter seat construction, the Railway Safety and Standards Board (RSSB) to harness the power of data for safety and security systems design, and helped improve the MADYMO software suite, the global ‘industry standard’ for crash simulation and protection.

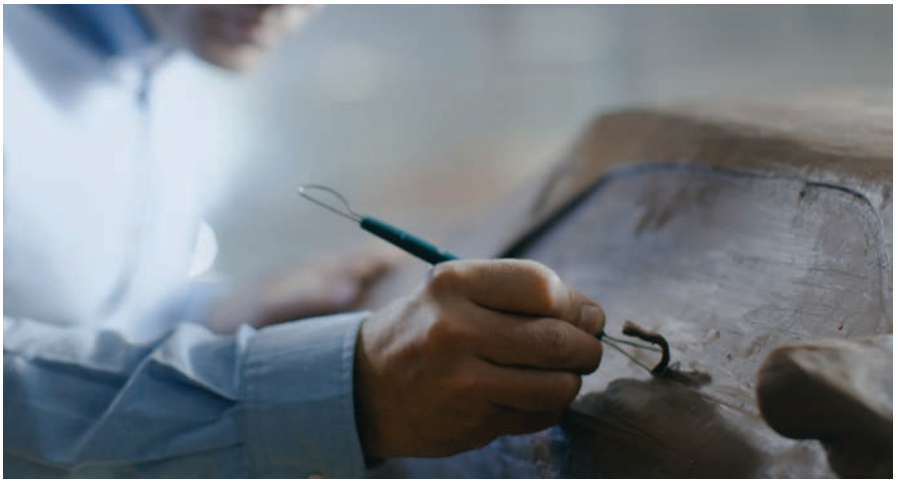
The scope of our research is vast and varied, but is consistent in placing people at its centre: from hybrid vehicles to cyber security, from human factors in transport accessibility to biomechanics and crash protection. Many of the important principles of good design and the science of evaluation are transferrable across the transport modes. Similarly, many of the issues are common because at the heart of road, rail, air and maritime systems we are concerned not with specific technologies, but with the needs and capabilities of people.

Saving lives, improving safety, reducing congestion and cutting harmful emissions are core goals for the Centre for Mobility and Transport. Integrating design and engineering with the growing influence of connectivity, automation, shared and electrified vehicles, our research champions seamless transport systems and is pioneering the development of innovative vehicles using lightweight, efficient and recycled materials. It is therefore fitting that more than 40 years after launching the UK's first undergraduate course in automotive design, May 2017 saw the opening of the University's £7 million **National Transport Design Centre (NTDC)** to teach and inspire the next generation of vehicle designers.

The NTDC, built with support from government and partners, such as Roland, will support UK innovation in the transport industry and provide greater opportunities for designers to join the automotive, aerospace, rail and marine worlds. It comes after our researchers, working with the Automotive Council UK and other industry experts, predicted future shortfalls in the graduate talent pool, such as the reduction in job applications for clay modelling.

By 2050, two-thirds of the world's population is predicted to live in cities; there will be double the number of people aged 60 or older; and the planet will be two degrees warmer. As these trends emerge we are seeing radical shifts in consumer expectations and values. The challenges of moving people and goods between, around and within cities will become ever more complex, and will rely on radical solutions. Vehicles are expected to be comfortable, reliable, safe, economic and ecological; connectivity is taken as necessary, not just desirable. World mobility isn't changing. It has changed. And this is only the beginning."

Director of Strategic Initiatives David Wright, Coventry University



As well as a focus on postgraduate education, research projects in collaboration with industry will also be an important part of the centre's work. Our research is organised under two key meta-themes: the factors which influence vehicle, transport system and infrastructure design; and the tools and technologies for articulation of design in the physical and virtual worlds.

By 2020, it is expected that the UK will produce more than two million vehicles per year in the motor industry alone, creating around 9,000 extra jobs in manufacturing, and potentially 28,000 more across the supply chain. Meanwhile, the International Air Transport Association reported recently that the airline industry currently boasts 63 million supply chain jobs.

The NTDC and Centre for Mobility and Transport will be well-placed to support these sectors to continue to grow by providing first-class facilities for the next generation. State-of-the-art features include: a six-metre long interactive Powerwall which allows users to explore detailed design and engineering concepts in virtual reality; advanced clay milling facilities for creating full-sized physical models of vehicles; and a projection mapping system which can cast digital images onto 3D objects below, helping designers to assess how multiple options would appear on full-scale models.

Our stellar reputation within the automotive sector has also helped to secure our lead involvement in the £7.1 million **UK Connected Intelligent Transport Environment (UK CITE) project**, launched in June 2017 and funded through the UK's innovation agency, InnovateUK. The project, which will create the UK's first fully connected infrastructure on public roads, will establish how technology can improve journeys, reduce traffic congestion and provide in-vehicle entertainment and cyber-security safety services through better connectivity. The aim is to explore how different communication technologies can be used to better inform drivers and facilitate the next generation of automated vehicle systems with the goal of improving safety and reducing congestion.

The UK CITE consortium, jointly led by Visteon Engineering Services Limited and Jaguar Land Rover, alongside Coventry University's Centre for Mobility and Transport and Horiba MIRA, will make recommendations on future transport and communications infrastructure to planners and industry. The project will also provide valuable data to support and encourage further research and design in the UK.

“The benefits of these technologies will only materialise if systems are designed in such a way that people are not only able and willing to use them, but also respond to them as intended. To gain a better understanding of how these systems impact drivers’ behaviour, we will investigate this in our new driving simulator facility, which will allow us to systematically explore the different factors that will affect drivers’ behaviour and technology acceptance.”

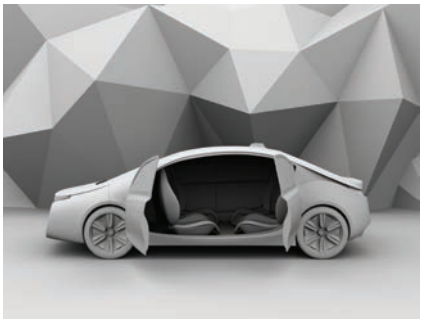
Principal Investigator Dr Olivier Haas, Coventry University

Focusing on human factors and traffic modelling, the Centre’s researchers will work with Horiba MIRA to develop simulation models to investigate the impact of the wider take-up of this technology over time on drivers, the infrastructure capacity of such technology, safety implications and user acceptance issues. This realistic research platform will provide the means to speed up the deployment of a connected and cooperative traffic environment. It will enable automotive, infrastructure and service companies to conduct public trials – as early as next year – of connected and automated vehicles in real-life conditions on 41 miles of five different road types and junctions within Coventry and Warwickshire.

News

Led by Dr Neophytos Lophitis, the Centre is participating in one of the Engineering and Physical Sciences Research Council’s (EPSRC) five flagship **Underpinning Power Electronics (UPE) projects**. Each of the three-year £1.2 million projects focuses on a different aspect of the UPE supply chain with the aim of creating new devices and applications to fully realise the energy saving potential of this emerging technology. Partnering Cambridge, Newcastle and Warwick on the ‘switch optimisation’ theme, we will be developing ultrahigh voltage silicon carbide (SiC) transistors. With voltage ratings over 15 kV, nearly 10 times the voltage rating of any SiC device on the open market, SiC insulated-gate bipolar transistors (IGBTs) have the potential to make considerable gains in efficiency for the National Grid, when connecting off-shore wind power to the network.

Our Cybersecurity team is set to receive a share of £31 million funding being awarded by InnovateUK in the second round of its connected autonomous vehicles competition (CAV 2) as part of a Government drive to make the UK’s CAV testing ecosystem the world’s most effective. We will work with London-based Crypta Labs, named ‘Cyber Security Start-up of the Year’ in 2015, on a £137K one-year project to conduct a systematic security assessment to determine if its quantum random number generating (QRNG) technology for automotive networks is truly random and therefore uncrackable. The team has also joined forces with Cardiff University to help ensure the UK is primed to respond to policy challenges posed by the ever-growing threat of cyber-attacks. Human judgments about threat, risk, mitigation and consequences are vital in shaping future regulation, policy, public and private sector initiatives. The £500K EPSRC funded project will see experts from the two universities work together to make recommendations to the UK’s policy advisers on future cybersecurity decision-making processes. They will explore how UK policymakers are currently selecting, assessing and prioritising evidence, which comes from a wide range of sources including official threat intelligence, industry reports and academia. The project will examine the human dimension of cybersecurity, but will shift focus away from the ‘end user’ – for example, potentially vulnerable businesses – towards the civil servants who are instrumental in providing short and long-term policy advice regarding cyber threats.



The Centre has been awarded €675K Horizon 2020 funding to join 16 partners as part of the €8 million **SIMUSAFE project**, which is led by ITCL from Spain. It is well known that the majority of road traffic accidents are caused by human error; improving road safety therefore requires a greater understanding the individual and collective behaviour of drivers, passengers, cyclists, pedestrians and their interaction with safety-related systems and services. Whereas simulation already provides reliable, safe, and efficient environments to research road safety behaviour, its validity may be limited by artificial and unrealistic behaviour of road users within simulated environments. The goal of SIMUSAFE (SIMUlator of Behavioural Aspects for SAFEr Transport) is to develop realistic multi-agent behavioural models in a transit environment and gather data not available in real world conditions. Our team will develop a multi-actor (motorbike-bicycle-car) simulation facility and conduct extensive simulator trials to, for example, assess the impact of cardiovascular medicines on cognitive functioning and risk-taking behaviour. The project outcomes are expected to not only influence driver training curricula but also road transport policy.

As a member of the Intelligent Mobility Partnership – Midlands Competence Centre of Excellence (IMPART), we were heavily involved in the two-day **2016 Midlands Intelligent Mobility Conference** launched on November 31, 2016. Our sessions covered 'Accessibility and intelligent mobility'; 'Cyber Security: The Biggest Challenge Facing Intelligent Mobility?'; and 'Opportunities in New Mobility, How Business Can Engage and Benefit'. Running 2015-2018, IMPART is a research partnership between Coventry, Loughborough, De Montfort and Nottingham Trent universities to increase mobility, improve safety and enhance user benefits while simultaneously reducing pollution, consumption and congestion. We are collectively engaged in £14.6 million of research activity from various sources, including the InnovateUK, EU, ERDF and EPSRC, as well as the private sector.

In June 2017, Senior Lecturer in Human Factors Dr Dale Richards presented in Denver at **Aviation 2017**, organised by the American Institute of Aeronautics and Astronautics (AIAA) Aviation Forum, chairing a panel session of speakers from NASA Langley, MIT and the MITRE Corporation on the nature of human-autonomy interaction within the 'Demand for Unmanned Symposium'. Dale, who recently provided guidance for NATO nations on sense and avoid systems for UAVs, has been invited to join the Specialist Team for Human Factors, working alongside the United States Air Force, NASA, BAE Systems and Defence Research and Development Canada.

In February 2017, Principal Lecturer Dr James Shippen was invited by the Royal Ballet and Institute of Physics to present to a sell-out seminar in London's Royal Opera House, having analysed the injury risks of ballet using the **Biomechanics of Bodies (BoB) musculoskeletal modelling system**. BoB, which calculates anatomical trajectories, muscle loads, joint and ground reaction forces, is used globally for applications as diverse as medical devices optimisation, sports technology, automotive design, ergonomics and patient rehabilitation. It revealed loads as high as 14 times body weight occurred within the dancers' ankle joints.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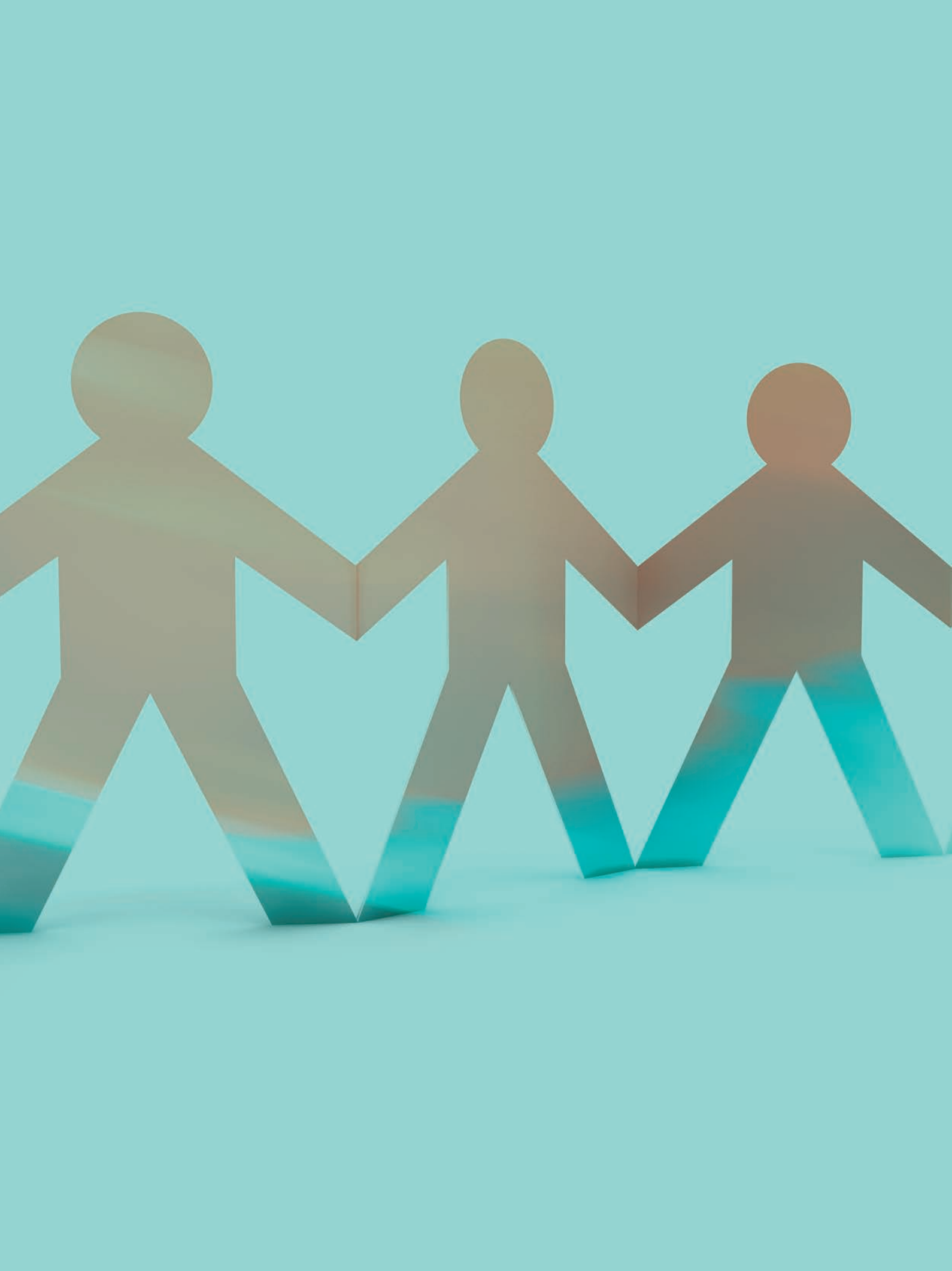


Research Review
Winter 2017

Our people

09

Led from the top by the Pro-Vice-Chancellor, our researchers – many world-leading experts in their field – possess a wealth of commercial, industry and academic experience, generating new knowledge to create a better future for us all.

Steve Austin, Head of the School of Energy, Construction and Environment

Steve Austin has over 15 years of teaching experience, five spent in further education before he joined Coventry University in 2006, where he gained his MSc in Management for Construction. Steve's research interests focus on the pedagogy of teaching within Built Environment disciplines, particularly group work and virtual processes. He has been invited to present at numerous international learning conferences and involved in several projects that look at the effective use of peer and self-assessment in teamwork, the use of virtual teams for group projects and virtual reality construction simulation training. In addition, he has been and continues to be involved in European projects that look at improving the English language skills of European construction workers. In September 2016, his work was published as part of the Royal Institution of Chartered Surveyors (RICS) COBRA 2016 conference, held in Toronto, Canada, the world's leading annual construction, building and real estate research conference. In January, the Journal of Information Technology in Construction featured his collaborate research to raise awareness of Building Information Modelling (BIM) and increase training opportunities in the Middle East.

Supply chain risk management is one of the most important issues for business, attracting the attention of both academics and practitioners in the supply chain area. In an increasingly interconnected and globalised world, as well as traditional 'physical' supply chain issues, such as shortage of raw materials or production plant failures, companies must contend with the impact of social and environmental decisions along supply chains.

Dobrila recently carried out a joint EPSRC research project with the universities of Bristol, Nottingham and Strathclyde in the resilience and robustness of dynamic manufacturing supply networks. It develops and applies various mathematical methods to real-world supply chain problems with a view to improving sustainability in supply chain performances in the presence of various risks and uncertainties, providing greater insight into areas such as cost, robustness and flexibility. She has also been working as a co-partner of an FP7 funded project on **'Intelligent Systems Configuration Services for Flexible Dynamic Global Production Networks'**. The research identified, modelled and analysed various types of risks which impact and propagate through complex global production networks, proposing a novel risk management framework to support decision maker's analysis of uncertainty in those parameters which have the highest impact on global production networks' revenue.

Professor Dobrila Petrovic joined Coventry University in 1998 and became Professor of Optimisation and Control in 2009. Her main research areas include modelling and treatment of uncertainty, fuzzy evolving systems, fuzzy rule-based causal maps and fuzzy optimisation in domains such as supply chain management, inventory control, reverse logistics, production scheduling, scheduling in health care and forecasting. She has carried out research on several research projects awarded by the EPSRC in decision support and optimisation of supply chain management and control, as well as FP7 – EU (European Union) grants on supporting highly adaptive network enterprise collaboration and risk management in global production networks, and DSTL (Defence Science and Technology Laboratory) in the area of system modelling under uncertainty. Dobrila has published nearly 50 papers in peer reviewed journals and chapters in edited books and nearly 100 papers in proceedings of international conferences. She is an Associate Editor of International Journal of Systems Science, International Journal of Systems Science: Operations & Logistics, IMA Journal of Management Mathematics. According to the ranking carried out by Prof Tang et al. from UCLA, Anderson School of Management, University of California, Los Angeles, two of her papers are among the top 10 'most cited' and of 'most prestige' in the field of supply chain risk.

In the manufacturing sector, we are promoting the benefits of additive manufacturing (AM) – better known as **3D printing**. AM offers a range of logistical, economic and technical advantages when compared with conventional manufacturing processes; for example, reduced time-to-market and improved buy-to-fly ratio from lightweight components in the aviation industry. However, its widespread adoption for metallic engineering parts and components remains a challenge – there is a lack of knowledge and concerns about engineering structural integrity.

Capitalising on Coventry's reputation as world experts in the study of materials structural performance for safety critical applications, the Centre for Manufacturing and Materials Engineering is leading a £100K EPSRC funded project to enhance the confidence of both manufacturers and end-users that AM-built materials are at least as safe and reliable as those produced by the traditional machine-from-solid processes. Running until January 2019, it pools the experience of the UK's world-renowned AM manufacturing technology centre (MTC), Rolls-Royce Plc, Lloyd's Register Foundation, STFC Rutherford Appleton Laboratory, the universities of Oxford, Manchester and Leicester, and the East China University of Science and Technology. It will develop an experimentally-validated, microstructure-based model with the capability to predict the fatigue deformation and damage initiation in AM-built Ti-6Al-4V, the most prevalent titanium alloy in aerospace applications. The project has significant potential benefits for current and future AM end-users ranging from aerospace, nuclear and automotive, as well as biomedical industries. By providing in-depth knowledge about of structural integrity of AM-built parts and how AM-built materials perform in demanding environments, it will help to remove one of the hurdles for successful commercialisation of AM technologies worldwide.

Bo Chen, Lecturer in Materials and Manufacturing Processes

Bo joined Coventry in September 2015. He has worked previously as a Research Associate in the School of Materials, The University of Manchester, and as a Teaching Associate and Research Assistant in the Department of Mechanical Engineering, University of Bristol before that. Bo has degrees in Materials Science and Engineering from Beihang University in China (BSc) and in Mechanical Engineering from University of Bristol in the UK (PhD). His research interests are in the use of both experimental and modelling techniques at different length-scales to develop a mechanistic understanding of materials performance and predict the lifetime of engineering components operating under extreme environments (creep, fatigue and oxidation). To date, he has published 13 journal papers and 15 conference papers.

Infrared remote sensing of volcanoes

Volcanic activity consists of the transfer of heat from the interior of the Earth to the surface. The activity observed and expressed in the thermal signature relate directly to the geological processes underway.

For example, a fresh lava flow or an active lava lake. It could be subtler, such as a degassing surface or warmed crater-lake. Such activity can be observed from space, using the thermal sensors present on many Earth-orbiting satellites. For over 50 years, scientists have utilised such sensors and are now able to determine the sort of volcanic activity being displayed without hazardous and costly field expeditions. One such scientist is Dr Matthew Blackett, who leads the Faculty's Environment and Water Research Group. He analyses the large datasets to better understand the activity at a volcanic site to determine a volcano's status and predict future activity. Acknowledged as a key expert, his work assessing the theoretical basis of the discipline and its history was recently published in the April edition of the Journal of Imaging. Much of Matthew's remote sensing research can be conducted from anywhere, although he has been lucky enough to conduct fieldwork on places as varied as Hawaii and Central America. In recent years, Matthew's research has focused on volcanic activity in Indonesia – one of the most prone volcanic regions globally.

Dr Matthew Blackett, Senior Lecturer in Physical Geography and Natural Hazards, completed his PhD at King's College, London, where he utilised his computing and geographic skills in the remote sensing of earthquakes and volcanoes. He subsequently lectured both there and the London School of Economics. He joined Coventry in 2010 and received a research fellowship. His research interests focus on examining how we can monitor and model hazardous events remotely - without putting researchers at risk, while providing data useful for hazard and environmental change management. In February 2017, he was a keynote speaker at the International Conference of Indonesian Society for Remote Sensing and, in July 2017, was a visiting lecturer in Natural Hazards at Sichuan University, China. Matthew has held Research Fellowships at the University of Alaska Fairbanks and the University of Hawaii Manoa and is a member of affiliate faculty at the College of Natural Science and Mathematics and the Department of Geoscience, University of Alaska Fairbanks.

Developing the next generation of flight decks

Flight crew are central to aircraft operations and the optimisation of the pilot interfaces is vital for safe and efficient flight. Back in 2014, Coventry partnered with GE Aviation, BAE Systems and University of Southampton to design the next generation of flight decks, one of seven aerospace research projects supported by InnovateUK, worth £60 million in total aimed at helping Britain remain at the forefront of the global aerospace market. Expanding on the earlier project and now also incorporating Rolls Royce in the consortium, Coventry is now taking part in a follow-on project, also supported by InnovateUK. The Open Flight Deck (OFD) project is valued at more than £23 million in total. The flight deck technology will need to co-opt the latest developments in computing platforms, crew aids and pilot interaction technologies, but deliver these improvements in a cost-competitive manner as airline operators demand reduced costs. The project will also develop new crew aids to both optimise flight crew work load and improve situational awareness while extending safe operations.

The research and development will integrate new and existing applications to add functionality, simplify the flight deck, reduce error potential and harness big data opportunities.

Professor of Human Factors Don Harris has spent three decades providing expert guidance on Human Factors in the aerospace, automotive and defence industries. He was a member of the FAA/EASA Human Factors Certification Working Group that developed new certification rules for civil aircraft flight decks and accident investigator attached to the Division of Army Aviation. A Fellow and Chartered Member of the Institute for Human Factors and Ergonomics and a Chartered Psychologist, he is a member of the Aircraft of the Future Specialist Advisory Group at the Aerospace Technology Institute; the Human Factors Special Adviser on the National Air Traffic Services Safety Review Committee; and a Visiting Professor at Shanghai Jiao Tong University. Don was awarded the 2006 Hodgson Prize by the Royal Aeronautical Society and was part of the team that received the 2008 Ergonomics Society President's Medal. He has been chair of the Engineering Psychology and Cognitive Ergonomics conference series since 1996, published almost 300 book chapters, journal and conference papers and edited or written 27 books on Human Factors.

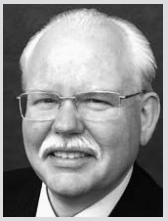
Improving thermal comfort in schools

Global environmental and energy concerns have led to a rapid growth in mandating the construction of more energy efficient buildings and dwellings in 2013, Dr Montazami has undertaken a range of consultancy roles on joint projects between Coventry University and various enterprises, which have provided her with an in-depth knowledge of children's thermal comfort. Her research is particularly of interest to architects, teachers, engineers, school administrators and policy makers.

It has revealed that children's threshold comfort temperatures are at least 3°C lower than teachers. Based on this, she has subsequently developed an algorithm to predict children's thermal dissatisfaction rate – both overheating and cooling – which is being used to help designers and teachers deliver and control classroom environments in a way that maximises educational performance. Her study also demonstrated that the socio-economic background of children is likely to influence their perceptions of comfort in primary school classrooms and, in turn, the behaviour that they adopt to adjust their individual comfort. Thermal experiences at home are likely to be reflected in a child's thermal perception in the classroom.

Research Fellow and Lecturer Dr Azadeh Montazami joined Coventry University in 2011. A leading expert on thermal performance with a focus on school buildings, she is currently serving on a Department of Education (DoE) Advisory Board to revise guidelines on ventilation, thermal comfort and indoor air quality in schools, known as 'Building Bulletin BB101'. The health and performance of students and teachers are influenced by the internal environment of school buildings; providing good environmental conditions with minimum energy usage is an ongoing concern. Azadeh's research spans sustainability in architecture with a focus on providing good environmental conditions in buildings, and investigating the obstacles that building professionals are faced in this context. She teaches Environmental Design to undergraduate architecture students at Coventry University, and supervises research students, masters students and undergraduate students, with the theme of sustainability and low energy building. Azadeh has collaborated with other researchers and published various papers with focuses on indoor environment, occupants' satisfaction and users' behaviour inside buildings.

New appointments



In December 2016, **Professor of Geomaterials Mark Tyrer** was appointed as the Executive Director of the Centre for the Built and Natural Environment. A Chartered Scientist, Mark is a geochemist and cement chemist with interests in resource efficiency and environmental protection. He brings a wealth of commercial and academic experience, having worked as an independent scientist, as well as guiding research in a range of professional bodies and several UK universities. He spent 10 years working with the Mineral Industry Research Organisation (MIRO) as a Research Manager, providing technical guidance and advice to a range of industrial clients. His work at Imperial College and later independent practice involved work with BP; Shell; Britannia Refined Metals; the Health and Safety Executive; Castle Cements; Tarmac; The National Physical Laboratory; and others. Since 2012, Mark has chaired the Cementitious Materials Group for the Institute of Materials, Minerals and Mining (IOM3) and currently serves on the British Standards Committee B/516 (Cements) and on the Concrete Society Expert Working Group on the Analysis of Hardened Concrete. He also previously chaired the Construction Materials Group for the Society of Chemical Industry. He was elected as a Fellow of the Geological Society of London in 1993, a Fellow of the Institute of Materials Minerals and Mining in 2003, a Fellow of the Mineralogical Society of Great Britain and Ireland in 2013 and to its Council in 2014. He joined Coventry as visiting Professor of Construction Materials at Coventry in 2008, receiving the IOM3 Pfeil award (2011) for work on CO2 reduction in the cement industry. He maintains strong links with University College, London, the National Physical Laboratory and Imperial College, London, where he is currently an Honorary Senior Research Fellow. In 2015, he was elected as a member of the Mathematics Advisory Panel at the National Physical Laboratory with whom he has worked for 15 years.

Professor Jonathan Lawrence joined the University as Head of the Laser Engineering and Manufacturing Research Group within the Manufacturing and Materials Engineering Faculty Research Centre. He has been active in laser materials processing and associated fields of research for more than 20 years. His main research contribution has been around laser surface engineering science and technology, with emphasis on using lasers for material's wettability characteristics modification, improving the biocompatibility of materials and laser shock peening (LSP). Professor Lawrence has also developed new science and approaches to bonding and welding of a wide range of materials, as well as a technique for the laser ignition of gas turbines. He has presented and published widely in these areas – with eight books, 10 book chapters and over 140 international journal papers. His work has yielded six patents relating to the novel use of lasers and laser materials processing. Professor Lawrence is Editor-in-Chief of Lasers in Engineering and the International Journal of Laser Science: Fundamental Theory and Analytical Methods. He serves on the editorial boards of three international academic journals and is a Steering Committee Member for the Association of Industrial Laser Users (AILU).

Dina Shona Laila took up her post as Senior Lecturer in Instrumentation and Control in August 2016, having previously worked at several other prominent universities such as the University of Southampton and Imperial College London. As part of the Centre's Control Engineering expert, she has been working on various research projects on control theory and applications. Her main research interest is in the area of nonlinear control and its various applications.

Dina has been among very few most active female researchers in control engineering field in the UK. Her PhD thesis, where she has established an important framework on design and analysis of nonlinear sampled-data systems, is currently used as a main reference by researchers in this field. Her strong background in control theory has allowed her to apply various control design and analysis approaches to various applications, both in simulation and in hardware implementation or embedded systems applications. She has worked on various research projects on practical control applications to mechanical, electro-mechanical, power electronics, automotive, air vehicle and health rehabilitation. Her research works also span to the field of nonlinear identification and systems monitoring, particularly for power systems.

A Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), she actively serves on the IEEE Control Systems Society Conference Editorial Board. She is also an active member of the Editorial Board for the European Control Conference, an Associate Editor for the European Journal of Control, and also serves as a member of Technical Committee for the Adaptive and Learning Systems of the International Federation of Automatic Control (IFAC TC 1.2). She also serves as a Reviewer for the EPSRC and other research funding bodies in the UK and abroad.

Former Research Engineer for TRL, **Huw Davies** moved from Cardiff University to become Senior Lecturer in Automotive Systems Engineering. His experience covers motorsport engineering, injury biomechanics, low carbon vehicle design and safety. Huw presented on the challenges and opportunities of lightweight vehicles at the first World Light Electric Vehicle Summit in Barcelona in September. He recently hosted a workshop on the 'Experiences and prospects of electric freight vehicles in the UK' for the International Energy Agency's Hybrid and Electric Vehicle Technology Collaboration Program (HEV TCP).

Dr Davies' primary interest is in the development of technical policy / regulatory frameworks, more specifically the establishment of the evidence base, identifying performance requirements and developing assessment methodologies. His initial focus was on promoting innovation in vehicle structural design to improve road safety, but has since extended to include the innovative vehicle technologies required for climate change mitigation. Dr Davies sees his role in collaborative research as bringing innovation to the way that we evidence, measure and assess performance of new vehicle technologies, thus ensuring that technology is developed in a direction that provides a high benefit ratio.

Priorities for research at Coventry University

Coventry University is known for delivering research focused on 'excellence with impact' where we can truly make a difference.

Combining a portfolio of different disciplines, we are committed to improving lives through the research we carry out. Much like the city of Coventry itself, we have a successful history of innovating solutions and techniques that add value to our economy – whether through knowledge transfer or commercialisation of a new idea – and we remain at the forefront of intelligent thinking with our cutting-edge research across a variety of fields.

As part of our work during REF2014, our 'Grand Challenge Initiatives' focused our research efforts on seven key global issues which explored the following; sustainable agriculture, an aging society, low carbon vehicles, integrated transport and logistics, low impact building, digital media and human security.

Harnessing the latest science and technology to pioneer new and more intelligent ways of doing things remains a cornerstone of our research. We will also reflect our core value of 'being global in our outlook and being impactful in all we do'.

Building on the success of REF2014, in which 61% of our research was rated as 4* or 3*, the highest classifications achievable, we wish to be nationally and internationally recognised within the academic, business and government communities as undertaking research of the highest quality that has impact beyond academia, yielding economic, social and cultural benefits.

Expanding on our existing large-scale strategic business partnerships, we will extend our relationships with world-leading institutions (both in the UK and overseas) to drive high-quality, high-impact research and diversify our income from business and international programmes.

Excellence will be defined as a combination of originality, significance and rigour: the triad that lies at the heart of global peer esteem. Impact will be defined as economic, social, cultural, policy-influencing, or practice-enhancing, depending on the nature of the disciplines.

To achieve this, our research strategy is based around five pillars:

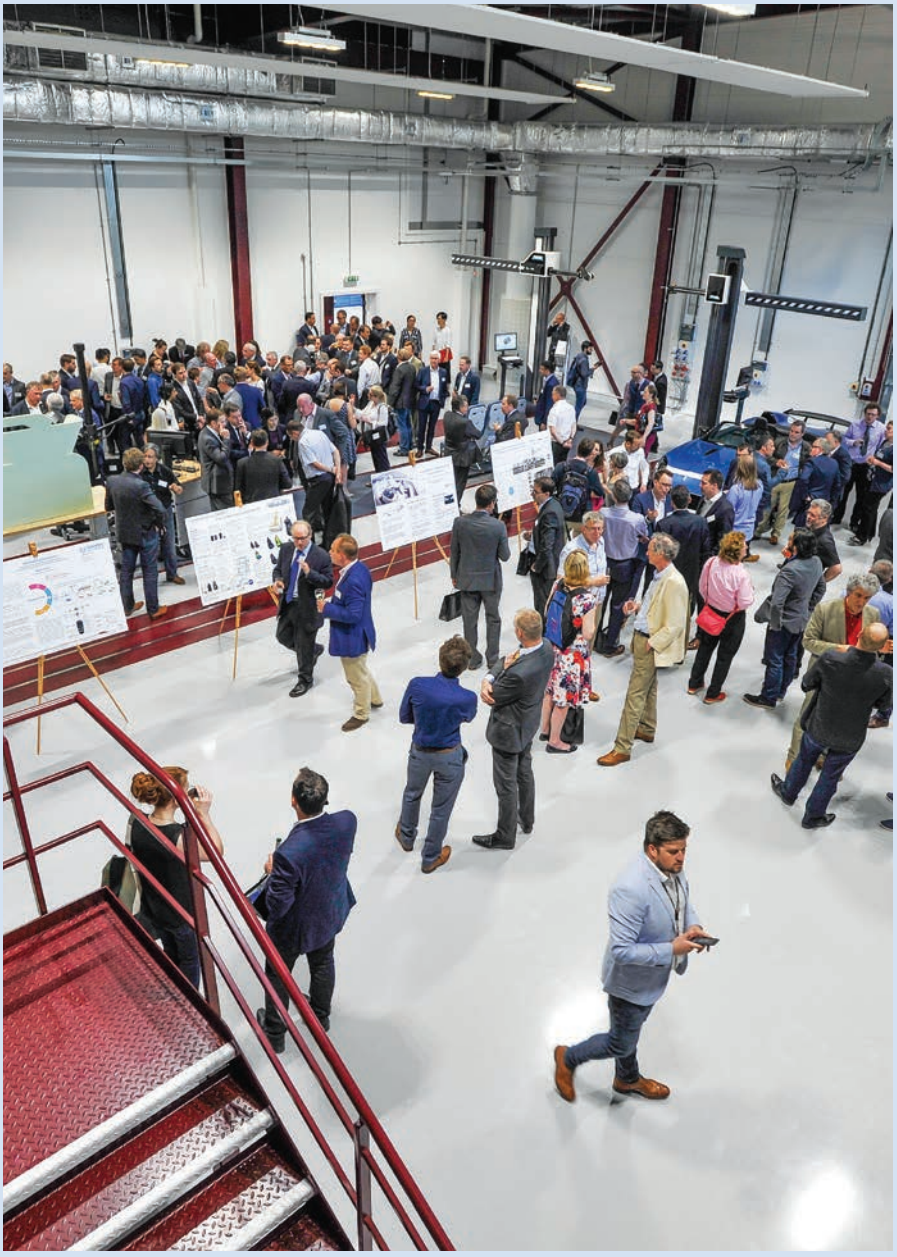
- Research informed teaching
- University and Faculty Research Centres
- Career development and progression for research staff
- Partnerships with world-leading institutions
- Diversification of research income.

Professor Richard Dashwood, Pro-Vice-Chancellor (Research), Coventry University

Professor Richard Dashwood joined Coventry University early in 2016 as deputy vice-chancellor (research) and he continues his research as professor of engineering materials.

He started his career at Imperial College London where he spent 19 years as a researcher and academic in the Department of Materials before joining the University of Warwick as the Professor of Engineering Materials in the Warwick Manufacturing Group. His leadership roles at Warwick included becoming Academic Director of Warwick Manufacturing Group and the Chief Technology Officer for the WMG High Value Manufacturing Catapult centre; he established research relationships several major companies, including Jaguar Land Rover, Tata Steel, Cummins and Tata Motors.

He has been involved in the UK Automotive Council for five years, first as a member of the Lightweight Structures Working Group and more recently as a member of the Manufacturing Technology Working Group. He is a member of the Advisory Board Member for the Knowledge Intensive Product Realisation (KIPR) project at Jönköping University, Sweden, and chairs the Strategic Advisory Board for the Designing Alloys for Resource Efficiency (DARE) EPSRC project based at Sheffield University. Currently, Richard's main research focus is the application of mechanics, microstructure and electrochemistry of materials to solve the advanced manufacturing challenges involved in realising low carbon mobility.



The future for research in the Faculty

Within the Faculty of Engineering, Environment and Computing, our goal is to generate world-leading scientific discoveries for the good of humanity.

People lie at the heart of our research strategy: we strive to create an open, effective, supporting and rewarding research culture that produces opportunities, raises motivation, engages and retains staff. Long-term, we hope to double the postgraduate research cohort and increase our engagement with Research Councils and other funders.

In 2016/17, we enhanced the support given to academics by instigating an in-depth training programme to support early career researchers (ECRs) submit their first EPSRC bid. So far, around 30 ECRs have received the training and the success rate over the year, on awards, has been 75%. In total, the Faculty has invested over £0.5 pump-priming to enable ECRs to establish new research networks and conduct experimental work with appropriate facilities and equipment. For the fourth year in a row, we have organised and delivered the Summer Research Internship Programme, enabling over 140 undergraduate and postgraduate taught students to spend two months working on a variety of research projects.

The past year has seen the launch of an exciting strategic partnership and co-tutelle PhD programme with Deakin University, a five-star rated institution in Australia, which shares our vision of research with impact and working with industry to solve real problems. Providing an unparalleled international experience, research students will work alongside world-class researchers across two continents and be awarded two degrees. Four new PhD students enrolled in May 2017 and a further four will join us next year.

Moving forward, our aim is to strengthen existing relationships in the UK, Europe and the rest of the world, while embarking on new strategic, international collaborations that increase esteem and promote high quality research. We want to deepen our industrial links and promote long-term strategic partnerships that are multi-faceted.

We will continue to pursue scientific breakthroughs and technological advances, developing world class engineering solutions to global problems. We will focus on:

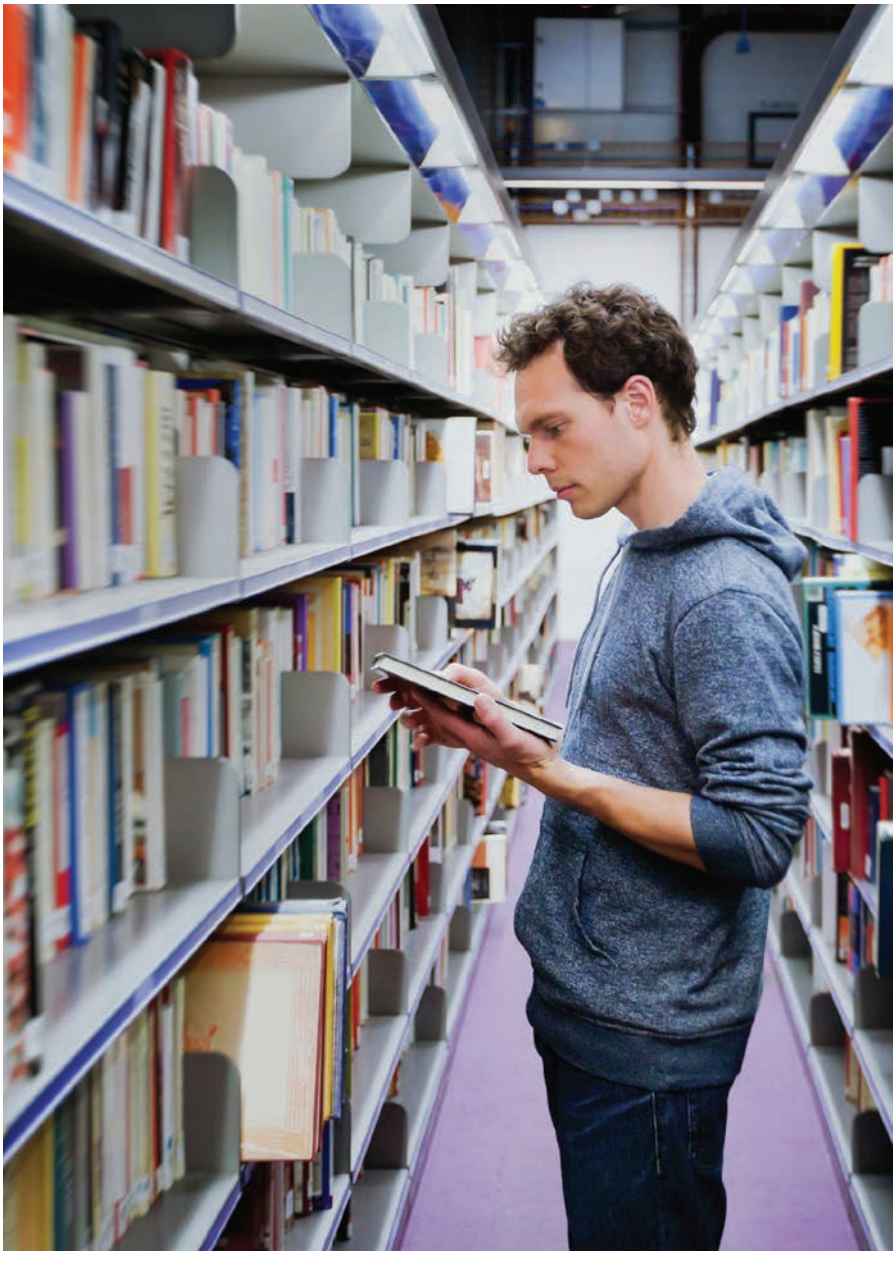
- Sustainability for environments and communities
- Energy neutrality for the built environment
- Materials and processes discovery and utilization for the manufacturing industry
- Understanding and measurement of complex flows
- Future cities design from transportation networks to future proof vehicle design.

Associate Dean (Research), Engineering, Environment and Computing

With a research career spanning over 20 years, Elena established and led research into the Internet of Things (IoT) at Coventry, prior to taking on the role of overseeing the Faculty's research as an Associate Dean. She holds a PhD in Intelligent Sensor Systems from Coventry University in 2000 and became a Professor of Pervasive Computing in 2009.

Over the course of her career, Elena has accrued a sturdy academic reputation in smart sensing systems. She is an active disseminator of research both to the academic community and industry and is actively involved with government organisations to promote the knowledge transfer from academia to industry and society at large. Her work draws sponsorship from the UK Research Councils, the British Council and directly from industry, supporting several research staff and graduate students. She is a member of the EPSRC College of Peers, and an expert advisor for the European Commission on wireless sensing and IoT.

Her current research centres on the development of deployable Wireless Sensor Networks (WSNs), focusing on the use of sensing technologies for improving people's life and towards the adoption of wireless technologies for fulfilling UK's carbon footprint reduction targets in transportation and the built environment. This includes: human safety enhancement through physiological sensing and risk prediction; buildings monitoring and occupant empowerment; and energy efficient air and road transportation.

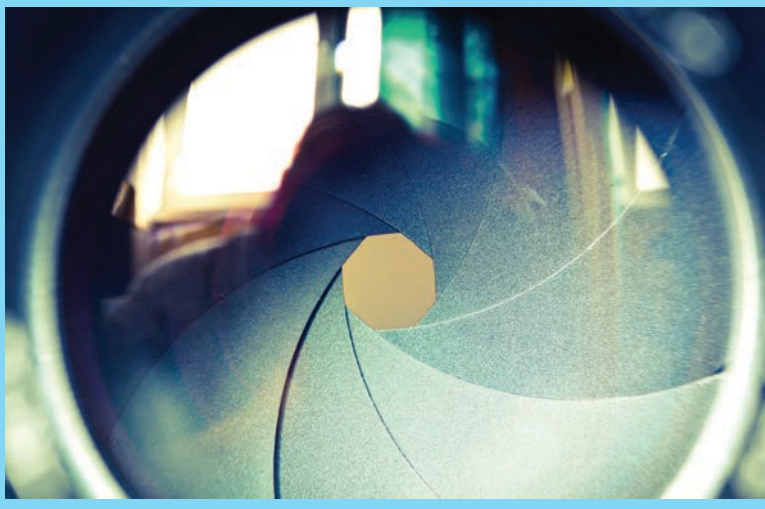


James Simester, Technology Director, Institute for Advanced Manufacturing and Engineering (AME)

Research Review

Winter 2017

Faculty of Engineering, Environment and Computing



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