



University of
Nottingham

UK | CHINA | MALAYSIA

Faculty of Engineering

Research and
Knowledge Exchange

Annual Report 2018



Karl Gregg, Research Technician



George Thomas, EngD student in the Cleaner Fossil Energy and Carbon Capture Technologies Group Laboratories



Angela Aston, Equality, Diversity and Inclusion Officer



Rachel Brereton, Head of Research Operations



Dr Ifty Ahmed, Advanced Materials Research Group and Lead of the Researcher Career Development Group



Mark East, Senior Research Technician



Neonatal Transport Team, Bioengineering Research Group



Dr Clement Uguna, Research Fellow in the Cleaner Fossil Energy and Carbon Capture Technologies Group



Professor John Andrews with members of the Resilience Engineering Research Group



Lauren North and April Exhall-Black, Human Resource Officers



Matthew Kessler, PhD Student, Geohazards and Earth Processes Research Group



Dingming Liu and Fedaa Abd-AlHamid, PhD students in the Cleaner Fossil Energy and Carbon Capture Technologies Research Group



Dr Manuel Chiachio Ruano, Research Fellow, Resilience Engineering Research Group



Centre for Additive Manufacturing Laboratories at the Advanced Manufacturing Building



Dr Ben Coomber, Richard Adams and Rob Thomas, Senior Research Operations Officers



Dr Robin Irons, Cleaner Fossil Energy and Carbon Capture Technologies Research Group



Fedaa Abd-AlHamid, PhD student in the Cleaner Fossil Energy and Carbon Capture Technologies Laboratories



Researcher Career Development Group: Dr Chris Hill, Dr Ifty Ahmed, Dr Orla Williams, Dr Omar Ramadan and Dr Mikhail Matveev



Impact Development Team: Vicki Ball, Rachael Duthie, Deanne Hewson and Dr Jon Collett



Professor Tim Heath, Dr Peter Rutherford and Professor Dr Robin Wilson, Environment, People and Design Group



Mark Hardy, Centre for Additive Manufacturing Research Technician



Dr Claudia Fecarotti, Research Fellow, Resilience Engineering Research Group



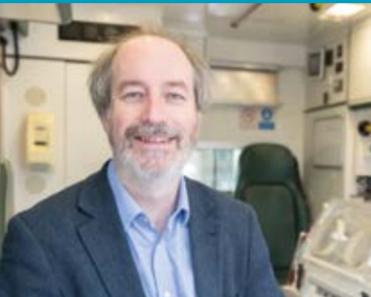
Dr Michael Kent, Research Fellow, Environment, People and Design Research Group



Hayley Foster, G2TRC Project Manager, Gas Turbine and Transmissions Research Centre (G2TRC)



Dr Juan Chiachio Ruano, Research Fellow, Resilience Engineering Research Group



Professor Donal McNally, Head of the Bioengineering Research Group



Phil Bennett, Senior Technical Manager



Professor Stuart Marsh, Faculty Director of Postgraduate Research and Head of the Geohazards and Earth Processes Research Group



Dr Tao Yang, Power Electronics, Machines and Control Research Group



Faculty of Engineering Research Office: Dr Mirabelle D'Cruz, Richard Adams, Karen Attreed, Dr Ben Coomber, Dr Vicky Hards, Rachael Duthie, Deanne Hewson, Rebecca Stokes, Dr Jon Collett, Hayley Revill, Rob Thomas and Diane Karim



Joseph White, Centre for Additive Manufacturing Research Technician



Members of the Neonatal Transport Team, Bioengineering Research Group

Contents:

Introduction - Professor Sarah Sharples	6
Our Achievements	8
Faculty Research Portfolio	10
Faculty of Engineering Research Groups	12
Advanced Manufacturing Technology	14
Advanced Materials	16
Architecture, Culture and Tectonics	18
Architecture, Energy and Environment	20
Bioengineering	22
Bioprocess, Environmental and Chemical Technologies	24
Centre for Additive Manufacturing	26
Centre for Structural Engineering and Informatics	28
Cleaner Fossil Energy and Carbon Capture Technologies	30
Composites	32
Environment, People and Design	34
Fluids and Thermal Engineering	36
Food, Water and Waste	38
Gas Turbine and Transmissions Centre	40
Geohazards and Earth Processes	42
George Green Institute for Electromagnetics Research	44
Human Factors	46
Microwave Process Engineering	48
Nottingham Centre for Geomechanics	50
Nottingham Geospatial Institute	52
Nottingham Transportation Engineering Centre	54
Optics and Photonics	56
Power Electronics, Machines and Control	58
Resilience Engineering	60
Faculty Thematic Areas	62
Advanced Manufacturing	63
Aerospace and Transport Technologies	64
Energy	65
Healthcare Technologies	66
Sustainable and Resilient Cities	67
Research Impact	68
PhD Highlights	72
Summary - Professor Andy Long	74



A portrait of Professor Sarah Sharples, a woman with short brown hair, smiling and wearing a purple floral scarf. She is standing in front of a blurred background that appears to be a university building with blue signs.

**Professor Sarah Sharples,
Associate Faculty
Pro Vice Chancellor
for Research and
Knowledge Exchange**

I am very pleased to introduce the second annual research highlights report from the Faculty of Engineering at the University of Nottingham. 2016-17 was another tremendously busy year, with wide-ranging success in fundamental engineering science and delivery of research with real industrial and societal impact.

Our research awards totalled £47million for the year, a value which represents the efforts of over 200 academic and research staff within the faculty. The research activities within engineering continue to come from a diverse set of funders, including the Engineering and Physical Sciences Research Council (EPSRC), Innovate UK, European Commission and Industry.

Our EPSRC portfolio remains strong, and major awards from the past year include the Future Additive Manufacturing Platform Grant, Future Formulations and the Future Composites Manufacturing Research Hub. Our partnerships with industry, funded through collaborative Research and Development, continue to demonstrate the national and international impact of our work, with projects focusing on domains such as energy, transport, aerospace, healthcare, manufacturing and cities in particular.

In the light of so many international changes in the funding landscape, it has been good to see our EU partnerships retained, both through our engagement with Marie Curie Innovative Training Networks (ITNs), Horizon 2020 (H2020) projects, and in particular our leadership of the academic contribution to CleanSky2. As we look forward to clarity on our opportunities to maintain our strong relationships with EU collaborators, we are continuing to develop our international partnerships with other worldwide institutions. Our formal collaboration with Virginia Tech has now been in place for several years, and we anticipate developing other partnerships with Universities with clear synergies with our research strengths over the next 12 months.

We continue to look to our research groups for scientific leadership of research activities in the faculty. We were pleased to welcome the formation of a new research group in Resilience Engineering in 2016, and in mid 2017, after several new staff joined the University as part of our launch of activities in Food Processing, we have formed a new group in Food, Water and Waste. Our externally-facing Institutes in Aerospace Technology, Advanced Manufacturing and Energy Technologies continue to provide a strong focus for our external engagement, with increasing numbers of multidisciplinary teams from both within the Faculty and with colleagues around the University tackling industry-led challenges.

Research in engineering is a team game, involving academic, research, technical and professional administration staff, alongside our impressive group of over 580 PhD students. Our annual Postgraduate Research Student showcase was a hugely enjoyable day, bringing together our diverse groups of students in sharing their research ideas and responding to the formidable challenge of communicating several years of work in only three minutes.

I look forward to another successful, varied and exciting year of research, and would like to take this opportunity to thank all staff and students for their tremendous hard work and contribution to our faculty's research excellence.

Professor Sarah Sharples,
*Associate Faculty Pro Vice Chancellor for
Research and Knowledge Exchange*

Thank you to all of the staff and students who have been involved in the production of this document. Particular thanks go to Rachael Duthie, who has led the activity, supported by the Heads of Research Group and the Engineering Research Office.

Our Achievements

Dr Emma Barney:

Chair of the ISIS User Committee for the Science and Technology Facilities Council. Recorder for the Board of Fellows for the Society of Glass Technology.

Dr Mark Jabbal:

Royal Aeronautical Society Specialist Group Committee for Aerodynamics.

Dr Georgios Dimitrakis:

General Secretary of the Association of Microwave Power for Education and Research in Europe (AMPERE).

Professor Alasdair Cairns:

Board member of the Institution of Mechanical Engineers (IMechE) Powertrain Systems and Fuels Group and IMechE Vehicle Thermal Management Systems committee.

Professor Wei Sun:

Member of the High Temperature Materials Committee (HTMC).

Professor Stuart Marsh:

UK representative on the Programme Board of the Intergovernmental Group on Earth Observations and member of the Hyperspectral Imaging Mission Expert Group of the European Space Agency.

Luke Todhunter:

Member of the British Standards Institution (BSI) and the International Organisation for Standardisation (ISO) group that focuses on 'Areal and profile surface texture' named Working Group 16, within a larger Technical Committee, TC213.

Dr Michael Craven:

Member of the National Steering Committee on the 'Digital and Healthy Living 2030 Task Force' of the National Centre for Universities and Business.

Dr Toby Blackman:

Member of the RIBA Validation Panel for Schools of Architecture.

Professor Terry Moore:

Member of a Government Office of Science led review into the Critical Dependencies of Satellite-derived Time and Position (the Global Navigation Satellite System (GNSS) Blakett Review).

Dr Xiaolin Meng:

Professor Terry Moore and Dr Xiaolin contributed to the written evidence submitted to the House of Lords Science & Technology Select Committee report on Connected and Autonomous Vehicles, the Future and to the Centre for Connected and Autonomous Vehicles report on UK Testing Ecosystem for Connected and Autonomous Vehicles.

Professor Richard Leach:

Secretary International Academy for Production Engineering CIRP STC S (Surfaces); European Society for Precision Engineering and Nanotechnology (euspen), Council Member (Director); and member of the International Organization for Standardization Committee ISO 213 "Dimensional and Geometrical Product Specification and Verification".

Dr Sreeja Veetil:

Awarded the Asia Oceania Geosciences Society (AOGS) Kamide Early Career Researcher Award.

Professor Patrick Wheeler:

ATI SAG (UK Aerospace Technology Institute - Strategic Advisory Group) member and member of the Engineering 2030 Advisory Board - modernisation of Engineering teaching/research organisation at the Universidad de Concepcion in Chile.

Professor Trevor Benson:

Committee (Jury) member for European Physical Society Quantum Electronics and Optics Thesis Prize 2017 and Fresnel Prize 2017 and member of the Institute of Physics Optical Group Committee.

Dr Hitendra Hirani:

Clean Sky 2 Thematic Topics Sherpa Working Group.

Dr Rachel Gomes:

University of Nottingham representative at the UK EPSRC Early Career Forum in Manufacturing Research and for the Papplewick Pumping Station and Water Education Trust.

Professor Sarah Sharples:

Verbal evidence given to House of Lords select committee included in report on Autonomous Vehicles published 2017; appointed as member of Science Advisory Council of Department for Transport; and continued serving as member of the Strategic Advisory Network for EPSRC.

Dr Adam Clare:

Subject editor for the Journal of Materials Processing Technology and Strategic Advisory Team member for EPSRC.

Dr Tanvir Hussain:

British Standards Institute (BSI) standards committee and Editorial Board member of Journal of Thermal Spray Technology.

Professor Serhiy Bozhko:

Member of SAE-AE7 International Standards Committee member (Aircraft Electric Power Systems) and Chair of AE-7M subcommittee working on Model-Based Design for Aircraft Electric Power Systems.

Professor Jonathan Hale:

Steering Group member of the Architectural Humanities Research Association (AHRA).

Professor John Crowe:

Member of the NIHR Invention for Innovation (i4i) Award Selection Panel; Remote Evaluator for the Irish Research Council (STEM) and member of the Panel of Advisors for Commonwealth Scholarship Commission in the UK.

Dr Andrew Dawson:

Chair of the US Transportation Research Board's Aggregate Committee and a member of a British Standards Institution (BSI) committee.

Dafne Gaviria Arcila:

Presented at the European Parliament, Strasbourg France. 6Th Symposium of CONACYT Fellows in Europe and winner of the prestigious ZONTA International Amelia Earhart Fellowship 2017.

Dr Louise Brown:

Member of the UK Research Software Engineers (RSE) Leaders' Network and chair of this year's RSE conference.

Dr Sue Cobb:

Board Member of the International Society for Virtual Rehabilitation and Program Committee Member of the International Conference on Disability, Virtual Reality and Associated Technology (Conference Co-Chair 2018).

Professor Herve Morvan:

Special Advisory - Future Propulsion, Aerospace Technology Institute (ATI), appraising, critiquing and validating the national aerospace strategy and Midlands Aerospace Alliance Board Member & Director.

Technician Highlights

Kevin Padgett, Samuel Barker and Kaylem Cooper:

Represented University of Nottingham technicians at the Palace of Westminster during Nottingham in Parliament Day in October 2017.

Samuel Barker:

Represented the University of Nottingham at the WorldSkills UK regional finals Competition in Computer Aided Design held at the NEC.

Alex Jackson-Crisp:

Achieved EngTech professional registration with the IMechE.

University of Nottingham:

First in the UK to have a trainee technician programme accredited by the IMechE.

Ben Shaw:

World Skills UK mentor and judge in CNC milling.

Katy McKenzie:

Appointed as a Fellow of the Higher Education Academy and awarded the Lord Dearing Award.

Vikki Archibald:

Appointed Associated Fellow of the Higher Education Academy.

Amy Pearson:

Appointed Associated Fellow of Higher Education Academy.

Tom Buss CEng MIMMM:

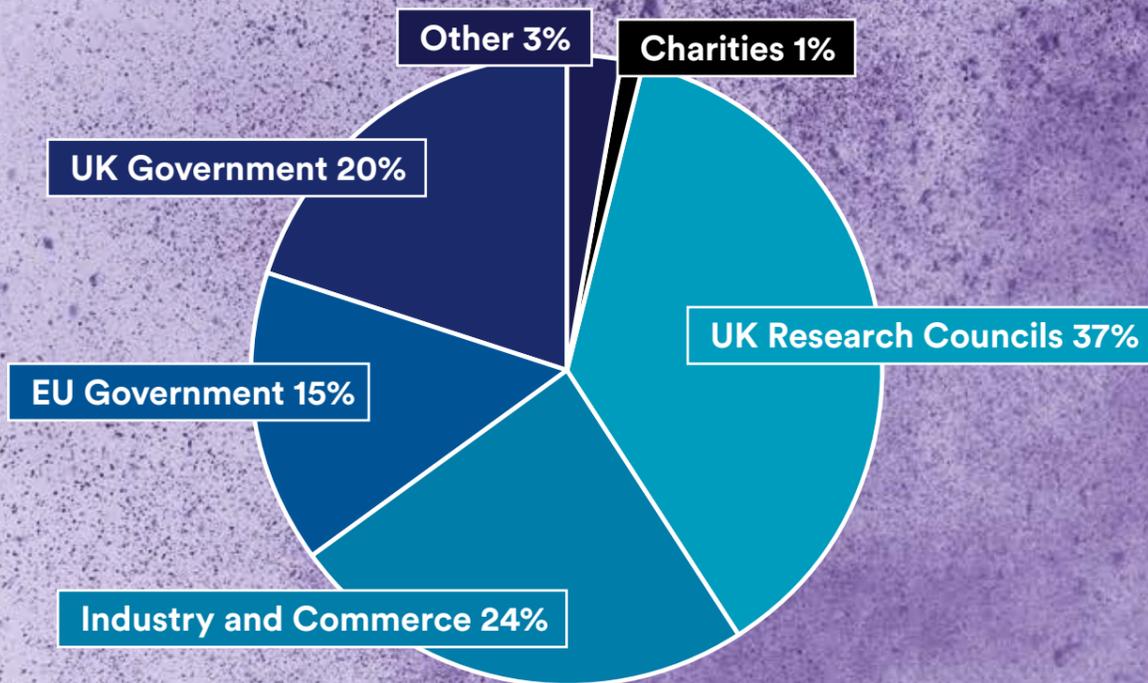
Achieved Chartered Engineer status through the Institutes of Materials, Minerals and Mining. This is the highest level of Professional Registration, recognising the skills and professionalism of people working in this field.

The Technical Team for Engineering Applications Workshops:

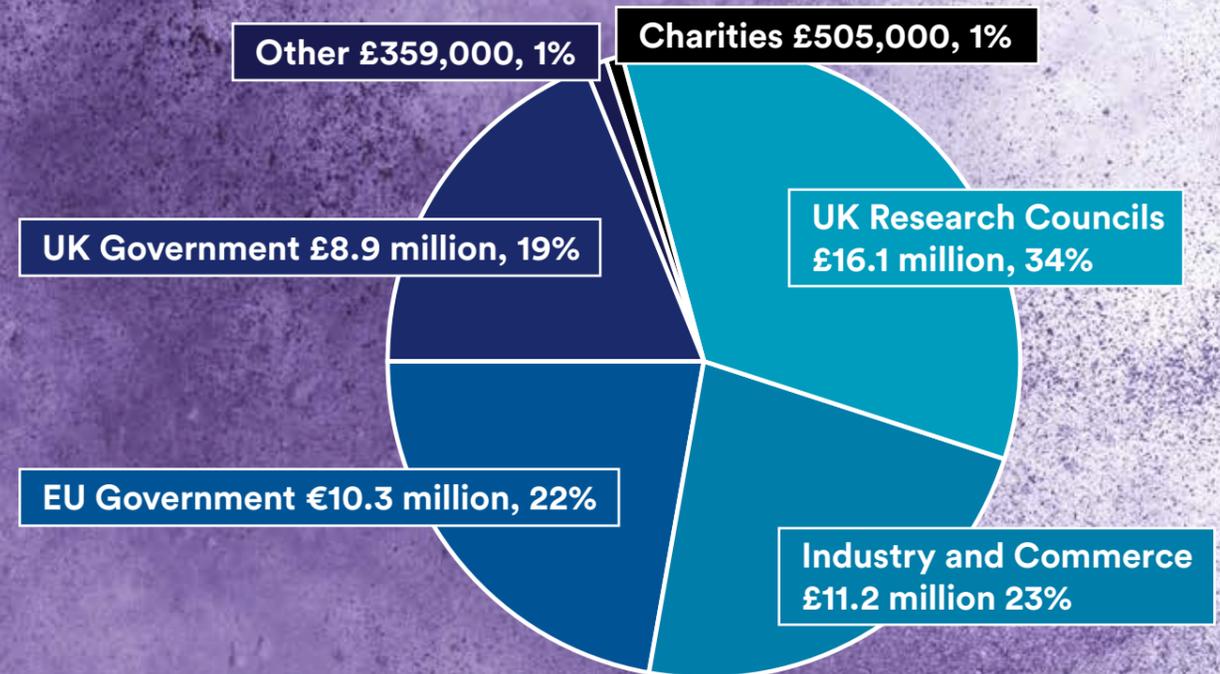
The Department of Mechanical, Materials and Manufacturing Engineering were awarded the Lord Dearing Award in the Summer 2016.

Faculty Research Portfolio

The Faculty of Engineering has a broad portfolio with significant funding from UK Research Councils, EU, UK Government and industry totalling £190m



During the academic year 2016/17, Engineering was awarded £47 million of new research grants. The split across funding sources is as follows:



Research Fellows recruited in 2016/17

The Faculty of Engineering recruited 66 researchers in the period 2016/17. 16 of these had independent funding, including Marie Curie fellowships, KTP associates and personal fellowships.

Post-Graduate Research

During 2016/17 the Faculty of Engineering awarded 140 PhDs; a further 113 submitted their theses, pending examination. In total, we had 580 registered PGR students distributed across the various engineering disciplines.

Patents

The Faculty of Engineering actively manages a portfolio of 80 patents with 6 new patents and 49 disclosures filed in 2016/17. We also have 4 spinout companies: Promethean Particles Ltd, SurePulse Medical Ltd, Geomatic Ventures Ltd and Added Scientific Ltd.

Faculty of Engineering Research Groups

Advanced Manufacturing Technology
Advanced Materials
Architecture, Culture and Tectonics
Architecture, Energy and Environment
Bioengineering
Bioprocess, Environmental and Chemical Technologies
Centre for Additive Manufacturing
Centre for Structural Engineering and Informatics
Cleaner Fossil Energy and Carbon Capture Technologies
Composites
Environment, People and Design
Fluids and Thermal Engineering
Food, Water and Waste
Gas Turbine and Transmissions Centre
Geohazards and Earth Processes
George Green Institute for Electromagnetics Research
Human Factors
Microwave Process Engineering
Nottingham Centre for Geomechanics
Nottingham Geospatial Institute
Nottingham Transportation Engineering Centre
Optics and Photonics
Power Electronics, Machines and Control
Resilience Engineering



Advanced Manufacturing Technology

Head of Group

Professor Svetan Ratchev

Home to several leading research centres, the Advanced Manufacturing Technology (AMT) Research Group is globally recognised to be at the forefront of research in manufacturing technologies and systems. Whether developing an existing product or creating a new one as a result of new advanced methods, our research portfolio addresses a number of challenges faced by society today; from investigating the use of robotics in surgical procedures to developing new smart solutions for assembly of aircraft wings and methods for repair of aero engines.

Research is conducted into all aspects of manufacturing processes and systems including machining, robotic assembly and metrology and is supported by world class teaching and research facilities, with the latest technologies and equipment. Over the years the AMT group has proved its ability to solve technical problems for industry while collaborating with some of the most reputable research groups and centres across the world.

Research Areas

- Advanced Robotics
- Manufacturing Systems
- Biomedical Manufacturing
- Machining and Condition Monitoring
- Manufacturing Metrology
- Metal Forming and Materials Processing
- Surface Engineering and Processes
- Tooling and Fixturing

More information can be found on the AMT website:
nottingham.ac.uk/go/amt



Research Portfolio

The AMT group started 12 projects between Aug 2016 and July 2017. These projects were sponsored by a range of funders and industrialists such as, Rolls Royce; Additive Manufacturing technologies; Siemens; the National Physical Laboratory and the EPSRC, amounting to £2,570,187 in total.

Projects include:

EPSRC Multi-sensor in-process metrology of laser powder bed fusion additive manufacturing: Fusing form, texture and temperature measurement

Dr Simon Lawes, £283,156

Using an intelligent combination of measurement data captured by multiple sensor systems to accurately detect defects and measure the form, texture and thermal distribution of the metal powder bed. This multi-sensor system will have profound benefits for process control of L PBF processes as well as providing a wealth of in process data to feed into future research.

EPSRC Through life performance: From science to instrumentation

Professor Dragos Axinte, £318,826

A platform grant that brings together a world leading team of colleagues from Nottingham and Cranfield with a strategic research capability on through-life performance improvement, including complex in-situ degradation assessment technologies. This research is part of a long-term research agenda to develop High Value Manufacturing (HVM) products with longer functional life and lower whole life cost.

EPSRC High Resolution Biomedical Imaging Using Ultrasonic Metamaterials

Dr Adam Clare, £202,070

Developing a new approach to enhancing the performance of diagnostic ultrasound.

H2020 MSCA ITN PAM2 Precision Additive Metal Manufacturing

Professor Richard Leach, £330,952

This Marie-Curie Innovation Training Network brings together research institutes, national measurement institutes and commercial entities from across Europe to advance the precision of Additive Manufacturing (AM).

H2020 CS2 VADIS

Professor Svetan Ratchev, £887,057

An innovate Clean Sky 2 project aimed at delivery new solutions for metrology assisted determinate assembly of large wing structures.

Key Publications

- Gherman L, Gleadall A, Bakker O, Ratchev S. (2017) Manufacturing technology: Micro-machining. *Springer Tracts in Mechanical Engineering*, Issue 9783319396507: 97-127.
- Piano S, Su R, Leach R. (2017) Micro-scale geometry measurement. *Springer Tracts in Mechanical Engineering*, Issue 9783319396507: 197-221.
- Gasper AND, Catchpole-Smith S, Clare AT. (2017) In-situ synthesis of titanium aluminides by direct metal deposition. *Journal of Materials Processing Technology*, 239: 230-239.
- Gomez C, Su R, Thompson A, Dlsciacca J, Lawes S, Leach R. (2017) Optimization of surface measurement for metal additive manufacturing using coherence scanning interferometry. *Optical Engineering*, 56: 111714.
- Gatea S, Ou H, McCartney G. (2016) Review on the influence of process parameters in incremental sheet forming. *International Journal of Advanced Manufacturing Technology*, 87: 479-499.
- Fanicchia F, Axinte DA, Kell J, McIntyre R, Brewster G, Norton AD. (2017) Combustion Flame Spray of CoNiCrAlY & YSZ coatings. *Surface and Coatings Technology*, 315: 546-557.





Advanced Materials

Head of Group

Professor David Grant

Providing solutions in a range of fields, from medicine to energy storage, the Advanced Materials Research Group (AMRG) specialises in research on materials, surfaces and interfaces to enhance the performance of existing technologies and develop novel functionality. Research is leading to technologies which provide reductions in healthcare costs, address issues linked to an ageing population and investigate new ways for energy storage. The group is building a dynamic, interactive community in materials research enhancing research excellence and impact. The group will continue to develop and train highly qualified researchers; conduct internationally leading research in materials science and engineering and interact with stakeholders to achieve knowledge transfer.

Research Areas

- Surfaces and Interfaces
- Biomaterials
- Energy

More information can be found on the AMRG website:
nottingham.ac.uk/go/amrg

Key Publications

- Felfel RM, Poozha L, Gimeno-Fabra M, Milde T, Hildebrand G, Ahmed I, Scotchford C, Sottile V, Grant DM, Liefelth K. (2016) In vitro degradation and mechanical properties of PLA-PCL copolymer unit cell scaffolds generated by two-photon polymerization. *Biomedical Materials*, 11: 015011.
- Jin X, Sun W, Shipway PH. (2016) Derivation of a wear scar geometry-independent coefficient of friction from fretting loops exhibiting non-Coulomb frictional behaviour. *Tribology International*, 102: 561-568.
- Chen M, Lu J, Felfel RM, Parsons AJ, Irvine DJ, Rudd CD, Ahmed I. (2017) Wet and dry flexural high cycle fatigue behaviour of fully bioresorbable glass fibre composites: In-situ polymerisation versus laminate stacking. *Composites Science and Technology*, 150: 1-15.
- Murray JW, Ang ASM, Pala Z, Shaw EC, Hussain T. (2016) Suspension High Velocity Oxy-Fuel (SHVOF)-Sprayed Alumina Coatings: Microstructure, Nanoindentation and Wear. *Journal of Thermal Spray Technology*, 25: 1700-1710.
- Stuart BW, Titman JJ, Gimeno-Fabra M, Ahmed I, Grant DM. (2016) Insights into structural characterisation and thermal properties of compositionally equivalent vapour-condensed and melt-quenched glasses. *Materials & Design*, 111: 174-184.
- Yang F, Li M, Li L, Wu P, Pradal-Velázquez E, Sinclair DC. (2017) Optimisation of oxide-ion conductivity in acceptor-doped $\text{Na}_{0.5}\text{Bi}_{0.5}\text{TiO}_3$ perovskite: approaching the limit? *Journal of Materials Chemistry A*, 5: 21658-21662.
- Liu J, Janjua ZA, Roe M, Xu F, Turnbull B, Choi K-S, Hou X. (2016) Super-hydrophobic/icephobic coatings based on silica nanoparticles modified by self-assembled monolayers. *Nanomaterials*, 6: 232.
- Tang Z, Furniss D, Neate NC, Barney E, Benson TM, Seddon AB. (2016) Dy^{3+} -doped selenide chalcogenide glasses: influence of Dy^{3+} dopant-additive and containment. *Journal of the American Ceramic Society*, 99: 2283-2291.

Esteem Indicators

Prizes and Awards

- Katherine Pitrolino won best Oral presentation UKSB.
- Congratulations to Miquel Gimeno-Fabra manager of the E-bike team who were the MotoE champions 2016.
- New Visiting Professor to Mid-Infrared Photonics Group: Professor Mark Farries of Gooch and Housego, UK.

Fellows

- Welcome to Dr Ming Li who has joined the group as a lecturer after his Nottingham Research Fellowship.

Committees

- Dr Colin Scotchford is President of the UK society of Biomaterials.
- Dr Ifty Ahmed on organising committee for the The 9th International Conference on Borate Glasses, Crystals and Melts and the 2nd International Conference on Phosphate Materials.
- Professor Angela Seddon member of the International Advisory Board, Optical Society of America, NOMA (Novel Optical Materials) and Advanced Solid State Lasers (ASSL) from 2017.

Journal Editors

- X Hou and F Xu, Guest editors of a special issue of "Nanomaterials": Nanocomposite Coatings.

Research Projects

The Advanced Materials Research Group continues to have a diverse and sustained portfolio of projects in the areas of Surface and Interfaces, Energy and Biomaterials. New Projects, funded by the EPSRC include:

Development of a synthetic Haematoma:

Via an effective biomaterials/biologics strategy releasing biotherapeutic ions into the surrounding environment, to be delivered via minimally invasive injection procedures.

Thermally driven Solar Air Conditioning (TSAC):

Developing a novel compact and thermally-driven air conditioning (A/C) system for potential use as a new solar cooling technology.

Multi Layered and Blended Deposition of Sacrificial Thin-Film Coatings of Phosphate Based Glasses for Preventing Biofilm Formation

Producing an antimicrobial provisional thin coating of Phosphate Based Glasses to temporarily inhibit bacterial attachment via a disruptive surface and also kill bacteria during and post-surgery.

Ceramics production: COld-cOntainer processing for Long wavelength mid-infrared fibre optics (COOL)

Novel, cold-container processing to enable rapid manufacture of long wavelength mid-infrared selenide glasses, of hyper-purity for portable, real-time molecular sensing and imaging.

The EPSRC Impact Accelerator Account funded a number of high impact studies such as: **Nano-enhanced body armour** for industrial testing of the fabrics on an approved test range for bullet spike and stab resistance.

Internal Higher Education Innovation Funding was also used to allow **Kevlar** to be scaled to a roll in collaboration with Promethean Particles and Aegis (now part of Safariland).

Arthritis Research UK funding was also secured for collaboration with JRI Ltd for *in vivo* studies and road mapping to commercialisation of osteochondral repair using a unique **non delaminating chitosan structure**.

Innovate UK has also been granted for development of **hydrogen tank storage technology** with Luxfer Cylinders, ITM Power and Arcola Energy.



External Activities

Outreach

- SmallPeice Trust-Residential Children Visit - During the visits of the Trust in university, students visited CEE labs and took part in three hours of lab activities designed for them.

Patents

- Two patents were submitted in the areas of porous phosphate based glass for bone regeneration and chitosan non delaminating osteochondral defect construction.



Architecture, Culture and Tectonics

Head of Group

Professor Jonathan Hale

The Architecture, Culture and Tectonics (ACT) Research Group studies the relationships between people and the structures that surround us. The effects of the design and layout of a building on our social and cultural interactions are explored, as well as ways in which we can make our architecture more meaningful and sustainable.

Our research combines the themes of Culture (for example: architectural humanities, history, theory, and urbanism), Tectonics (experimental structures, materials and digital fabrication) and Design (including augmented reality and practice-led research). Our research has been applied to designing exhibition spaces (including the Dinosaurs of China exhibition at Wollaton Hall and two museums in China), analysing historical architecture (such as Lincoln Cathedral), and the design of novel structures (through Knowledge Transfer Partnerships and consultancies).

Research Areas

- Culture
 - ▶ Architecture and Embodiment
 - ▶ Digital Heritage
 - ▶ Museums
 - ▶ Urban History
- Tectonics
 - ▶ Lightweight Materials and Membranes
 - ▶ Experimental Structures
 - ▶ Digital Fabrication
 - ▶ Material Matters
- Design
 - ▶ Practice-led Research
 - ▶ Live Design-and-Build Projects
 - ▶ Project Specification
 - ▶ Creative Materials Practices

More information can be found on the ACT website:
▶ nottingham.ac.uk/go/act

Research Projects

Paul Mellon Fellowship

Dr Chantelle Niblock, £5,000

Translating a substantive 3D scan data of Lincoln Cathedral into a user-friendly, interactive virtual reality exhibition and online digital archive. This project will utilise game-based learning to enhance visitor experience and engage the public sector through 3D virtual storytelling.

Esteem Indicators

Prizes and Awards

- Dr Paolo Beccarelli was awarded the European Patent EP2868844A1 “Structural roofing system and method of using the same” focused on inflatable beams.

Committees

- Professor Jonathan Hale continued as Steering Group member (and Research Excellence Framework (REF) sub-committee chair) for the AHRA (Architectural Humanities Research Association), and book series editor for ‘Critiques: Critical Studies in Architectural Humanities’ (Routledge 2004-).
- Dr Paolo Beccarelli elected vice-chair of TensiNet, the international association on tensioned membrane construction, Spring 2017.

Journal Editors

- Professor John Chilton, together with Peter Gosling, Marijke Mollaert and Bernd Stimpfle co-edited the special issue TENSINET – COST TU1303 International Symposium 2016 “Novel structural skins - Improving sustainability and efficiency through new structural textile materials and designs”, Procedia Engineering, Volume 155, Pages 1-516 (2016).

Demonstrators

- A Knowledge Transfer Partnership demonstrator: Passive heat recovery and storage system for the Ethylene Tetra Fluoro Ethylene (ETFE) foil encapsulated greenhouse façade/roof using phase change material.



Key Publications

- Professor Jonathan Hale’s Monograph: ‘Merleau-Ponty for Architects’ (Routledge 2017).
- Dr Didem Ekici’s co-edited book: ‘Healing Spaces: Modern Architecture and the Body’ (Routledge 2017), collaboration with Professor Sarah Schrank, California State University.
- Professor John Chilton’s co-authored book with Gabriel Tang, ‘Timber Gridshells: Architecture, Structure and Craft’, (Routledge 2017).

External Activities

Conferences and Events

- ACT ran an annual two day PhD Summer School (12th – 13th July 2017) inviting current collaborative architecture UK/EU partners, students and a lead keynote speaker, new Honorary Professor, Harry Francis Mallgrave (from the Illinois institute of technology, USA).
- Professor John Chilton and Dr Paolo Beccarelli were part of the organizing committee for the International conference TensiNet – COST TU1303 International Symposium 2016 “Novel structural skins - Improving sustainability and efficiency through new structural textile materials and designs”

Knowledge Transfer Partnerships

- Dr Paolo Beccarelli’s KTP associate is working to develop novel tensile membrane structures and adaptable textile-covered building facades, integrating tensile photovoltaic membranes for energy harvesting and environmental control to assist Europe’s renewable energy generation targets.

International

- International consultancy focused on the digital modelling and structural improvement of membrane structures which resulted in the supervision of the structural design, manufacturing and installation of the “Off the Cuff” pavilion designed by US architects Diller Scofidio + Renfro for the Milan Design Week 2017.

Exhibitions

- Dinosaurs of China was a major international exhibition - the first of its kind in Europe - shown at Wollaton Hall, Nottingham’s Natural History Museum in the summer of 2017. Organised by Dr Wang Qi, the design of the exhibition demonstrated how the layout, visitor route and architecture of the museum building can contribute to the exhibition narrative (storytelling) and how it is perceived and experienced by the museum visitor – enhancing their learning experience. The project helped to create longstanding collaborative relationships with both the Palaeozoological Museum of China (PMC) and the Institute of Vertebrate Palaeontology and Palaeoanthropology (IVPP) in Beijing, who generously loaned exhibits from their unique fossil collections.



Architecture, Energy and Environment

Head of Group
Professor Saffa Riffat

Adapting our buildings to cope with the impact of global warming is the challenge being tackled by the Architecture, Energy and Environment (AEE) Research Group. The ambition of the Research Group is to improve the sustainable practice of architecture and engineering, in order to enhance the quality of the built environment. Working with a number of industrial partners, they research methods to reduce the impact of those technologies we take for granted, like air conditioning and energy. Our innovative on-campus Creative Energy Homes gives the group access to live research projects investigating affordable and sustainable housing of the future.

Research Areas

- Sustainable Building Design
- Sustainable Energy Technologies
- Smart and Innovative Materials
- Sustainable Urban Living

More information can be found on the AEE website:
nottingham.ac.uk/go/ae-research



Research Projects

The AEE group started 12 projects between August 2016 and July 2017, amounting to £1,348,936 in total. Below are a selection of these projects:

EPSRC Revolutionary Rotary Ericsson

Professor Saffa Riffat, £98,670

Developing a mechanical heat pump utilising the Ericsson thermodynamic cycle and a highly efficient environmentally friendly working fluid to replace the conventional vapour compression cycle that uses harmful CFC's. To be utilised in both engines and coolers.

British Council Solar Powered Water Desalination

Professor Saffa Riffat, £178,912

To develop and initiate deployment of an innovative small-scale, low-energy, low-cost solar-powered water desalination or water system, based on a breakthrough on solar powered desalination system. The proposed system will provide fresh water from saline and brackish water using solar powered, small-scale desalination system suitable for commercial and household applications.

Innovate Low-cost efficient

Professor Saffa Riffat, £260,419

Investigating the technical and commercial feasibility of a novel technology that would enable Ground Source Heat Pumps (GSHPs) powered by low carbon energy sources to become economically viable for a wide range of space heating applications.

Innovate combined water production

Professor Saffa Riffat, £100,922

Developing a novel hybrid air conditioning technology for vehicles, which will reduce both their direct carbon emissions by being more energy efficient and their indirect carbon emissions by employing the natural refrigerants, CO₂ and water instead of high global warming R134a.

Innovate Joint research key technologies

Professor Saffa Riffat, £340,717

Developing a revolutionary thin-film photovoltaic vacuum glazing (PV-VG) for buildings, eliminating the need for inert gases, such as Argon, used in conventional windows.

H2020 MCIF Solar-store

Professor Saffa Riffat, £144,460

H2020 a-Si PVT-ORC

Dr Yuehong Su, £126,099

Innovate SOUL

Dr Lucelia Rodrigues, £12,936

To find Innovative solutions for system challenges in urban living and energy generation and supply by investigating integrated solutions to systemic challenges in urban areas, resilience of infrastructure and cities to environmental and societal pressure and solutions for affordable, sustainable and secure energy delivery.

Innovate PULSE

Dr Chris Wood, £20,800

To build upon existing knowledge of the PULSE air tightness testing technology. The current technology which is applicable to the testing of conventional buildings is close towards commercialization. The new sector of high integrity enclosures requires the development of a miniaturized unit and therefore mathematical and practical analysis required in to assess technical feasibility.

Supporting EPSRC Priorities in Industrial Strategy Challenge Fund

EPSRC Workshop

Dr Lucelia Rodrigues, £25,000

Supporting EPSRC Industrial Strategy Challenge Fund (ISCF)

Dr Lucelia Rodrigues, £25,000

Optimising Home Energy and Environmental Monitoring to Support Independent Living.

EPSRC Demonstration systems and user engagement

Dr Chris Wood, £15,000

External Activities

Conferences and Events

■ The Group has organized several sustainable energy technology and buildings dissemination events. For example, it has organised major international SET conferences over the past 17 years. Members of the Group are also on various organisation committee (e.g. Conference Steering UK Passivhaus Conferences).

Postgraduate Research Activities

■ AEE currently supervises 40 PhD students and aims to maintain this number in 2018, attracting high calibre students joint supervised with the University of Nottingham's campuses in the UK, China and Malaysia.

Key Publications

Members of the Group published papers in high impact journals and international journals.

- Aydin D, Casey S, Chen X, Riffat S. (2018) Numerical and experimental analysis of a novel heat pump driven sorption storage heater. *Applied Energy*, 211: 954-974.
- Parra D, Norman SA, Walker GS, Gillott M. (2017) Optimum community energy storage for renewable energy and demand load management. *Applied Energy*, 200: 358-369.
- Shao J, Darkwa J, Kokogiannakis G. (2016) Development of a novel phase change material emulsion for cooling systems. *Renewable Energy*, 87: 509-516.
- Talebi B, Haghghat F, Mirzaei PA. (2017) Simplified model to predict the thermal demand profile of districts. *Energy and Buildings*, 145: 213-225.
- Calautit JK, Hughes BR, Nasir DS. (2017) Climatic analysis of a passive cooling technology for the built environment in hot countries. *Applied Energy*, 186: 321-335.

Esteem Indicators

Prizes and Awards

- Energy Globe Award: Since 1999, The Global Energy Awards honour organizations and individuals who are dedicated to achieving excellence in the energy industry.
- Rushlight Award: The Rushlight Awards focus on the technology and innovation achievements in the journey to meeting these goals.
- Local and national media coverage of the Trent Basin Community Energy Scheme incorporating Europe's largest community energy battery.

Journal Editors

■ Members of the group are editor in chief or on the editorial boards for various journals, including:

Dr Parham Ahranjani, Editor in Chief of Advances in Building Energy Research.





Bioengineering

Head of Group

Professor Donal McNally

The primary goal of the Bioengineering Research Group is to solve important clinical and biological problems that will advance medical science across the globe. The research undertaken by the group has led to advances in treatments of spinal deformities and injuries, as well as impacted the evolution of day-to-day medical devices we take for granted, such as baby incubators. The group achieves this success by solving important clinical and biological problems through the application of multi-scale characterisation and modelling. The applications areas that are researched by the group include impact biomechanics, clinical monitoring, biomimetic cell and tissue engineering and crop and bio renewable engineering.

Research Areas

- Clinical and Impact Biomechanics
- Clinical Monitoring
- Biomimetic Cell and Tissue Engineering
- Crop and Bio renewable Engineering

More information can be found on the Bioengineering website:
nottingham.ac.uk/go/bioengineering



Research Portfolio

The Bioengineering group has a total Research Portfolio of £1,590,681, with three projects starting between Aug 2016 and Jul 2017. These projects were sponsored by the EPSRC and NIHR, amounting to £905,322 in total. Projects included:

NIHR Improving neonatal outcomes with an evidence-based, multi-disciplinary developed transport system

Professor Donal McNally, £876,562

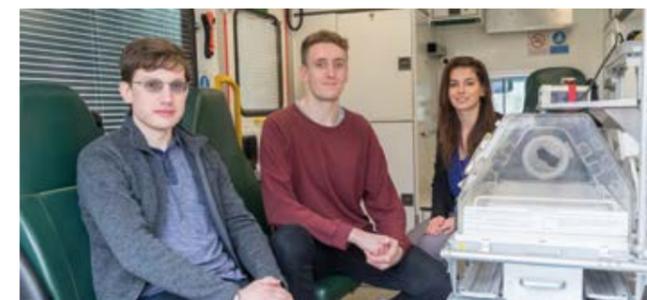
Producing the next generation of new-born transport systems that will reduce the noise and vibration experienced to a level such that the journey is much less stressful and so the risk of brain injury is significantly reduced.

EPSRC Institutional Award: Unobtrusive behavioural monitoring via the interactions of daily living

Professor John Crowe, £15,000

EPSRC Institutional Award: UNIFY Plus - understanding the unmeasurable: a framework for linking macro to micro level tissue movement in non-union

Dr Alistair Campbell-Ritchie, £13,760



Key Publications

- Aboulkhair NT, Maskery I, Tuck C, Ashcroft I, Everitt NM. (2016) Improving the fatigue behaviour of a selectively laser melted aluminium alloy: Influence of heat treatment and surface quality. *Materials and Design*, **104**: 174-182.
- Jung DS, Crowe JA, Birchall JP, Somekh MG, See CW. (2017) Anti-confocal assessment of middle ear inflammation. *Biomedical Optics Express*, **8**: 230-242.
- Croft W, Reusch K, Tilunaite A, Russell NA, Thul R, Bellamy TC. (2016) Probabilistic encoding of stimulus strength in astrocyte global calcium signals. *GLIA*, **64**: 537-552.
- Yang Y, Ritchie AC, Everitt NM. (2017) Comparison of glutaraldehyde and procyanidin cross-linked scaffolds for soft tissue engineering. *Materials Science and Engineering C*, **80**: 263-273.
- Blaxter L, Yeo M, McNally D, Crowe J, Henry C, Hill S, Mansfield N, Leslie A, Sharkey D. (2017) Neonatal head and torso vibration exposure during inter-hospital transfer. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, **231**: 99-113.
- Thompson A, McNally D, Maskery I, Leach RK. (2017) X-ray computed tomography and additive manufacturing in medicine: A review. *International Journal of Metrology and Quality Engineering*, **8**: 17.

Equipment and Demonstrators

Equipment

- A new sports engineering course has been set up and presented an opportunity for new staff, part of a University Strategic Development Fund and resulted in space being refurbished at the sports village for a lab.

Demonstrators

- The University of Nottingham's research ambulance was secured as a part of the NIHR Improving Neonatal Outcomes project. The ambulance will be used for measurement and testing, however there are ambitions to also use this as a demonstrator for outreach purposes.



Bioprocess, Environmental and Chemical Technologies

Head of Group

Professor Alex Conradie

Specialising in biological sciences, chemistry and engineering, the group aims to develop sustainable manufacturing, generating materials from renewable resources. These products can range from the very chemicals that remove the chewing gum from our pavements, right through to methods of efficiently producing life-saving anti-malarial drugs.

The Bioprocess, Environmental and Chemical Technologies (BECT) Research Group is aligned with the University of Nottingham's Green Chemicals Beacon of Excellence, and therefore has ambitions to deliver transformational and sustainable chemical technologies, meeting UN sustainable development goals such as Climate Action and Sustainable Industrialisation.

Research Areas

- Bio-manufacturing
- Enzyme Engineering
- Sustainable Chemical Technologies
- Molecular and Process Modelling
- Techno-economic and Life Cycle Analysis

More information can be found on the BECT website:
nottingham.ac.uk/go/bect

Research Projects

The BECT group started 14 projects between August 2016 and July 2017. These projects were sponsored by a range of funders and industrialists such as BBSRC, EPSRC, GCRF and The Leverhulme Trust, including:

BBSRC Continuous Bio production

Professor Gill Stephens, £1,576,297

Establishing generic design procedures to underpin the introduction of continuous bio-manufacturing processes for commodity/platform chemicals and added value intermediates.

Leverhulme Advanced Molecular materials a

Dr Victor Sans Sangorrin, £161,448

Developing a new paradigm, combining molecular and bulk synthetic approaches and an innovative approach to 3D printing, in which the specific properties of materials and devices can be tuned by the application of external stimuli (magnetic, electric, light...) during the fabrication process.

EPSRC Designer Hybrid

Dr Anca Pordea, £99,728

Designing a novel, hybrid chemo-enzymatic catalyst, combining the best features of chemical and enzymatic catalysis, by introducing metal catalysts into natural enzymes.

Institutional EPSRC Engineering Water Resilience Doctoral Training Programme

Dr Rachel Gomes, £280,000

Teaching and Research Programme in Food Process Engineering, University of Nottingham Strategic Development Fund

Dr Rachel Gomes, £1,400,000

EVAL-FARMS – Evaluating the threat of antimicrobial resistance in agricultural manures and slurries

Dr Rachel Gomes, £1,500,000

Esteem Indicators

Prizes and Awards

Four papers published, by Dr Victor Sans Sangorrin, were featured on the covers of the respective journals:

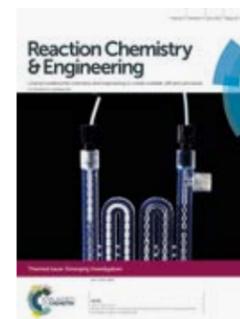
- Tuneable 3D printed bioreactors for transaminations under continuous-flow, E. Peris, O. Okafor, E. Kulcinskaja, R. Goodridge, S. V. Luis, E. Garcia-Verdugo, E. O'Reilly, V. Sans, **Green Chemistry**, 2017, 19, 5345-5349.
- A Simple Approach to the Visible-Light Photoactivation of Molecular Metal Oxides, S. Fujimoto, J. M. Cameron, R.-J. Wei, K. Kastner, D. Robinson, V. Sans, G. N. Newton, H. Oshio, **Inorganic Chemistry**, 2017, 56, 12169-12177.
- Advanced reactor engineering with 3D printing for the continuous-flow synthesis of silver nanoparticles, O. Okafor, A. Weilhard, J.A. Fernandes, E. Karjalainen, R. Goodridge, V. Sans, **Reaction Chemistry and Engineering**, 2017, 2, 129-136.
- Orbital Engineering: Photoactivation of an Organofunctionalized Polyoxotungstate, J. M. Cameron, S. Fujimoto, K. Kastner, R.-J. Wei, D. Robinson, V. Sans, G. N. Newton, H. Oshio, **Chemistry: A European Journal**, 2017, 23, 47-50.

Fellows

- Dr Helena Gomes was awarded an Anne McLaren Fellowship, briefly joining the BECT group before more naturally aligning with the new Food, Water, Waste research group.

Committees

- Dr Anna Croft is lead for Dial-a-Molecule's Statistical Methods group.



Key Publications

- Dragone V, Sans V, Henson AB, Jaroslaw MG, Cronin L. (2017) An autonomous organic reaction search engine for chemical reactivity. *Nature Communications*, 8: 15733.
- Dowling DP, Kung Y, Croft AK, Taghizadeh K, Kelly WL, Walsh CT, Drennan CL. (2016) Structural elements of an NRPS cyclization domain and its intermodule docking domain. *Proc Natl Acad Sci USA*, 113: 12432-12437.
- Okafor O, Weilhard A, Fernandes JA, Karjalainen E, Goodridge R, Sans V. (2017) Advanced reactor engineering with 3D printing for the continuous-flow synthesis of silver nanoparticles. *Reaction Chemistry and Engineering*, 2: 129-136.
- Jäger CM, Croft AK. (2017) Radical Reaction Control in the AdoMet Radical Enzyme CDG Synthase (QueE): Consolidate, Destabilize, Accelerate. *Chemistry*, 23: 953-962.
- McKechnie J, Saville B, MacLean HL. (2016) Steam-treated wood pellets: Environmental and financial implications relative to fossil fuels and conventional pellets for electricity generation. *Applied Energy*, 180: 637-649.
- Hamid, H.A., Jenidi, Y., Thielemans, W., Somerfield, C., and Gomed, R.L., 2016. Predicting the capability of carboxylated cellulose nanowhiskers for the remediation of copper from water using response surface methodology (RSM) and artificial neural network (ANN) models *Industrial Crops & Products*. 93, 108-120.

External Activities

Conferences and Events

- Integrating design across the scales with 3D printing, V. Sans, ESSF, Nottingham (UK), June 2017, Invited plenary lecture.
- Emerging antimicrobial additive manufacturing technologies and the Chinese Wall, Qun Cao, Erno Karjalainen, Scott G. Mitchell, Victor Sans, Nspine, London (UK), June 2017, invited keynote lecture.
- 2nd International Conference on Hydrogen Atom Transfer (iCHAT 2017), Rome, Italy, 03 July 2017.
- Ruđer Bošković Institute, Zagreb, Croatia, 28 June 2017.
- 31st Molecular Modelling Workshop 2017, Erlangen, Germany, 28 March 17.
- Mipomat Workshop Innovative Surfaces and Materials, Primosten, Croatia, 30 August 2016.

Outreach

- Wonder 2017: Members of BECT hosted three stands at the event, including: Extracting DNA from Strawberries; a Saliva Indicator Test; and Virtual Reality for Protein Structures. They also had a bioreactor on display.
- A summer student from a local school was hosted as an outreach activity forming the basis for her Crest Gold Award, producing a good set of results for her report.



Centre for Additive Manufacturing

Head of Group

Professor Richard Hague

Additive Manufacturing (3D printing) techniques continue to evolve quickly and the the Centre for Additive Manufacturing (CfAM) is at the forefront of this research. The research undertaken by this group spans across both fundamental and applied research. The next stage of development of this new technology will be to go beyond using single materials (either polymer or metal) and instead use multiple materials – both functional and structural – in unison to engineer highly functional, durable and life-changing items such as prosthetic limbs, complex pharmaceutical devices and advanced engineering components.

The core research carried out within the group is focussed on investigating the underpinning processes, materials and computational methods for multifunctional Additive Manufacturing, giving the potential to move beyond structural applications and create fully functional systems using Additive Manufacturing rather than passive individual components.

The group works closely with business to translate its technology through to commercial use, and has set up its own consultancy company (www.addedscientific.com) to more fully engage with multiple industrial sectors. By working across both academic and commercial enterprises, new opportunities for increasing functionality and adding value to the technology have been created.

Research Areas

- Underpinning processes, materials and computational methods for Additive Manufacturing
- Additive Manufacturing Management

More information can be found on the CfAM website:
nottingham.ac.uk/go/CfAM

Key Publications

- Vaithilingam J, Simonelli M, Saleh E, Senin N, Wildman RD, Hague RJM, Leach RK, Tuck CJ. (2017) Combined Inkjet Printing and Infrared Sintering of Silver Nanoparticles using a Swathe-by-Swathe and Layer-by-Layer Approach for 3-Dimensional Structures. *ACS Applied Materials and Interfaces*, 9: 6560-6570.
- Clark EA, Alexander MR, Irvine DJ, Roberts CJ, Wallace MJ, Sharpe S, Yoo J, Hague RJM, Tuck CJ, Wildman RD. (2017) 3D printing of tablets using inkjet with UV photoinitiation. *International Journal of Pharmaceutics*, 529: 523-530.
- Aboulkhair NT, Everitt NM, Maskery I, Ashcroft I, Tuck C. (2017) Selective laser melting of aluminum alloys. *MRS Bulletin*, 42: 311-319.
- He Y, Tuck CJ, Prina E, Kilsby S, Christie SDR, Edmondson S, Hague RJM, Rose FRAJ, Wildman RD. (2017) A new photocrosslinkable polycaprolactone-based ink for three-dimensional inkjet printing. *Journal of Biomedical Materials Research - Part B Applied Biomaterials*, 105: 1645-1657.

Recent Scientific and Technological Advances

- Development of 20+ new inks for 3D inkjet including those for microelectronics, medical devices, pharmaceuticals and bio-compatible materials.
- First successful (accurate and repeatable) deposition of high temperature metallics by drop-on-demand jetting (metaljet), giving rise to the potential of digital metals not possible in other AM techniques.
- Successful “reactive jetting” (separate deposition of monomers and catalyst followed by in-situ polymerisation) that exploits the drop-on-demand potential of inkjet whilst overcoming the inherent viscosity and rheological material challenges of deposition by piezo driven actuation.
- High viscosity jetting of silicones giving rise to a wider palette of engineering materials.
- Low temperature laser consolidation of bulk nanoparticle slurry feedstock, enabling the processing of copper for electronic applications.
- Multiphoton polymerisation coupled with optical tweezers enabling the manipulation of particles (via optical tweezing) and freezing in place with two photon mechanisms, giving the capability to build up structures with defined materials (effectively a nanocomposite production system).
- Investigation and development of computational methods and design systems for multifunctional AM capable of creating cellular structures.

Journal Editors

- Dr Martin Baumers, Associate Editor for the Special Issue in the *Journal of Industrial Ecology: Environmental Dimensions of Additive Manufacturing and 3D Printing*.

Research Projects

EPSRC Formulation for 3D printing

Professor Ricky Wildman, £3.53m (EP/N024818/1)

Creating a plug and play platform for a disruptive UK industry. Industry contributions to Formulation for 3D printing: £446k (UK) and \$231k (US)

EPSRC Future Additive Manufacturing Platform Grant

Professor Richard Hague, £1.73m (EP/P027261/1)

US Air Force Office of Scientific Research

Professor Ricky Wildman, £116k

Complex materials for advanced device fabrication through the combination of holographic optical tweezers and multiphoton absorption

EPSRC Centre for Doctoral Training in Additive Manufacturing and 3D printing

Professor Chris Tuck, £4.5 million

EPSRC Studentship Funding £258k and £96k industry funding (EP/101534x/1).

Prizes and Awards

- Dr Yinfeng He received internal funding from the university through Hermes fellowship for development of a prototype machine for a new 3D printing technique. The basic concept of this technique has been approved in previous work and a patent has been filed at the University of Nottingham in November 2016.

Equipment and Facilities

- CfAM in collaboration with Schools of Pharmacy and Chemical Engineering was successful in securing funding from Wolfson Foundation for a new clean room facility. This unique facility will be a platform for demonstrating the power of AM to change pharma delivery aiming to produce tablets that offer control over structure and composition, ultimately allowing the dose and the drug(s) to be personalised to the need of patients.

Conferences and Events

- Annual International Conference on Additive Manufacturing and 3D Printing.
- The Engineering and Science for Sustainable Future (ESSF), interdisciplinary PG student led conference (Joint AM, Sustainable Chemistry and BBSRC CDT) - June 2017.



Centre for Structural Engineering and Informatics

Head of Group

Dr Walid Tizani

The Centre for Structural Engineering and Informatics (CSEI) is a major centre for research in structural engineering, computational mechanics, construction materials, wind engineering, engineering design and construction informatics leading to solutions that contribute toward modern, resilient and sustainable societies.

The Centre works with world-leading universities and industrial partners to address the challenges of building, connecting and operating future cities. CSEI brings the information technology revolution to construction, using new computational modelling techniques to better understand structures and materials, allowing the life of existing infrastructures to be safely extended and improving resilience against natural and man-made hazards.

Research Areas

- Advanced Construction Materials
- Engineering Design and Construction
- Structural and Computational Mechanics
- Wind Engineering and Structural Dynamics
- Building Information Modelling

More information can be found on the CSEI website:
▶ nottingham.ac.uk/go/csei

Key Publications

- Abdelatif, A. O., Owen, J. S., & Hussein, M. F., 2017, Modelling and parametric study of the re-anchorage of ruptured tendons in bonded post-tensioned concrete, *Structural Engineering*, 143(12).
- Kakouris, E. G. and Triantafyllou, S. P., 2017, Phase-field material point method for brittle fracture, *Numerical Methods in Engineering*, 2017, 112, 1750-1776.
- Liu, T., 2017, Simulation of cell-substrate traction force dynamics in response to soluble factors, *Biomechanics and Modeling in Mechanobiology*, 2017, 16(4), 1255-1268.
- Ninic, J. and Meschke G., 2017, Simulation based evaluation of time-variant loadings acting on tunnel linings during mechanized tunnel construction, *Engineering Structures*, 135, 21-40.
- Oti, A. H., Tizani, W., Abanda, F. H., Jaly-Zada, A. & Tah, J. H. M, 2016, Structural sustainability appraisal in BIM, *Automation in Construction*, 69, 44-58.

Committees

- Scientific Committee for The 8th annual Symposium on Simulation for Architecture and Urban Design (SimAUD) 2017 conference, Toronto, Canada, May 22-24, 2017.
- Editorial Board and Technical Committee of the ASCE 2017 International Workshop on Computing in Civil Engineering (IWCCE 2017). the University of Washington, Seattle, Washington, USA from June 25 – 27, 2017.
- International scientific Committee of the European Conference on Product and Process Modelling (ECPPM 16), Limassol Cyprus 9-11 September 2016.
- Scientific Committee of the 16th International Conference on Computing in Civil and Building Engineering, ICCCB2016, Osaka July 6 - 8, 2016, Japan.
- BSI Committee B/525/01/02 Wind loadings.

Journal Editors

- Dr Walid Tizani is an Associate editor of the American Society of Civil Engineers Journal of Computing in Civil Engineering and Editor-In-Chief of the Journal of Advances in Computational Design, Techno Press.
- Dr John Owen is on the Editorial board of Proceedings of the ICE, Engineering and Computational Mechanics.

Research Projects

CSEI started four projects between August 2016 and July 2017. These projects were sponsored by a range of funders and industrialists such as, Horizon 2020; Defence Science and Technology Laboratory (DSTL); EPSRC; the Royal Society; and Zhongliang Graphene & Science Tech Corp, including:

Defence Science Technology Laboratory (DSTL)

£92,394

Development of bioinspired, lightweight self-healing composite synthetic foam core sandwich structures for blast mitigation

Zhongliang Graphene and Science Tech Corp

£1,121,528

Research and industrialization of graphene Lithium-sulphur battery with high performance

EPSRC PAF DSTL

£3,500

Royal Society

£12,436

Understanding strain rate sensitivity of fibre reinforced composite materials: a multiscale approach

Horizons 2020 – MARQUESS

CleanSky II project (as Co-investigator), £105,000

Horizons 2020 – Safe-FLY ITN project

(as Co-investigator), £123,896

External Activities

Conferences and Events

- Organised the 24th Workshop on Intelligent Computing in Engineering, Nottingham 10-12 July 2017
- Organised the “Uncertainty Quantification across multiple scales for solid mechanics” Mini symposium for the 2017 International Conference on Uncertainty Quantification in Computational Sciences and Engineering, 15-17 June 2017, Rhodes Island, Greece.
- Organised the “Computational Methods for Nonlinear Dynamic Processes” Minisymposium for the 2016 EMI International Conference, October 25-27, 2016, Metz, France.

Postgraduate Research Activities

- CSEI PhD student Alex Hardcastle has been awarded Best Oral Presentation for his presentation “A new coupled computational framework for fluid pressurized frack evolution in porous media” at the 3rd Annual InterPore Conference on Porous Media, Warwick 4-5 Sept 2017.



Cleaner Fossil Energy and Carbon Capture Technologies

Head of Group
Professor Colin Snape

The vision of the Cleaner Fossil Energy and Carbon Capture Technologies (CFECCT) Research Group is to be central to accelerating the development of the next generation of more efficient CO₂ capture, and to expand the range of cleaner technologies for coal, biomass and waste utilisation. The vision maps directly onto the drive for de-carbonisation across the power, heat and industry sectors, much of this being articulated through the recently published Industrial Strategy. This will be achieved by building upon our current grant portfolio including Centres for Doctoral Training and a number of EPSRC, EU and Industry-funded projects. The Group will continue to act as hub within the Faculty and the University for Cleaner Fossil Energy research including conventional power generation, CO₂ capture and biomass thermochemical conversion technologies.

Research Areas

- Carbon Dioxide Capture
- Combustion and Cleaner Coal Technologies
- Biomass Thermochemical Conversion
- Oil, Gas and the Environment
- Smart Materials

More information can be found on the CFECCT website:
nottingham.ac.uk/go/cfecct

Research Projects

Antaco industrial contribution to an EngD project within the CDT for Lewis Tuck

Professor Colin Snape, £20,000

Innospec industrial contribution to an EngD project within the CDT for studentships Matteo

Professor Colin Snape, £20,000

8 EPSRC Centre for Doctoral Training Studentships EPSRC within the CDT for Carbon Capture Storage and Cleaner Fossil Energy

Professor Colin Snape, £471,000

Innovate Embedded systems

Dr Yupeng Wu, £205,648

A low cost solution for solar energy systems integrated into building facades and/or building roofs, by developing a novel lightweight BIPV system with optimised performance suitable for use in windows or glazed façades in buildings.

Equipment

- The Group benefits greatly from the wide range of modern analytical, laboratory and pilot-scale equipment available. The £2.5 million G-ERA funding obtained by the Group for pilot-scale facilities is being invested in (i) a hydrothermal carbonisation pilot-plant (£2 million) for converting wet waste biomass/waste into biocoal which is being constructed at Immingham and will be operated by CPL and (ii) a CO₂ capture rig to test new adsorbents on a 10 kg scale which will be placed in the in the Research Acceleration and Demonstration (RAD) Building (£0.5 million). The £1.5 million analytical facilities (DECC/EPSC capital grants, 2014) are linked externally to the EPSRC Pilot-scale Advanced Capture Test (PACT) facilities, led by the University of Sheffield, the British Geological Survey (BGS) and the Centre of Environmental Geochemistry, with the latter primarily for research on shale gas.

External Activities

Conferences and Events

A keynote was delivered by Professor Colin Snape and colleagues at the American Association of Petroleum Geologists SEG Conference, 15-18 October 2017, London entitled: An evaluation of shale gas potential in the Bowland Shale, UK using sequential high pressure water pyrolysis and methane adsorption.

Professor Colin Snape was a member of the International organising Committee for the 2017 international Conference on Coal science and technology.

International

- The Group has significant international reach within Europe and China. Currently, Dr Wu has a joint funded project with Sichuan University. Professor. Liu and Dr Sun are Special Professors at Southeast and Shangdong Universities, respectively. Professor. Snape has been a Professorship for Senior International Scientists in the Chinese Academy of Sciences, at the Shanghai Advanced Research Institute (SARI) and a joint Nottingham-SARI Research Centre on Low Carbon Technologies has been established. This has led to a joint doctoral training programme (10 PhDs per annum) being set up between SARI and Ningbo campus. Professor. Liu and Dr Sun had recently succeeded in securing £40k Newton Institutional Links Grant with partners in Mexico.

Postgraduate Research Activities

- Numbers remain high with the current 32.5 students split roughly 50:50 between CDT and international students.

Key Publications

Publications are continuing to be a real strength of the Group with over 30 peer reviewed publications during 2017 with >30% in the top 10% most cited journals and >50% in top 10% SNIP journals.

- Hoshino Y, Poshibaeva A, Meredith W, Snape CE, Poshibaev V, Versteegh GJM, Kuznetsov N, Leider A, van Maldegem L, Neumann M, Naeher S, Moczyłowska M, Brocks JJ, Jarrett AJM, Tang Q, Xiao S, McKirdy D, Das SK, Alvaro JJ, Sansjofre P, Hallmann C. (2017) Cryogenian evolution of stigmateroid biosynthesis. *Science Advances*, 3: e1700887.
- Liu X, Sun Y, Liu J, Sun C, Liu H, Xue Q, Smith E, Snape CE. (2017) Potassium and zeolitic structure modified ultra-microporous adsorbent materials from a renewable feedstock with favourable surface chemistry for CO₂ capture. *ACS Applied Materials and Interfaces*, 9: 26826-26839.
- Sun Y, Liang R, Wu Y, Wilson R, Rutherford P. (2017) Development of a comprehensive method to analyse glazing systems with Parallel Slat Transparent Insulation material (PS-TIM). *Applied Energy*, 205: 951-963.
- Connelly K, Wu Y, Chen J, Lei Y. (2016) Design and development of a reflective membrane for a novel Building Integrated Concentrating Photovoltaic (BICPV) 'Smart Window' system. *Applied Energy*, 182: 331-339.
- Zhang W, Sun C, Snape CE, Irons R, Stebbing S, Alderson T, Fitzgerald D, Liu H. (2017) Process simulations of post-combustion CO₂ capture for coal and natural gas-fired power plants using a polyethyleneimine/silica adsorbent. *International Journal of Greenhouse Gas Control*, 58: 276-289.
- Sarroza AC, Bennet TD, Eastwick C, Liu H. (2017) Characterising pulverised fuel ignition in a visual drop tube furnace by use of a high-speed imaging technique. *Fuel Processing Technology*, 157: 1-11.

Outreach

- Regular activities are held with local schools, including Carlton Le Willows Academy and the Bluecoat Academy via the EPSRC Centre for Doctoral Training in Carbon Capture Storage and Cleaner Fossil Energy.
- For more information about the CFECCT Centre for Doctoral Training, please view the Centre's YouTube video: <https://www.youtube.com/watch?v=z2Z1GuMcDrg&t=1s>





Composites

Head of Group

Professor Nick Warrior

The Composites Research Group works on materials science, design and manufacturing projects for composites across the TRLs 1 to 6. Working closely with academic and industrial partners from the automotive, aerospace and rail sectors and the materials supply chain we aim to develop sustainable technologies for carbon fibre composites in high-performance applications. We lead the EPSRC Future Composites Manufacturing Research Hub with The University of Bristol and our work includes developing high-fidelity simulations of manufacturing processes and relating the output to the material and mechanical properties of the composites components. We have proven models for mechanical simulation and failure prediction in multi-scales, including the well-known TexGen software. In our new Advanced Manufacturing Building we have a well-founded laboratory including automated robotics cells, autoclave and out-of-autoclave facilities including compression moulding and a range of preforming technologies including braiding, diaphragm forming and a new emerging Hub-based activity in automated fibre deposition.

Research Areas

- Composites Manufacturing
- Textile Composites
- Mechanical and Failure Analysis
- Recycling of Composites
- Biocomposites

More information can be found on the Composites website:
nottingham.ac.uk/go/composites

Research Projects

EPSRC - The Future Composites Manufacturing Hub

Professor Andy Long, £7,899,241

Underpinning the development of next-generation composite manufacturing processes to reduce cost, increase performance and improve sustainability.

Horizon 2020 - CleanSky 2 - Multiscale Analysis of Airframe Structures and Quantification of Uncertainties System (MARQUESS)

Professor Arthur Jones, £590,541

MARQUESS will enable comprehensive modelling and simulation studies to optimise decision making regarding the structural design of aircraft platforms.

Horizon 2020 - European industrial doctorate for damage modelling and online detection in aerospace composite structures (SAFE-FLY)

Dr Dimitrios Chronopoulos, £505,697

Developing efficient techniques for predicting ultrasonic wave interaction with damage in composite structures for structural health monitoring of aerospace structures.

Innovate UK: Project Century - Building a volume supply chain for affordable lightweight composite structures (DALV - GKN Composite Reinforced Tubular Components)

Professor Nick Warrior, £250,016

Developing design and manufacturing technologies to produce structural composites at the rates required by volume automotive applications.

Innovate UK: Thermoplastic Overmoulding for Structural Composite Automotive Applications (TOSCAA)

Professor Nick Warrior, £265,137

Integrating a range of innovative, lightweight material and process technologies to enable development of a unique thermoplastic over-moulded structural automotive component.

AVIC: Design and Strength Analysis of Braided Composite Joints

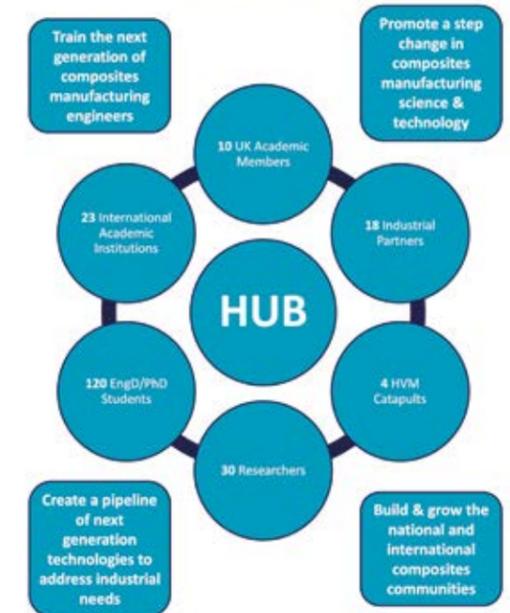
Professor Shuguang Li, £100,000

Utilising expertise in the area of characterising 3D textile composites to facilitate the design of typical structural elements.

Key Publications

- Matveev MY, Long AC, Brown LP, Jones IA. (2017) Effects of layer shift and yarn path variability on mechanical properties of a twill weave composite. *Journal of Composite Materials*, 51: 913-925.
- Meng F, McKechnie J, Turner TA, Pickering SJ. (2017) Energy and environmental assessment and reuse of fluidised bed recycled carbon fibres. *Composites Part A: Applied Science and Manufacturing*, 100: 206-214.
- Li S, Sitnikova E, Liang Y, Kaddour A-S. (2017) The Tsai-Wu failure criterion rationalised in the context of UD composites. *Composites Part A: Applied Science and Manufacturing*, 102: 207-217.
- Chen S, McGregor OPL, Endruweit A, Elsmore MT, De Focatiis DSA, Harper LT, Warrior NA. (2017) Double diaphragm forming simulation for complex composite structures. *Composites Part A: Applied Science and Manufacturing*, 95: 346-358.
- Chronopoulos D. (2017) Wave steering effects in anisotropic composite structures: Direct calculation of the energy skew angle through a finite element scheme. *Ultrasonics*, 73: 43-48.
- Corbridge DM, Harper LT, De Focatiis DSA, Warrior NA. (2017) Compression moulding of composites with hybrid fibre architectures. *Composites Part A: Applied Science and Manufacturing*, 95: 87-99.

EPSRC Future Composites Manufacturing Research Hub





Environment, People and Design

Head of Group
Dr Pete Rutherford

Not only can building developments have an effect on the environment, but they can impact on society too. The Environment, People and Design (ePaD) Research Group aims to improve the quality of life, health and wellbeing for individuals within the built and natural environments. This aspiration means the group conducts research which can guide the design and management of environments to have a positive impact on those individuals, communities and societies who inhabit them. The focus of ePaD is on the application of physical principles to the environmental modelling and design of technologies, buildings and urban settlements.

Research Areas

- Appropriate and Sustainable Design
- Environmental Science, Modelling and Psychophysics
- Landscape Architecture and Design

More information can be found on the ePaD website:
nottingham.ac.uk/go/epad

Key Publications

- Sun Y, Liang R, Wu Y, Wilson R, Rutherford P. (2017) Development of a comprehensive method to analyse glazing systems with Parallel Slat Transparent Insulation material (PS-TIM). *Applied Energy*, 205: 951-963.
- Yan F, Wilson R, Rutherford P, Craik RJM. (2016) The use of damping to reduce the contribution of flanking paths to sound transmission in buildings. *Noise Control Engineering Journal*, 64: 64-74.
- Sousa G, Jones BM, Mirzaei PA, Robinson D. (2017) A review and critique of UK housing stock energy models, modelling approaches and data sources. *Energy and Buildings*, 151: 66-80.
- Gallagher M, Beard M, Clifford MJ, Watson MC. (2016) An evaluation of a biomass stove safety protocol used for testing household cookstoves, in low and middle-income countries. *Energy for Sustainable Development*, 33: 14-25.
- Allen K, K Connelly K, Rutherford P, Wu Y. (2017) Smart windows—Dynamic control of building energy performance. *Energy and Buildings*, 139: 535-546.
- Altomonte S, Logan B, Feisst M, Rutherford P, Wilson R. (2016) Interactive and situated learning in education for sustainability. *International Journal of Sustainability in Higher Education*, 17: 417-443.
- Sivapalan S, Clifford MJ, Speight S. (2016) Engineering education for sustainable development: using online learning to support the new paradigms. *Australasian Journal of Engineering Education*, 21: 61-73.
- Shah DU, Nag RK, Clifford MJ. (2016) Why do we observe significant differences between measured and 'back-calculated' properties of natural fibres? *Cellulose* 23: 1481-1490.
- Porter N. (2017) Branding Landscape. LA Plus: *Interdisciplinary Journal of Landscape Architecture*, 82-89.

Research Projects

The ePaD group started three projects between August 2016 and July 2017, sponsored by HEFCE and Innovate UK.

Innovate Smart Biogas Network

Dr Mike Clifford, £68,226

Biomass Fuel at the Nexus: Policy Lessons from bottom-Up Perspectives in Urban Ghana

Dr Mike Clifford, £55,000

Higher Education Funding Council (HEFCE) Mindfulness and Space: Environments for Well-being

Dr Nicole Porter, £1,087

Equipment

- Cirrus Research Trojan 2 Noise Nuisance Recorder.

Esteem Indicators

Committees

- Dr Ben Jones: CIBSE Natural Ventilation Group committee member.

Prizes and awards

- Dr Mike Clifford won the Universitas 21 Award for Internationalisation (2016) "for long-term dedication to the furthering of international education"

External Activities

Conferences and Events

- Dr Ben Jones organised the Air Infiltration and Ventilation Centre: Workshop on Health Metrics for Buildings March 2017. He was also a speaker at:
 - ▶ Achieving better homes, better air, better health. Royal College of Paediatrics and Child Health April 2017.
 - ▶ Air Infiltration and Ventilation Centre: Health Metrics for Buildings: workshop review March 2017.
 - ▶ Chartered Institution of Building Services Engineers: Breath Easy: Is it possible for low energy houses to be healthy? October 2016.

Outreach

- Dr Ben Jones was appointed Chair and primary author of CIBSE Applications Manual 10 (Natural Ventilation in Non-Domestic Buildings) revision working party.

International

- Dr Ben Jones was invited to be a board member and UK representative at the Air Infiltration and Ventilation Centre, attending meetings in Nottingham and Brussels.

Committees

- Dr Nicole Porter, Dr Ben Jones and Dr Parham Ahranjani contributed to the Environment, Food and Rural Affairs Committee's Joint inquiry into improving air quality.





Fluids and Thermal Engineering

Head of Group

Professor Yuying Yan

With core expertise covering the fields of experimental fluid mechanics, computational fluids dynamics, two-phase flow, heat transfer enhancement and thermodynamics, the Fluids and Thermal Engineering (FLUTE) Research Group works on a large variety of technology applications, including internal combustion engines, HVAC and refrigeration, gas and oil processing, thermal management and heat exchangers. The work performed by this group has led to improvements in the efficiency of fluid controls, conventional and new energy cars, refrigeration and air-conditioning units, and chemical and industrial processes.

FLUTE is a cornerstone discipline underpinning a large variety of industrial sectors, such as automotive, power machinery, power generation, power electronics, aerospace, gas and oil, and renewable energy. It is also playing a vital role in many other engineering fields, including new material fabrication, sustainable manufacturing and aerospace and marine technologies, medical and pharmaceutical engineering, etc. Due to this, group members have delivered internationally recognised research over the past decades and gained international reputations.

Research Areas

- Engines and Combustion
- Heat Transfer Enhancement
- HVAC, Refrigeration and Thermal Management
- Multiphase Flow
- Process Optimisation
- Turbine and Wing Fluid Mechanics

More information can be found on the FLUTE website:
nottingham.ac.uk/go/flute



Research Projects

EPSRC Innovative Low Carbon, High Fuel Efficiency Power Generation Technology

Professor Alistair Cairns, £110,813

To improve understanding of the ideal combustion system via theoretical analysis, simulation and engine testing.

EPSRC Nano-structured PCM Composites for Compact Space Heating: n-CoSH

Dr Donald Giddings, £284,461

Developing the next generation of high energy density, affordable and sustainable PCM-based composites that are suitable for thermal storage devices, specifically for domestic space heating applications

EPSRC Electromagnetically-assisted Catalytic-upgrading of Heavy Oil (ECHO)

Professor Sean Rigby, £332,197

On Developing downhole upgrading for heavy oil production beyond current capabilities to obviate the need for surface plant, and reduce the environmental impact of heavy oil production. The objectives are to develop new, hybrid, thermal and electromagnetic production technology, together with a suitable optimised catalyst to use with the new technology.

Total new projects: £2,416,156.

Equipment

- Dr Mark Jabbal has secured funding to acquire a wind tunnel test facility from Imperial College London.

External Activities

Conferences and Events

- Cross campus groups FLUTE and UNNC's Research Centre for Fluids and Thermal Engineering (FTE) organised 3rd international symposium of Fluids and Thermal Engineering (Professor Yuying Yan was the conference chair), received 150 papers and welcomed 135 attendees from more than 12 countries and regions. Seven academic members and eight PhD students from both FLUTE and FTE attended the conference.
- 17 student members from FLUTE participated in the International Conference on Multiphase Flow (ICMF) in Florence, Italy.
- Professor Yuying Yan has been elected to the UK Heat Transfer Committee (UKHTC). A decision has been made by the committee to hold the next national heat conference in Nottingham, UK in September 2019.

International

- Dr David Hann and Dr Buddhi Hewakandamby are working with the Russian Institute, via the EPSRC/Royal Academy Memphis grant.
- Professor Yuying Yan leads the EU funded ThermSmart Network (2017-2021) with 20 partners including international partners in Europe, Brazil, South America, China, Canada, Japan and the USA.
- Dr Xuerui Mao leads the EU network on turbo machinery flow 2017-2021.
- FLUTE hosted the visit of a delegation from RIPED PetroChina, one of the world top 500 companies, and the UoN PVC signed the new Memorandum of Understanding (MoU) for collaboration in January 2018.

Key Publications

- Mao X, Zaki TA, Sherwin SJ, Blackburn HM. (2017) Transition induced by linear and nonlinear perturbation growth in flow past a compressor blade. *Journal of Fluid Mechanics*, **820**: 604-632.
- Cherdantsev AV, Hann DB, Hewakandamby BN, Azzopardi BJ. (2017) Study of the impacts of droplets deposited from the gas core onto a gas-sheared liquid film. *International Journal of Multiphase Flow*, **88**: 69-86.
- Rabiou AM, Greaves M, Rigby SP. (2017) Dynamic Simulation of the Toe-to-Heel Air Injection Heavy Oil Recovery Process. *Energy and Fuels*, **31**: 1276-1284.
- Li B, Huang K, Yan Y, Li Y, Twaha S, Zhu J. (2017) Heat transfer enhancement of a modularised thermoelectric power generator for passenger vehicles. *Applied Energy*, **205**: 868-879.
- Janjua ZA, Turnbull B, Choy K-L, Pandis C, Liu J, Hou X, Choi K-S. (2017) Performance and durability tests of smart icephobic coatings to reduce ice adhesion. *Applied Surface Science*, **407**: 555-564.



Food, Water and Waste

Head of Group

Professor Patrick (PJ) Cullen

The Food, Water and Waste (FWW) Research Group are a newly formed multidisciplinary group aiming to deliver sustainable and resilient solutions to global challenges in the areas of food, water and resource security. The group has a wide range of expertise and collaborates with the food, bioproducts, waste and resource management, wastewater and agriculture industries.

Research Areas

- Advanced Processing Technologies
- Digestion
- Product Structural Design
- Sensors, Analytics and Modelling
- Waste and Resource Management
- Wastewater Treatment and Reuse

More information can be found on the FWW website:
nottingham.ac.uk/go/fww

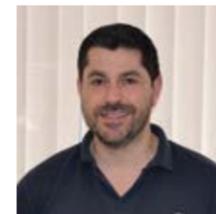
Introducing the new FWW academics to the Faculty of Engineering:



Dr Ourania Gouseti

Assistant Professor in Food Process Engineering

I've studied chemistry (BSc), food science (MSc), and chemical engineering (PhD). I'm fascinated by the delicate nature of food structures, and its importance in determining the characteristics and functionality of foods. I'd like to understand questions such as what makes a food safe, easy to transport, tasty and healthy, and how can we reduce food wastes and by-products. I study formation of food structures as well as de-structuring of food materials under different environments. As an example, one such environment is the human digestive system and my aim in this area is to promote healthy food design by understanding how different foods are digested in the gut. Through my work I aim to contribute in addressing global challenges, including public health, food security, and sustainability in the food sector. I have also studied and worked with music, as a performer and a composer.



Professor PJ Cullen

Professor in Process Engineering

I moved to UoN in June 2017 from the University of New South Wales in Sydney. My research is focused on the development of novel technologies for biological applications including agriculture, food, water and medicine. I am particularly interested in how non-thermal plasmas interact with biological material for food preservation, water treatment, crop growth and cancer treatment. I also research on the related field of Laser Induced Breakdown Spectroscopy (the laser famously used on the mars rover), to detect and map trace elements in plants, foods and drugs facilitating rapid detection of both beneficial and harmful chemicals.



Professor Serafim Bakalis

Professor in Food Process Engineering

Professor Serafim Bakalis has obtained a BS in Chemical Engineering from the National Technical University of Athens, Greece and a PhD in Food Science. His research interests include using a range of computational (e.g. CFD) and experimental techniques (e.g. experimental flow dynamics) to characterise complex phenomena and design food processes. Using the same techniques Professor Bakalis has developed models to describe and predict performance of consumer products, e.g. cleaning products, foods. Professor Bakalis has secured over £3m of funding over the years published more than 90 papers and 200 conference presentations. He is an Editor at the Food and Bio products Processing Part C



Dr Helena Gomes

Anne McLaren Research Fellow

Helena Gomes' fellowship aims to address two global challenges of modern society: the provision of water at a quality that is fit for reuse and generation of renewable, clean forms of energy.

These staff members will be joined in the new Food, Water and Waste group by existing Faculty colleagues, including:

- Dr Rachel Gomes
- Dr Richard Smith
- Dr Becca Ferrari
- Dr Nik Watson



Gas Turbines and Transmissions Research Centre

Head of Group

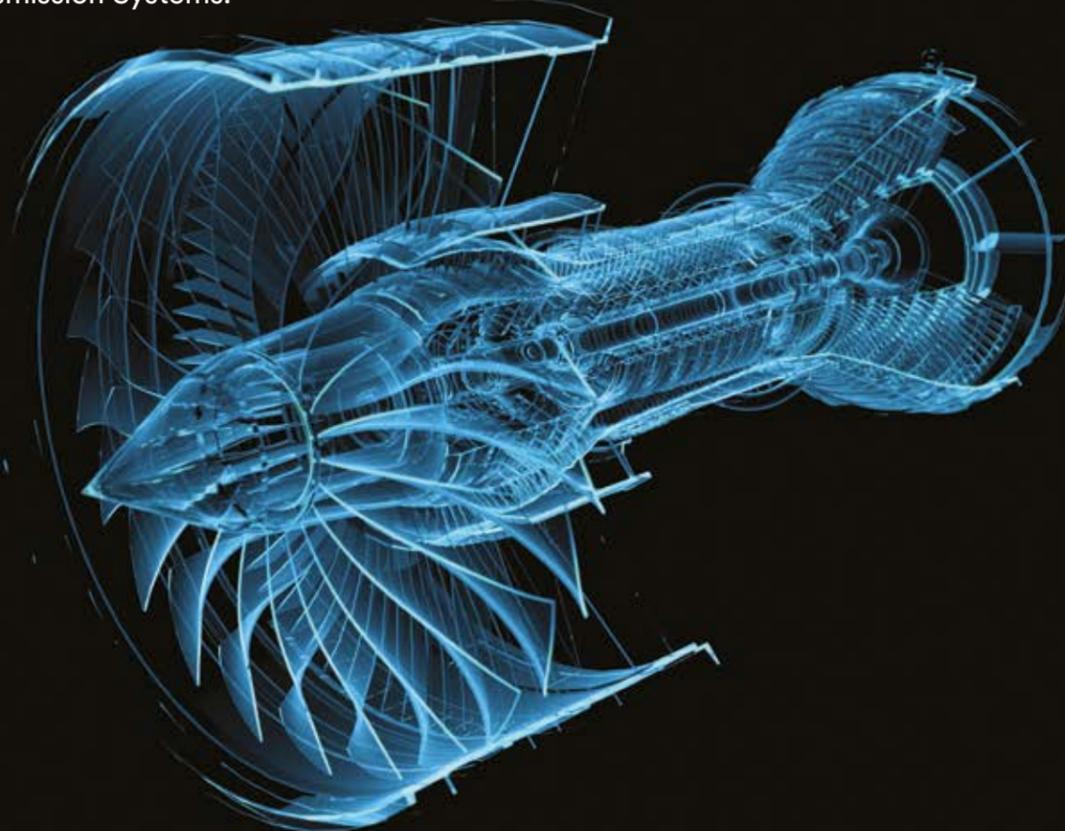
Professor Hervé Morvan

The inside of an aeroplane engine is full of components moving at high speed, with oil lubricating the rotating and stationary parts to reduce friction and prevent overheating. The aim of the Gas Turbine and Transmissions Research Centre (G2TRC) is to develop new technologies, analysis methods and understanding for existing and future gas turbine core and transmissions architectures, improving efficiency and reducing environmental impact. To achieve this, the Group has world-leading expertise in fluid-flow and heat transfer; materials engineering; and friction, wear and fatigue analysis at standard and elevated temperatures. The Group works closely with engineers at Rolls Royce Aerospace to improve the parts of the engine known as the transmission system, including everything to do with oil delivery and oil movement. Our work helps engine designers make more efficient and cleaner engines and also gives them better methods for doing the design work. G2TRC is also host to the Rolls Royce University Technology Centre in Gas Turbine Transmission Systems.

Research Areas

- Lubrication and Thermal Management
- Static and Dynamic Modelling
- Mechanical Behaviour and Materials Characterisation
- Computational Fluid Dynamics
- Process Modelling

More information can be found on the G2TRC website:
nottingham.ac.uk/go/g2trc



Research Portfolio

G2TRC has a total Research Portfolio of £22,027,684 with 12 projects worth £5,673,402 starting between August 2016 and July 2017. These projects were sponsored by a range of funders and industrialists such as Rolls Royce, Horizon 2020, the EPSRC, the Aerospace Technology Institute and Innovate UK; including:

Innovate UK: Critical Oil and Air System Technologies (COAST)

Dr Kathy Simmons, £1,560,000

To investigate hydraulic sealing in modern aero-engines with a view to minimise leakages, improve efficiency, allow for higher pressures and manage weight. One highlight of the project involves combining experimental work with the use and optimisation of smooth particle hydrodynamics, a meshless numerical technique, which the Centre has championed over the years for simulating bearing chambers.

H2020 Clean Sky 2: AERIS

Professor Hervé Morvan, £2,214,218

To consolidate, enhance and demonstrate the past 10 years of multiphase computational fluid dynamics development carried out at the Gas Turbines and Transmission Research Centre and the Rolls Royce Transmissions University Technology Centre at the University of Nottingham. This project is one of the Clean Sky 2 flagship projects led by Rolls Royce, for which the University is a core partner. It is carried in partnership with ANSYS who will implement the core developments in their models and solvers. The project will include experimental validation and engine-scale demonstration to increase the readiness of the technology.

EPSRC CornerStone

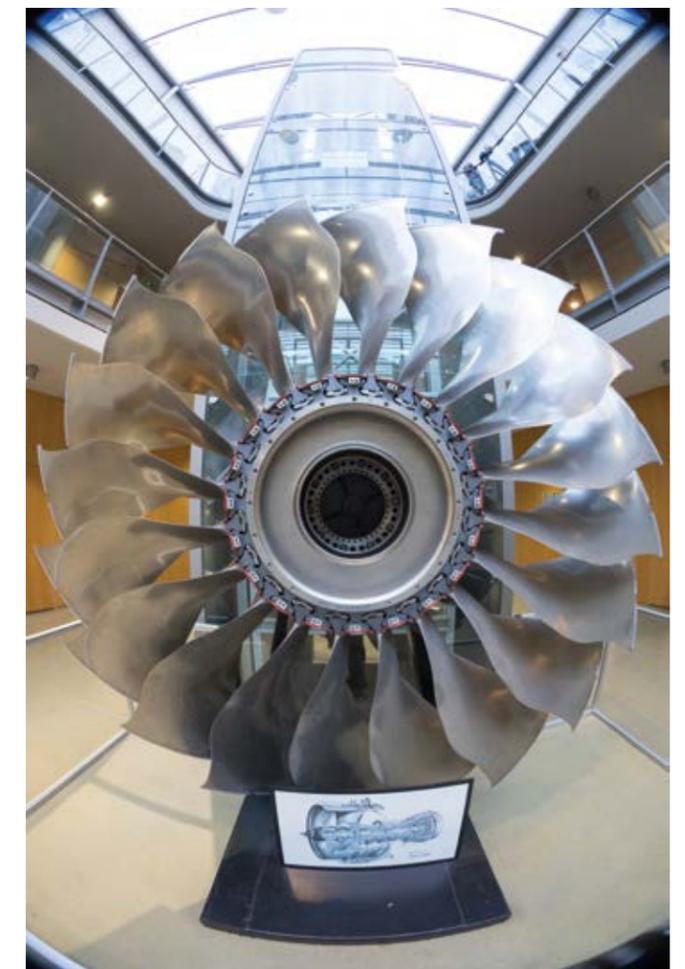
Professor Seamus Garvey, £4,628,571

This project, led by the University of Nottingham, involves the University of Oxford and Imperial College London. The project sets the foundation for the Rolls-Royce Mechanical University Technology Partnership which is the next evolution of the Rolls-Royce model of engagement with universities, and is set to investigate advanced mechanical engineering science to support future aero-engine architectures. At the University of Nottingham, the focus will be on thermal management and electro-mechanical couplings and interactions.

In parallel, the Gas Turbines and Transmissions Research Centre undertakes a range of activities on advanced materials and processes for application to aerospace and the energy sector. This includes the first Aerospace Technology Institute national facility: the 3-shaft test facility which is due for commissioning in 2018 and will support key activities in research and teaching with global customers.

Key Publications

- Sciacovelli A, Li Y, Chen H, Wu Y, Wang J, Garvey S, Ding Y. (2017) Dynamic simulation of Adiabatic Compressed Air Energy Storage (A-CAES) plant with integrated thermal storage – Link between components performance and plant performance. *Applied Energy*, **185**: 16-28.
- Hasan AF, Bennett CJ, Shipway PH, Cater S, Martin J. (2017) A numerical methodology for predicting tool wear in Friction Stir Welding. *Journal of Materials Processing Technology*, **241**: 129-140.
- Adeniyi AA, Morvan H, Simmons K. (2017) A Computational Fluid Dynamics Simulation of Oil-Air Flow between the Cage and Inner Race of an Aero-engine Bearing. *Journal of Engineering for Gas Turbines and Power*, **139**: 012506.
- Dodds PE, Garvey SD. (2016) The Role of Energy Storage in Low-Carbon Energy Systems. *Storing Energy: With Special Reference to Renewable Energy Sources*, Book Chapter Pages 3-22.
- Bristol A, Morvan HP, Simmons KA. (2016) Evaluation of a volume of fluid CFD methodology for the oil film thickness estimation in an aero-engine bearing chamber. *Proceedings of the ASME Turbo Expo*, Volume 2C-2016.





Geohazards and Earth Processes

Head of Group
Professor Stuart Marsh

Whether it is human activity such as drilling or natural occurrences like tsunamis and volcanic eruptions, there are a number of geohazards that cause major damage to the environment and infrastructure. In a time of significant environmental change, the grand challenges posed by Earth processes and their related geological hazards require integrated solutions. The Geohazards and Earth Processes (GEP) Research Group observe, numerically and physically model the changing Earth system to predict when hazards will occur and how we can prepare our infrastructure for their impact. The group uses their expertise to analyse geological hazards that relate to, for example, the processes of ground motion, erosion and debris flows, which in turn are controlled by large scale climate, hydrology, hydrogeological, tectonic, biological and anthropogenic factors. The group conducts research to be able to better assess the risk posed by these process to rocks, soils and water resources, all of which could have a significant impact on our planet.

Research Areas

- Ground Motion
- Ice and Avalanches
- Peat
- Risk & Resilience
- Tsunamis
- Volunteered Geographic Information

More information can be found on the GEP website:
nottingham.ac.uk/go/gep

Research Funding

Our Peat research activities started with seed corn funding from the University in 2015 to support a large international field workshop, and has since gone on to encompass three large grants, two post docs and an emerging set of high quality papers.

The main grant from the Natural and Environmental Research Council (NERC) is led by Dr David Large and involves validating a new and transformative remote sensing method to address the goals of their soil security programme by improving predictive understanding of the ability of peat to perform multiple functions in different landscape and climate settings, and resist, recover and adapt to changes in climate. The project is now well underway and has recorded some quite interesting surface dynamics over Munsary.

Another highlight was the successful completion of the EU funded HYDRALAB+ test campaign about “Tsunamis due to ice masses: Different calving mechanisms and linkage to landslide-tsunamis” in August 2017 at Deltares in Delft. Dr Valentin Heller led this work as project leader, with team members coming from the Coastal Research Centre in Hannover, TU Delft, ETH Zurich and Free University of Bozen-Bolzano. Several interviews have been given for the Dutch News Papers Kennislink and De Volkskrant.

Key Publications

- Heller V. (2017) Self-similarity and Reynolds number invariance in Froude modelling. *Journal of Hydraulic Research*, **55**: 293-309.
- Ali JM, Marsh SH, Smith MJ. (2016) Modelling the spatiotemporal change of canopy urban heat islands. *Building and Environment*, **107**: 64-78.
- Marshall C, Large D, Heavens N. (2016) Coal-derived rates of atmospheric dust deposition during the Permian. *Gondwana Research*, **31**: 20-29.
- Sowter A, Amat MC, Cigna F, Marsh S, Athab A, Alshammari L. (2016) Mexico City land subsidence in 2014-2015 with Sentinel-1 IW TOPS: Results using the Intermittent SBAS (ISBAS) technique. *International Journal of Applied Earth Observation and Geoinformation*, **52**: 230-242.
- Uguna JO, Carr AD, Marshall C, Large DJ, Meredith W, Jochmann M, Snape CE, Vane CH, Jensen MA, Olausen S. (2017) Improving spatial predictability of petroleum resources within the Central Tertiary Basin, Spitsbergen: A geochemical and petrographic study of coals from the eastern and western coalfields. *International Journal of Coal Geology*, **179**: 278-294.

Esteem Indicators

Prizes and Awards

- On the 19th June 2017, PhD student Matthew Kessler, won the prize for the Best Poster at the Link17 student-lead conference at the University of Nottingham, with his project on ‘Scale effects and scaling laws in Granular Slides’.

Committees

- On behalf of Defra, the UK Space Agency and NERC, Professor Stuart Marsh continued to represent the UK on the Programme Board of the Intergovernmental Group on Earth Observations (GEO). This body designs, guides, monitors and evaluates the GEO work programme, undertaken by 105 countries and 118 participating organisations worldwide, to deliver the Global Earth Observation System of Systems. He was also a member of the European Space Agency Hyperspectral Imaging Mission Expert Group. This was established to advise ESA on the design of a hyperspectral imaging satellite slated to be launched as the tenth in the Sentinel series of European Earth Observation satellites.



Journal Editors

- Dr Valentin Heller was invited to be Journal Editorial Board Member of the Journal of Marine Science and Engineering, Section Board for Ocean Engineering. He was also invited to be Guest editor for the special issue “Tsunami Science and Engineering II” in the Journal of Marine Science and Engineering. Stuart Marsh was invited to join the editorial board of a new, interdisciplinary journal on Big Earth Data.

External Activities

Conferences and Events

- Dr Barbara Turnbull attended Colloquium 588, Coupling Mechanisms and Multi-scaling in Granular-Fluid Flows, European Mechanics Society, Toulouse, France and presented on “Just-saturated axisymmetric column collapse” and the European Geophysical Union General Meeting, in Vienna, where she presented on “Partially Saturated Granular Column Collapse”.
- Dr David Large attended the International Peatland Society conference and IUCN Bogfest events to promote the peatland research.
- Dr Valentin Heller presented his work at the 4th International Symposium of Shallow Flows, Eindhoven, The Netherlands, on “Scale effects in shallow water vortices”.
- Matthew Kessler presented at the Colloquium 588, Coupling Mechanisms and Multi-scaling in Granular-Fluid Flows, European Mechanics Society, Toulouse, France, showing his work on “A laboratory-numerical approach for quantifying scale effects in dry granular slides”.

International

- Dr Barbara Turnbull has received an invitation to spend six weeks working as a guest scientist at Woods Hole Oceanographic Institute, during their Fluid Dynamics Summer School in 2018. David Large is working as a part of a consortia and building a network around the peat activity, including BEIS, Dept. for Environment and North American collaborators.

Postgraduate Research Activities

- One PhD student won best poster award and another won second best PhD paper across the Faculty at the Faculty PhD showcase. The PhDs are now up to 10 in total and they are performing well, growing in confidence and producing high quality papers. We have PhDs supported by the British Geological Survey (BGS) and the Coal Authority and were delighted to secure two University of Nottingham Excellence scholarships for two new PhD students during the review period.



George Green Institute for Electromagnetics Research

Head of Group
Professor Dave Thomas

Electromagnetics is fundamental to our everyday lives and equipment, such as Global Positioning Systems (GPS) and mobile phones. As an international centre of expertise in electromagnetics, the Institute is a global research leader in the areas of photonic and optoelectronic simulation, simulation for electromagnetic compatibility and power quality, and the transmission line modelling method (TLM). Applications of the research from the Institute include the use of infra-red signals for early detection of cancers; the development of the latest wireless chip-to-chip wireless communications; wave propagation control technologies; and expertise in how to locate cable faults. The group also pursues research that will ensure that electronic equipment does not interfere with other electronic equipment or systems, improving safety in a number of industries including communications, transportation, aerospace and the nuclear industry.

Research Areas

- Optics
- Numerical Modelling
- Communications
- Electromagnetic Compatibility

More information can be found on the GGIEMR website:
nottingham.ac.uk/go/ggiemr

Research Portfolio

British Council Monitoring Heritage Buildings with Optical Sensor Networks

Professor Trevor Benson, £234,033

Creating a new, accurate design of a novel multi-function gas sensor in the near and mid-infrared regions based on fibre optic sensors.

BAE Aerospace Applications of UTLM

Professor Phil Sewell, £30,000

Providing support to BAE in applying Unstructured TLM technology, comprising: provision of training, on-site visits, and project-specific reports and models.

Nottingham-Lund seed grant, in collaboration with the School of Mathematical Sciences

Professor Gregor Tanner, £5,000

Key Publications

Book

Recent Trends in Computational Photonics, (ed.) Arti Agrawal, Trevor M. Benson, Richard DeLaRue, and Gregory Wurtz. Springer Nature (2017). Contains three chapters written by members of the GGIEMR.

Journals

- Gradoni G, Arnaut LR, Creagh SC, Tanner G, Baharuddin MH, Smartt C, Thomas DWP. (2017) Wigner-Function-Based Propagation of Stochastic Field Emissions From Planar Electromagnetic Sources. *IEEE Transactions on Electromagnetic Compatibility*, Article in Press.
- Sewell PD, Benson TM, Vukovic A, Meng X. (2017) Complexity Reduction of Multiscale UTLM Cell Clusters. *IEEE Journal on Multiscale and Multiphysics Computational Techniques*, 2: 18-28.
- Ülkü HA, Bogaert I, Cools K, Andriulli FP, Bağcı H. (2017) Mixed Discretization of the Time-Domain MFIE at Low Frequencies. *IEEE Antennas and Wireless Propagation Letters*, 16: 1565-1568.
- de Pomerai DI, Iqbal N, Lafayette I, Nagarajan A, Kaviani Moghadam M, Fineberg A, Reader T, Greedy S, Smartt C, Thomas DWP. (2016) Microwave fields have little effect on α -synuclein aggregation in a *Caenorhabditis elegans* model of Parkinson's disease. *Bioelectromagnetics*, 37: 116-129.

Esteem Indicators

Prizes and Awards

- Dr Gabriele Gradoni - URSI Commission B EMTS, Espoo, Finland, August 2016, Young Scientist Award.

Fellows

- Professor Trevor Benson was appointed Fellow of The Royal Academy of Engineering (FREng); Fellow of the Institution of Engineering and Technology (FIET);; Fellow of the Institute of Physics (FInstP).

Committees

- Professor Trevor Benson was appointed as a Chair or co-Chair on many committees in 2016-17 for conferences and networks, including: CLEO-Europe 2017; International Conference on Transparent Optical on Sub-Wavelength Photonics, Nano-Photonics for all Optical Networks; Photonic Integrated Components and Applications; Optical Wave and Waveguide Theory and Numerical Conference; European Physical Society Quantum Electronics and Optics Thesis Prize 2017 and Fresnel Prize 2017; and the Institute of Physics Optical Group.
- Professor Dave Thomas was convenor for CIGRE Joint Working Group 3.41 EMC between communication circuits and power systems and he chaired COST Action IC1407 Advanced characterisation and classification of radiated emissions in densely integrated technologies (ACCREDIT). He was also Vice Chair IEEE Standards committee P2718 Guide for Near field Characterization of Unintentional Stochastic Radiators and sat on the EMC Europe steering committee.
- Dr Gabriele Gradoni was the Early Career Representative URSI Commission E for the triennium 2017-2020.

Journal Editors

- Professor Trevor Benson was appointed Editor in Chief Optical and Quantum Electronics and sat on the Editorial Boards of Microwave and Optical Technology Letters and IET Optoelectronics.

External Activities

Open Source Projects:

- BEAST: Boundary Element Analysis and Simulation Toolkit: <https://github.com/krcools/BEAST.jl>. Easy to use open source implementation of frequency and time domain boundary element methods. Collaborators from: University of Glasgow, TU Munich, IMT Atlantique, Politecnico di Torino.
- SACAMOS: State of the Art Cable MOdels for Spice Open Source Cable Models for EMI Simulations.
- Collaborators: European Space Agency, NLR Netherlands.

Outreach

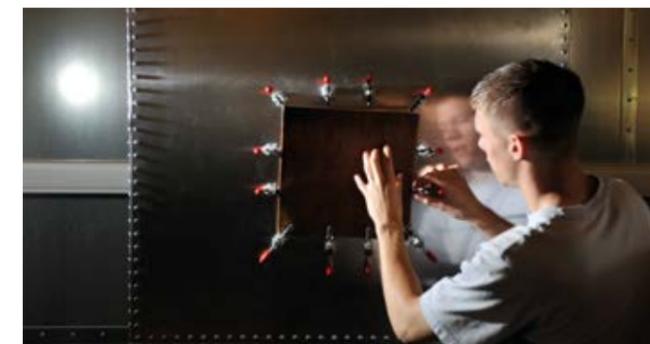
- Professor Dave Thomas led a seminar on Near Field Scanning Techniques for the Characterisation of Emissions from PCBs . COST 1407 Training school, Bratislava, Slovakia 5th - 6th April 2017. He also delivered two workshops on "EMC between communications Circuits and Power Systems in the frequency range 2-150 kHz" and Workshop presentation "Measurements and modelling in the Frequency range 2-150 kHz" IEEE EMC Symposium, Washington 2017.
- Dr Gabriele Gradoni delivered three seminars: Wave Control as a paradigm for Smart Electronic Systems: funding opportunities within the EU Horizon 2020 Work programme 2018-2020; phase-space methods in electromagnetics; Random Matrix Theory for complex electromagnetic wave systems.

International

- Professor Trevor Benson visited Wroclaw University of Technology.
- Professor Dave Thomas and Dr Gabriele Gradoni visited Lund University under seed grant.
- Professor Dave Thomas was also Visiting Professor for two weeks at the Federal University of Santa Catarina.
- Dr Gabriele Gradoni visited many International institutions in 2016/17, including:
 - ▶ The Laboratory of Condensed Matter Physics, University of Nice Sophia-Antipolis, Nice, France.
 - ▶ The Institute of Nanoelectronics, Technical University of Munich (TUM), Munich, Germany.
 - ▶ The Interdisciplinary Innovation Centre, NXP Semiconductor, Caen, France.
 - ▶ The Institut Langevin – Ondes et Images, Sorbonne University and CNRS, Paris, France.
 - ▶ The Department of Physics, University of Maryland, College Park.

Postgraduate Research Activities

- The GGIEMR welcomed its first three PhD students (Rohan Kalsi, Jomiloju Odeyemi and David Mabwa) funded under the EPSRC thematic doctoral training program in wave phenomena in complex media.





Human Factors

Head of Group

Dr Sue Cobb

The Human Factors Research Group (HFRG) is a multidisciplinary world-leading team applying human factors theory, methods and approaches across a wide range of application areas. We take a human-centred, systems approach to ensure design for usability, efficiency, effectiveness and wellbeing for individuals, teams and organisations. We use novel technologies such as virtual reality, simulations and mobile technologies to develop and evaluate design of future systems that will enhance the way we live and work. Our partnership links with industry and academia ensure that our research has impact in many domains including transport, healthcare, education, creative industries, manufacturing and future cities.

Research Areas

- Advanced Manufacturing
- Aerospace and Aviation
- Cultural Heritage
- Health and Healthcare Technologies
- Rail Transport
- Road Transport
- Smart Cities and Intelligent Mobility
- Technologies for Learning and Rehabilitation

More information can be found on the HFRG website: nottingham.ac.uk/go/hfrg



Research Portfolio

Our income was a total of £1,459,925 through a combination of industrial and research council funding as follows:

Jaguar Land Rover (JLR) Human Machine Interface (HMI) Design for future Vehicles

Professor Gary Burnett, £109,101

Investigation of the design variables that will influence the ultimate usability and user experience for alternative Augmented Reality (AR) Head-Up Display (HUD) concepts for navigation applications.

Jaguar Land Rover (JLR) Human Machine Interface (HMI) Design for Highly Automated Driving

Professor Gary Burnett, £50,480

Understanding the implications of different HMI strategies to assist drivers in efficiently resuming control of their vehicles during various takeover scenarios.

AECOM Stepped Limits for Managing Driver Speed in Roadworks

Professor Gary Burnett, £41,400

Understanding the implications of different configurations of speed limit signs within roadworks on the UK motorway/trunk road network.

Institute for Occupational Safety and Health (IOSH) Multisensory virtual environments for OSH training

Dr Glyn Lawson, £179,076

Evidence-based guidance for the development and use of Virtual Environments (VEs) in engaging effective training using cost-effective and accessible solutions

Honda Locating touchpads in Vehicles

Professor Gary Burnett, £9,100

Literature review focused on the human factors design issues for touchpad HMIs within vehicles

EPSRC Network Plus: Connected Everything

Professor Sarah Sharples, £955,767

Identifying the key challenges we face as digital technologies transform our industrial systems and to support new collaborations between academics from diverse discipline areas to address these challenges

- Three externally funded Horizon Centre for Doctoral Training PhDs from Ordnance Survey, a national consortium of rail industry partners, led by Rail Safety and Standards Board, and the Transport Systems Catapult (Total, £115k).

Key Publications

- Large DR, Burnett G, Crundall E, van Loon E, Eren AL, Skrypchuk L. (2018) Developing Predictive Equations to Model the Visual Demand of In-Vehicle Touchscreen HMIs. *International Journal of Human-Computer Interaction*, **34**: 1-14.
- Large DR, Clark L, Quandt A, Burnett G, Skrypchuk L. (2017) Steering the conversation: A linguistic exploration of natural language interactions with a digital assistant during simulated driving. *Applied Ergonomics*, **63**: 53-61.
- Antrobus V, Burnett G, Krehl C. (2017) Driver-passenger collaboration as a basis for human-machine interface design for vehicle navigation systems. *Ergonomics*, **60**: 321-332.
- Marinescu AC, Sharples S, Ritchie AC, López TS, McDowell M, Morvan HP. (2017) Physiological Parameter Response to Variation of Mental Workload. *Human Factors*, **60**: 31-56.
- Pickup L, Lang A, Atkinson S, Sharples S. (2018) The dichotomy of the application of a systems approach in UK healthcare the challenges and priorities for implementation. *Ergonomics*, **61**: 15-25.

Esteem Indicators

Prizes and Awards

- The publication “Merenda, C., Kim, H., Gabbard, J.L., Leong, S., Large, D.R., Burnett, G. (2017) Did you see me? Assessing perceptual vs. real driving gains across multi-modal pedestrian alert systems” which was produced through the collaboration between the University of Nottingham and Virginia Tech was awarded with an “honourable mention” at the 9th ACM International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Automotive UI 2017; Oldenburg; Germany; 24 September 2017.

Committees

- Professor Sarah Sharples appointed as member of Science Advisory Council for Department for Transport (DfT).
- Dr Mirabelle D’Cruz appointed as Secretary of the European Association of Virtual, Augmented and Mixed Reality (EuroVR).

Journal Editors

- Dr Glyn Lawson, Editorial Board of Applied Ergonomics.
- Professor Gary Burnett, Associate Editor for the International Journal of Mobile Human-Computer Interaction.
- Dr Sue Cobb, Associate Editor of Computer Animation and Virtual Worlds.
- Professor Sarah Sharples, special section editor for Applied Ergonomics.

Equipment and Demonstrators

Demonstrators

- The HFRG driving simulator has recently gone through a significant enhancement to improve fidelity - including a whole Audi TT vehicle and software with greater functionality and higher resolution graphics. As such, it now exists as a ‘state of the art’ facility for investigating driver/passenger behaviour with future, highly automated vehicles.

External Activities

Conferences and Events

- In March 2017, we celebrated 30 years of Human Factors Research at Nottingham with a showcase and networking event that attracted over 120 attendees from alumni to industrial, education and funding partners across the world. Exhibits and interactive demonstrations of our human factors work applied to a number of domains were presented. Our Postgraduate students were also given the opportunity to showcase their research.

Outreach

- The MarsCAPE project demonstrated the Mars Communicated through an Augmented Physical Environment exhibit at the National Space Centre, Leicester in November 2016; the Science in the Park event at Wollaton Hall, Nottingham in March 2017 and at the European Geosciences Union General Assembly held in Vienna, Austria in April 2017, attended by 15,000 delegates.
- Faculty of Engineering’s Christmas Lecture, Nottingham – HFRG presented 3D Tune-In digital games Dartanan and Darius and a sensory haptics project. ~200 local school children.
- June 2017 - Wonder 2017, Nottingham - HFRG presented a number of our European projects 3D-PITOTI, 3D-Tune-In and PASSME - ~7280 visitors.





Microwave Process Engineering

Head of Group Dr Chris Dodds

The Microwave Process Engineering (MPE) Research Group conducts multi-disciplinary research, development and commercialisation studies into electromagnetic technologies for materials processing applications. We investigate how microwave energy interacts with a wide range of processes and then use this knowledge and understanding to design, scale-up and commercialise microwave heating technologies.

Research Areas

To date, MPE have successfully demonstrated the application of microwave and radio frequency technologies to materials processing at a wide range of scales and technology readiness levels. The group has a wide portfolio of projects, spanning a range of industries including mining and minerals, energy, polymers, advanced materials, food and bio-products.

Specific examples of applications where this has been applied include: microwave enhanced mineral processing, clean-up of waste when drilling for oil and the manufacture of plastics.

More information can be found on the MPE website:
nottingham.ac.uk/mpe

Key Publications

The group continues to publish strongly with 50 papers published in 2016 and 2017 with 46% of papers ranked 10% by SNIP. Two key papers in 2017 arose from collaborative research with Rio Tinto, Teledyne e2v, Jenike and Johanson, and JK Tech Pty. These two papers describe the design, construction, commissioning and results from a scalable pilot-scale system for the microwave treatment of ores capable of operating at throughputs of up to 150 tph, shown in the image below:

- Buttress AJ, Katrib J, Jones DA, Batchelor AR, Craig DA, Royal TA, Dodds C, Kingman SW. (2017) Towards large scale microwave treatment of ores: Part 1 – Basis of design, construction and commissioning. *Minerals Engineering*, **109**: 169-183.
- Laybourn A, Katrib J, Ferrari-John RS, Morris CG, Yang S, Udoudo O, Easun TL, Dodds C, Champness NR, Kingman SW, Schröder M. (2017) Metal-organic frameworks in seconds via selective microwave heating. *Journal of Materials Chemistry A*, **5**: 7333-7338.
- Batchelor AR, Buttress AJ, Jones DA, Katrib J, Way D, Chenje T, Stoll D, Dodds C, Kingman SW. (2017) Towards large scale microwave treatment of ores: Part 2 – Metallurgical testing. *Minerals Engineering*, **111**: 5-24.
- Adam M, Beneroso D, Katrib J, Kingman S, Robinson JP. (2017) Microwave fluidized bed for biomass pyrolysis. Part I: Process design. *Biofuels, Bioproducts and Biorefining*, **11**: 601-612.
- Adam M, Beneroso D, Katrib J, Kingman S, Robinson JP. (2017) Microwave fluidized bed for biomass pyrolysis. Part II: Effect of process parameters. *Biofuels, Bioproducts and Biorefining*, **11**: 613-624.



Research Portfolio

- The Microwave Process Engineering Group have a current research grant portfolio of over £13million with 18 new projects in 2017 including EPSRC, Innovate UK and direct industry funding. Specific research project highlights include:
 - Five year strategic partnership agreed with Teledyne e2v (~£1.2million).
 - EPSRC New Investigator Grant “A predictive tool for bio-based chemical extraction” in collaboration with Mathematical Sciences, awarded to Dr Eleanor Binner.
 - Innovate UK Manufacturing and Materials - Ferrous By-product Recycling Using Microwave Technology.

Esteem Indicators and People

- MPE was highly commended at the IChemE awards in the Team Award for their work “Towards Large Scale Microwave Pre-Treatment of Ores” and a finalist in the Research Project Award.
- This year Derek Irvine has been promoted to Professor, Juliano Katrib to Senior Research Fellow and Mohammed Adam joined the group as a research fellow following completion of his PhD.
- Dr Chris Dodds was selected to join the Steering Committee of the European Innovation Partnership in Raw Materials, a stakeholder platform that brings together representatives from industry, public services, academia and Non-Governmental Organisations (NGO’s). Its mission is to provide high-level guidance to the European Commission, Member States and private actors on innovative approaches to the challenges related to raw materials.



Nottingham Centre for Geomechanics

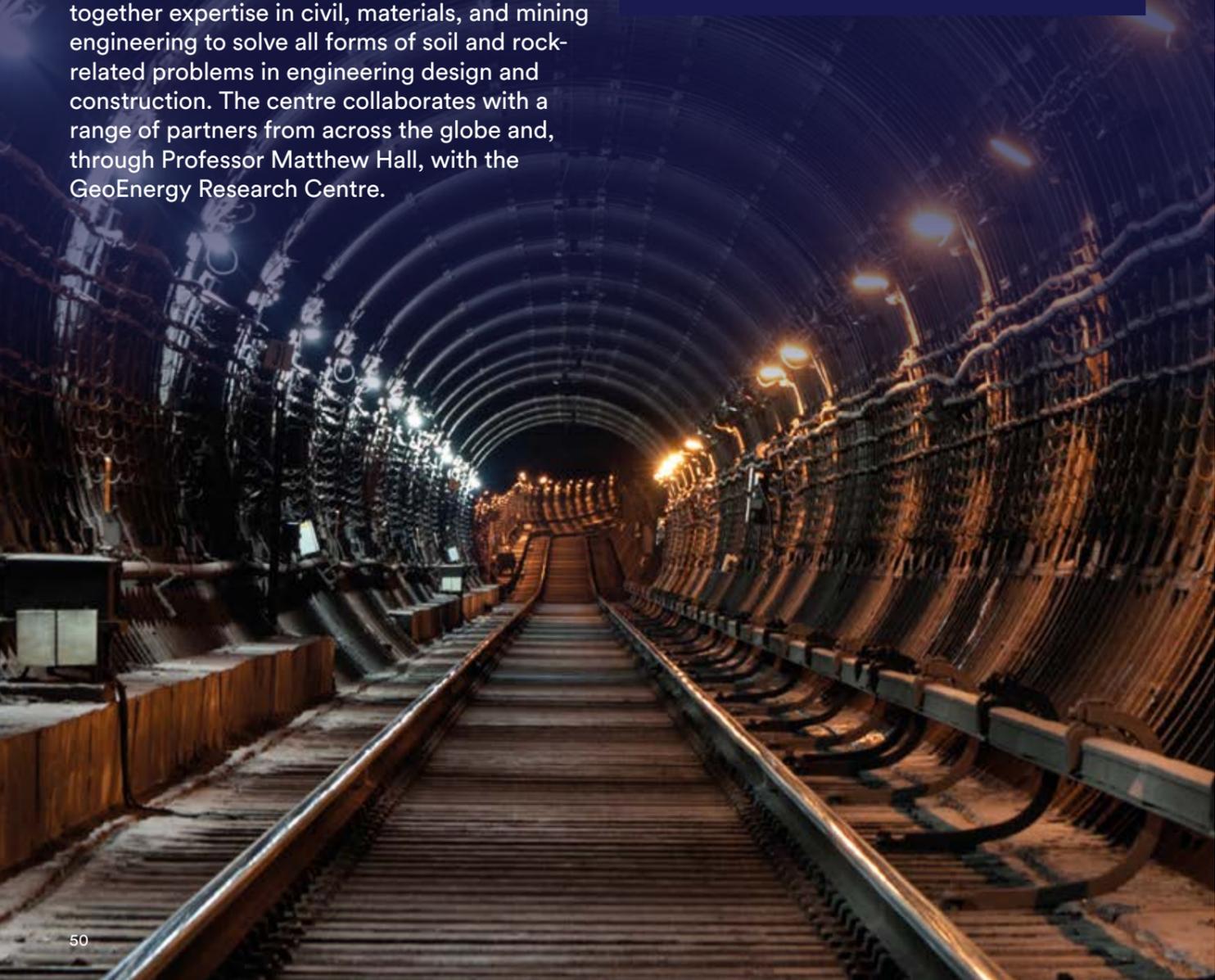
Head of Group
Dr Alec Marshall

Humans interact with soils and rock in all manner of construction and development activities. Examples include the foundations beneath our buildings, the underground networks of tunnels and pipelines we rely on for transport and water, and the extraction of natural resources from the ground. The Nottingham Centre for Geomechanics (NCG) conducts research which helps us to understand the complex ways that these natural materials behave, so that safe and effective engineering solutions can be developed. The centre brings together expertise in civil, materials, and mining engineering to solve all forms of soil and rock-related problems in engineering design and construction. The centre collaborates with a range of partners from across the globe and, through Professor Matthew Hall, with the GeoEnergy Research Centre.

Research Areas

- Constitutive and Numerical Modelling
- Centrifuge Modelling
- Laboratory and In-situ Testing
- Soil and Rock Structure Interaction
- Transportation Geotechnics
- Underground Excavation and Tunnelling

More information can be found on the NCG website:
nottingham.ac.uk/ncg



Research Projects

H2020 ENOS

Professor Matt Hall, £372,596

Enabling decarbonisation of fossil fuel-based power and energy intensive industries. ENOS aims to develop onshore CO2 storage, close to CO2 emission points. The ENOS project will help to demonstrate that CO2 storage is safe and environmentally sound.

EPSRC PAF

Professor Matt Hall, £40,590

Experimental research to investigate the complex behaviour of fluids contained in nano-sized pores within shale and tight rock formations, and to better understand fluid flow in shale reservoirs.

Equipment

- The NCG 4m diameter geotechnical centrifuge, which is used to replicate full-scale geotechnical systems (e.g. cyclic loading of offshore piles, tunnel construction under buildings, ground-borne vibrations from high-speed trains) within small-scale models at elevated gravity (up to 150 times Earth's gravity) recently benefitted from an upgrade to its data acquisition and control systems, allowing more advanced testing of complex engineering problems.

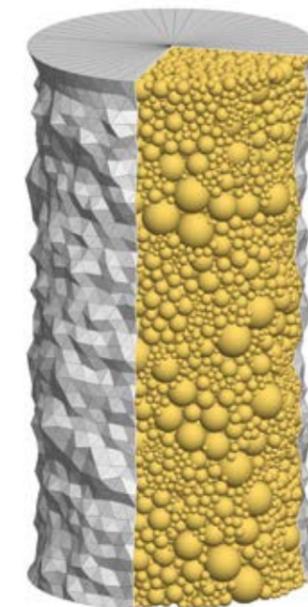


Introducing Dr Athina Grizi, Assistant Professor

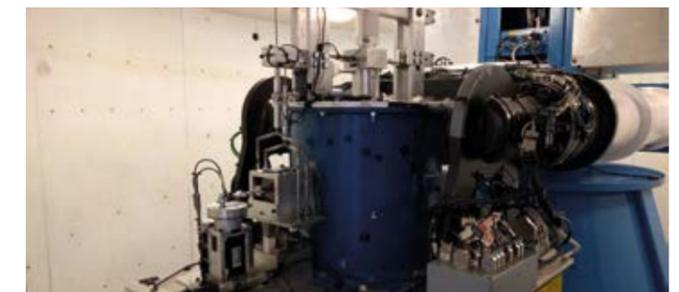
Dr Athina Grizi joined the Nottingham Centre for Geomechanics in January 2018. She holds a BSc in Civil Engineering and MSc in Geotechnical Engineering from the University of Patras, Greece and a PhD in Geotechnical Engineering from the University of Michigan, USA. Her research interests primarily focus on investigating ground vibrations due to man-made construction activities using experimental and numerical methods. In addition, Dr Grizi has experience and wants to explore further the use of non-invasive methods for subsurface imaging, and health assessment and analysis of the risk profile of retaining structures.

Key Publications

- de Bono, J. and McDowell, G.R. 2016. The fractal micro mechanics of normal compression *Computers and Geotechnics*, Volume 78, 1 September 2016, 11-24.
- de Bono, J. and McDowell, G.R. 2016. Particle breakage criteria in discrete element modelling. *Geotechnique* Volume 66, Issue 12, 1 December 2016, 1014-1027.
- Tang X., Ripepi N., Stadie N.P., Langjie Y., Hall M.R. 2016. A dual-site Langmuir equation for accurate estimation of high pressure deep shale gas resources. *Fuel*. 185 10-7.
- Lacinska A.M., Styles M.T., Bateman K., Wagner D., Hall M.R., Gowing C. and Brown P.D. 2016. Acid-dissolution of antigorite, chrysotile and lizardite for ex situ carbon capture and storage by mineralisation. *Chemical Geology*. 437 153-69.
- Mo, P.Q., Marshall, A.M., and Yu, H.S. 2017. Layered effects on soil displacement around a penetrometer. *Soils and Foundations*. 57(4): 669-678
- Grizi, A., Athanasopoulos-Zekkos, A., and Woods, R. D. 2016. Ground vibration measurements near impact pile driving. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*, 142(8).
- Franza, A. and Marshall, A.M. 2017. Centrifuge modelling study of the response of piled structures to tunnelling. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*. 144(2).



A virtual sand sample created using Discrete Element Modelling software. Various stresses and strains can be exerted on this virtual sample, and the behaviour can then be compared to that obtained from real sand samples. The use of a virtual sand allows, for example, the particle interactions to be studied and manipulated, which can help to explain why the real material behaves as it does.



Centrifuge model used to investigate the performance of offshore wind turbine foundations during thousands of wind/wave load cycles.



Nottingham Geospatial Institute

Head of Group
Professor Terry Moore

The Nottingham Geospatial Institute (NGI) carries out research on all aspects of surveying, mapping, positioning and navigation technologies. In particular, it specialises in satellite navigation systems such as the Global Positioning Systems (GPS) to deliver technology that can be used on large-scale projects such as monitoring the movement of long bridges and potential natural hazards, navigating aircraft in our skies, or to simply guide the next generation of driverless car around our roads.

Research Areas

- Engineering Surveying and Remote Measurement
- Geospatial Science
- Positioning and Navigational Technologies
- Propagation Effects on GNSS

More information can be found on the NGI website:
nottingham.ac.uk/ngi

Research Portfolio

Training REsearch and Applications network to Support the Ultimate Real time high accuracy EGNSS solution (TREASURE)

Dr Marcio Aquino, EU H2020 MSCA ITN, £711,431

Combining different satellite systems to operate together is a new development known as multi-GNSS, which is key to provide instantaneous, high accuracy positioning anywhere in the world.

Future GNSS Positioning

Professor Terry Moore, Advance Manufacturing Supply Chain Initiative (AMSCI), £500,000

Collaboration with Rockwell Collins (UK) Ltd on GNSS signals, receivers, signal processing, and data processing, to develop future multi-constellation, multi-frequency GNSS and integrated PNT capabilities.

Requirement Evaluation of CAV Location Performance and Platform Development (RECAPD)

Dr Xiaolin Meng, Innovate UK, £79,827

Technical solutions that address essential real-world location issues to improve autonomy and connectivity in Connected and Autonomous Vehicles (CAV).

EO-SCANS - Earth Observation for the Surveillance of Critical Assets for National Security

Dr Xiaolin Meng, Innovate UK, £49,301

Developing a method for calibrating InSAR data using levelling surveys and high precision GNSS positioning, to suit particularly difficult terrain types.

Esteem Indicators

Prizes and Awards

- Sreeja Veettil was nominated and awarded with the Asia Oceania Geosciences Society (AOGS) Kamide Early Career Researcher Award.
- Sreeja Veettil was promoted to Level 5 Senior Research Fellow.

Committees

- Dr Xiaolin Meng was elected President of the International Association of Chinese Professionals in Global Positioning Systems (CPGPS) on 1st January 2017.
- Professor Terry Moore was elected Vice-President, and President-Elect of the Royal Institute of Navigation, in July 2017 and to the Council of the Institute of Navigation, as a Technical Representative, in January 2017.

Journal Editors

- Dr Xialon Meng was appointed as a Guest Editor of Journal of Global Positioning Systems.
- Dr Stephen Grebby was appointed as Guest Editor of the Geosciences Special Issue on Advances in Lithological and Structural Mapping Using Earth Observation Data.

External Activities

Prizes and Awards

- Professor Terry Moore was invited to General Lighthouse Authorities Workshop on Future PNT Strategy, August 2016; and the European Space Agency (ESA) Galileo Evolutions Programme, Phase 1 Review, September – November 2016. He was also a member of a Government Office of Science led review into the Critical Dependencies of Satellite-derived Time and Position (the GNSS Blackett Review).
- Professor Terry Moore and Dr Xiaolin Meng contributed to the written evidence submitted to the House of Lords Science and Technology Select Committee report on Connected and Autonomous Vehicles, the Future, published in March 2017.
- The NGI has been very actively leading the interests in access to raw GNSS measurements from Android (N) based smartphones and tablets. It has co-authored a White Paper on this topic along with the European GNSS Agency (GSA), The European Space Agency (ESA) and Airbus.

Key Publications

- Basiri A, Lohan ES, Moore T, Winstanley A, Peltola P, Hill C, Amirian P, Figueiredo e Silva P. (2017) Indoor location based services challenges, requirements and usability of current solutions. *Computer Science Review*, 24: 1-12.
- Eichhorn MP, Ryding J, Smith MJ, Gill RMA, Siriwardenae GM, Fuller RJ. (2017) Effects of deer on woodland structure revealed through terrestrial laser scanning. *Journal of Applied Ecology*, 54: 1615-1626.
- Grebby S, Field E, Tansey K. (2016) Evaluating the use of an object-based approach to lithological mapping in vegetated terrain. *Remote Sensing*, 8: 843.
- Han H, Wang J, Meng X, Liu H. (2016) Analysis of the dynamic response of a long span bridge using GPS/ accelerometer/anemometer under typhoon loading. *Engineering Structures*, 122: 238-250.

Conferences and Events

- Professor Terry Moore was invited to give a Keynote Lecture at the RIN International Navigation Conference, INC 16, Glasgow in December 2016.
- The NGI organised and hosted the International Conference on Location and GNSS, ICL GNSS 2017, which was held at the jubilee Conference Centre in Nottingham during July 2017.
- Professor Terry Moore was a member of the organising committee for the International Navigation Conference, INC 2016, which was held in Glasgow, December 2016.
- Professor Terry Moore was the Peer-Review Co-Chair for the 29th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS+ 2016), which was held in Portland, Oregon, September 2016. Dr Stephen Grebby was co-convenor of the Remote Sensing and Photogrammetry Society (RSPSoc) 2016 Annual Conference in September 2016 held at the Jubilee Conference Centre, Nottingham.
- Dr Xialon Meng chaired the Sino-UK Seminar on Structural Health Monitoring of Infrastructure held in Wuhan China, in May 2017. He also chaired and was Editor for the IEEE Proc of 2017 Forum on Cooperative Positioning and Service (CPGPS) in May 2017.

Outreach

- Dr Xiaolin Meng organised two-week training course National Administration of Surveying, Mapping and Geoinformation (NASG) in August 2016.

International

- The Sino-UK Geospatial Engineering Centre focuses on the National Administration of Surveying, Mapping and Geoinformation (NASG) CEO annual training course, preparations of joint project grant applications, provision effective assistance to NGI running projects and events with China such as ESA's GeoSHM, Innovate UK's iSHM, etc., and receiving short-term senior visitors and long-term junior researchers from China.



Nottingham Transportation Engineering Centre

Head of Group
Professor Gordon Airey

The Nottingham Transportation Engineering Centre (NTEC) undertakes cutting edge research into the mechanical performance and durability of transport infrastructure materials in roads, railways and airfields. The research conducted at the centre looks to optimise the performance of these materials when they are exposed to changing traffic loading and environmental conditions, such as increased traffic loads and flows and exposure to extreme weather conditions. The centre has addressed a number of different areas related to transport infrastructure with activities in asset management and maintenance, smart materials and sensors, ballast and subgrade stabilisation, intelligent infrastructure, recycling and alternative materials, and self-healing materials.

Research Areas

- Asset Management
- Design and Performance
- Materials
- Sustainability and the Environment
- Resilience and Climate Change
- Smart Systems and Materials

More information can be found on the NTEC website:
nottingham.ac.uk/ntec

Research Projects

H2020 European Training Network on Sustainable Multifunctional Automated Resilient Transport Infrastructures (SMARTI ETN)

Dr Davide Lo Presti and Professor Gordon Airey, £983,092

Sustainable Multi-functional Automated Resilient Transport Infrastructures ETN, will bring together a stimulating platform where the stakeholders of the transport infrastructure sector will work alongside world-wide experts in smartening of systems (developers of high-tech sensors, advanced monitoring equipment, automated structures, etc.) with direct support from the roads, railways and airports managers. This environment will enable talented graduates to conceive the transport infrastructure network of the future and will provide them with world-wide extended training in each of the four pillars supporting the SMARTI vision: designed to last by maximising recycling and minimizing impact (Sustainable), conceived not for transport purposes only and towards optimisation of land use (Multi-functional), equipped for communicating with managers and users, to allow a more intuitive use and a simplified management (Automated), built to be adaptable to natural and anthropogenic hazards (Resilient).

Tarmac Development of aggregates packing model for asphalt mixtures

Dr Alvaro Garcia Hernandez and Professor Andrew Dawson, £112,000

Developing an operational asphalt mixture design software tool to evaluate and predict mixture performance in terms of workability and design voids, and assess the impact of changing aggregate types on the mixtures.

Action Sustainability LTD - Circular Economy Metrics

Dr Tony Parry, £30,000

EPSRC Institutional Award Delivering Reliable low-volume roads to Brazil

Professor Andrew Dawson, £24,975

Key Publications

- Fang X, Garcia A, Winnefeld F, Partl MN, Lura P. (2016) Impact of rapid-hardening cements on mechanical properties of cement bitumen emulsion asphalt. *Materials and Structures*, **49**: 487-498.
- D'Angelo G, Thom N, Lo Presti D. (2016) Bitumen stabilized ballast: A potential solution for railway track-bed. *Construction and Building Materials*, **124**: 118-126.
- Prince R, Byrne M, Parry T. (2016) Meta-analytic framework for efficiently identifying progression groups in highway condition analysis. *Journal of Computing in Civil Engineering*, **30**: 04015044.
- Zhang J, Airey GD, Grenfell J, Apeagyei AK, Barrett M. (2016) Development of a composite substrate peel test to assess moisture sensitivity of aggregate-bitumen bonds. *International Journal of Adhesion and Adhesives*, **68**: 133-141.
- Nassar AI, Mohammed MK, Thom N, Parry T. (2016) Mechanical, durability and microstructure properties of Cold Asphalt Emulsion Mixtures with different types of filler. *Construction and Building Materials*, **114**: 352-363.
- Hassn A, Chiarelli A, Dawson A, Garcia A. (2016) Thermal properties of asphalt pavements under dry and wet conditions. *Materials and Design*, **91**: 432-439.

Postgraduate Activities

- NTEC launched a new MSc course on Transportation Infrastructure Engineering (with Sustainable Highway and Sustainable Railway streams) in 2016.

External Activities

Outreach

- Dr Alvaro Garcia's research into the use of encapsulated oil to rejuvenate and potentially providing a means of self-healing pavements and repairing potholes was covered across various media outlets during the year including the BBC's The One Show and local BBC radio. Articles of Dr Garcia's research was also reported in The Times and the Daily Mail.



Esteem Indicators

Prizes and Awards

- Winner of the Rees Jeffreys Award 2017 for best paper on highway engineering:

Wright, M., Parry, T. and Airey, G. Chemical pavement modifications to reduce ice adhesion. Proceedings of the Institution of Civil Engineers, Transport. **169**(2), 76-87, 2016.

Fellows

- Dr Tony Parry appointed Fellow of the TRL Academy.

Committees

- Professor Andrew Dawson appointed to Chair of US Transportation Research Board's Committee on Aggregates (2016-2019).

Journal Editors

- Professor Andrew Dawson member of Editorial Boards of Int'l. J. Pavement Engineering (Taylor and Francis) and Transportation Geotechnics (Elsevier).

International Conferences

- Professor Andrew Dawson co-chair of Anglo-Brazilian Workshop for Early Career Researchers on Pavements for energy harvesting and dependable low-volume roads (2016).
- Professor Gordon Airey and Professor Andrew Dawson chaired sessions at 10th Bearing Capacity of Roads, Railroads and Airfields (Athens, June 2017).
- Professor Andrew Dawson member of International Advisory Committee for 11th Bearing Capacity of Roads, Railroads and Airfields (Trondheim, 2021).



Optics and Photonics

Head of Group
Professor Matt Clark

The Optics and Photonics Research Group works on a wide range of topics from the basic, fundamental sciences of the way that light and sound behave, all the way to applications of this science in industry and healthcare. This has led to development of varied technologies, such as microscopes that can use ultrasound to image inside of single cells to clothing that can monitor the health and well-being of patients. The group is one of the largest research groups in the Faculty of Engineering with 12 academics. The group has impacted several sectors, from the design of new light microscope accessories to accurately measuring neonatal heart-rates. Two of the Faculty's spin-out companies (Monica Healthcare and Surepulse) have originated in technology developed by the Optics and Photonics Research Group.

Research Areas

- Cell Optics
- Materials and Non-Destructive Evaluation/Testing (NDE/T)
- Healthcare Optics
- Nano Optics and Photonics

More information can be found on the Optics and Photonics website:
nottingham.ac.uk/go/opticsphotonics

Research Portfolio

The Optics and Photonics group has a total Research Portfolio of £5,843,726, with nine projects starting between August 2016 and July 2017. These projects were sponsored by a range of funders and industrialists such as, Rolls Royce, YouCare Technology, Gill Corporation, EPSRC and Innovate UK amounting to £1,449,977 in total. Projects include:

EPSRC Functionalised optical fibre multiparameter sensing platform for monitoring during artificial ventilation

Dr Serhiy Korposh, £100,554

Applying novel advanced functional materials to the development of an optical fibre sensing platform and translation into healthcare practice. This project aims to develop a novel in situ measurement system based on functionalised optical fibres to monitor and control key parameters during invasive lung ventilation in the intensive care unit.

Innovate UK – Knowledge Transfer Partnership with Gill Corporation

Dr Serhiy Korposh, £252,264

EPSRC Closed Loop Control Systems for Optimisation of Treatment (Cyclops Healthcare Network)

Professor Stephen Morgan, £634,068

A multidisciplinary healthcare network to explore potential applications of a closed loop control approach, which involves continuous monitoring of key clinical parameters and utilising mathematical models to adapt treatment.

Rolls Royce SRAS Integrated Inspection

Professor Matt Clark and Dr Richard Smith, £366,074

Development of the SRAS technology for turbine blade inspection.

Key Publications

- Colombi A, Ageeva V, Smith RJ, Clare A, Patel R, Clark M, Colquitt D, Roux P, Guenneau S, Craster RV. (2017) Enhanced sensing and conversion of ultrasonic Rayleigh waves by elastic metasurfaces. *Scientific Reports*, 7: 6750.
- Abayzeed SA, Smith RJ, Webb KF, Somekh MG, See CW. (2017) Sensitive detection of voltage transients using differential intensity surface plasmon resonance system. *Optics Express*, 25: 31552-31567.
- Glass DG, McAlinden N, Millington OR, Wright AJ. (2017) A minimally invasive optical trapping system to understand cellular interactions at onset of an immune response. *PLoS ONE*, 12: e0188581.

Esteem Indicators

Prizes and Awards

- Francisco Ulises Hernandez Ledezma – Best Poster, 5th International Conference on Biophotonics.
- Don Peris – Best Paper, Optics + Ultrasound IV.

Conferences hosted

- Optics + Ultrasound III.

Invited talks by members of the group:

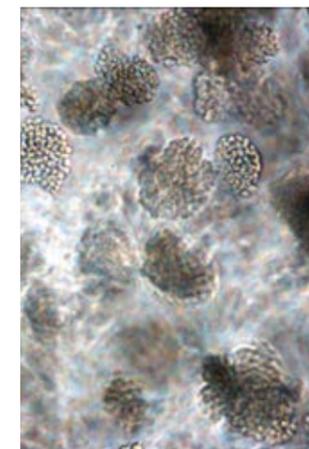
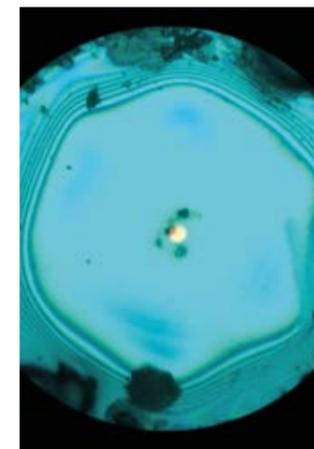
- Photonics West 2017 (San Francisco, USA).
- 7th EOS Topical Meeting on Optical Microsystems (Capri, Italy).
- EUGMS Congress 2017 (Nice, France).
- Optics + Ultrasound IV (Glasgow, Scotland).
- Son et Lumiere 2017 (GDR Ondes, Les Houches, France).
- Le Mans Acoustique Hub (Le Mans, France).

Impact

- SRAS, an ultrasonic imaging technique pioneered by the group is now being applied in the aerospace industry to image raw materials and components to ensure they can withstand the extremely high stresses inside aeroengines.

Optics and Photonics Seminars

- Over 25 research seminars with a dozen external speakers, including: Dr Paul Dalgarno from Heriot-Watt University and Dr Pete Collins from Iowa State University.





Power Electronics, Machines and Control

Head of Group

Professor Jon Clare

As one of the largest and most recognised groups in its field worldwide, the Power Electronics, Machines and Control (PEMC) Research Group undertakes research in Power Electronics and Electrical Machines/Drives that are fundamental to our technological advancement. These technologies underpin the electrification of transport and all renewable energy strategies and are vital for a sustainable future. The Group undertakes work across all of these fields, with research covering the entire space from basic components to complete systems. Key work performed by the group includes a significant contribution to “Clean Sky” (Europe’s largest research programme) developing innovative, cutting-edge technology aimed at reducing CO₂ emissions and noise levels produced by aircraft. The Group’s expertise has also contributed to the multi-international award winning UoN electric superbike, which was successfully built and refined on campus by a race team made up of students, researchers and academics.

Research Areas

- Power Electronic Systems (converters, control, system modelling)
- Electrical Machine Technologies (new configurations, analysis and design, manufacturing)
- Power Electronic Integration (packaging and assembly technologies, reliability, health management, multi-domain design tools)
- Drive Systems (advanced control, optimised converter/machine configurations, ultra-high performance drives)

More information can be found on the PEMC website: nottingham.ac.uk/go/pemc

Research Portfolio

The PEMC group has a total Research Portfolio of £24,763,476, with 18 projects starting between August 2016 and July 2017. These projects were sponsored by a range of funders and industrialists such as, Siemens, Alstom, BAE, EPSRC, Horizon 2020 and the Department of Business, Energy & Industrial Strategy, amounting to £7,131,230 in total.

The Group continues to host the EPSRC Centre for Power Electronics and is leading two of the five projects funded in the second tranche of themed funding.

The Cummins Innovation Centre has been renewed for another five years, following an excellent review from the Royal Academy of Engineering.

Esteem Indicators

Prizes and Awards

- Professor Jon Clare was awarded a Royal Society Wolfson Research Merit Award.
- Professor Pat Wheeler was appointed as a Li Dak Sum Chair Professor in Electrical and Aerospace Engineering, University of Nottingham Ningbo Campus, China.

Committees

- Professor Pat Wheeler was appointed as an Executive Steering Committee Member for the IET Power Electronics and Machine Drives Conference and also a member of the Universidad de Concepcion’s Engineering 2030 Advisory Board.
- Professor Serhiy Bozhko was appointed: a member of UK aerospace electrical power systems (EPS) NTC; and SAE International Standards Committee AE-7 on Aircraft Electrical Systems and the Chair of SAE AE-7M subcommittee on Model-Based design for Aircraft Electric Power Systems.

Journal Editors

- Professor Jon Clare: Associate Editor for IEEE Transactions Power Electronics, IEEE Journal of Emerging and Selected Topics in Power Electronics.
- Dr Alan Watson member of the Editorial Board for the IET Power Electronics Journal.
- Professor Chris Gerada is Associate Editor for IEEE Transactions Industry Applications.
- Dr Giampaolo Buticchi is Associate Editor for IEEE Industrial Electronics.

Key Publications

Below is a selection of the groups most highly cited publications from 2016 and 2017:

- Gurpinar E, Castellazzi A. (2016) Single-Phase T-Type Inverter Performance Benchmark Using Si IGBTs, SiC MOSFETs, and GaN HEMTs. *IEEE Transactions on Power Electronics*, 31: 7148-7160.
- Abebe R, Vakil G, Calzo GL, Cox T, Lambert S, Johnson M, Gerada C, Mecrow B. (2016) Integrated motor drives: State of the art and future trends. *IET Electric Power Applications*, 10: 757-771.
- Gao F, Bozhko S, Asher G, Wheeler P, Patel C. (2016) An Improved Voltage Compensation Approach in a Droop-Controlled DC Power System for the More Electric Aircraft. *IEEE Transactions on Power Electronics*, 31: 7369-7383.
- Romano G, Fayyaz A, Riccio M, Maresca L, Breglio G, Castellazzi A, Irace A. (2016) A comprehensive study of short-circuit ruggedness of silicon carbide power MOSFETs. *IEEE Journal of Emerging and Selected Topics in Power Electronics*, 4: 978-987.
- Gao F, Bozhko S, Costabeber A, Patel C, Wheeler P, Hill CI, Asher G. (2017) Comparative Stability Analysis of Droop Control Approaches in Voltage-Source-Converter-Based DC Microgrids. *IEEE Transactions on Power Electronics*, 32: 2395-2415.

External Activities

Conferences and Events

- PEMC hosted IEEE WEMDCD: <http://w1.icem.cc/wemdc2017/Committees>
- Professor Serhiy Bozhko was appointed General Chair of IEEE ESARS-ITEC Conference 2018 to be hosted by the University of Nottingham.

Strategic activities

- Electrification of transport and other industrial systems is a key enabler for a future green and sustainable society. At the heart of this are the electrical machines and power electronics technologies which need to be power dense, efficient, reliable and cost competitive. The University of Nottingham is a world leader in research in this field through its global Power Electronics and Machines Research group with facilities in the UK and China. It hosts the hub for the EPSRC Centre for Power Electronics and the Cummins Innovation Centre for Electrical Machines. Nottingham also leads the Advanced Propulsion Centre UK thematic spoke in Power Electronics.
- The University of Nottingham is investing in this area of research through the recently launched Propulsion Futures Beacon of Excellence with an aim to investigate all aspects of new electric propulsion systems including new materials, power conversion electronics and electrical machines. The Nottingham Electrification Centre (NEC) is a vehicle to take some of the electrical technologies developed through to commercialisation and exploitation.



Resilience Engineering

Head of Group

Professor John Andrews

The efficient performance of our critical infrastructure and its complex systems is vital to modern society, particularly in the transport, energy production and distribution, utilities and communications sectors. This multi-disciplinary group is dedicated to conducting research into developing modelling techniques to predict ways of improving the design, maintenance, and operation of engineering systems in order to reduce the frequency and consequences of failure. We also focus on improving the resilience of engineering systems to a broad range of disruptive events, from hazardous system failures, to natural and manmade disasters, ensuring adequate defences against their consequences, management of the disruptive event, and the rapid restoration of system functionality. The group has close ties to Network Rail, Lloyds Register Foundation, and The Royal Academy of Engineering.

Research Areas

Developing mathematical modelling techniques for more robust and resilient engineering systems:

- Risk and Reliability
- Asset Management
- System Complexity

More information can be found on the Resilience Engineering website: nottingham.ac.uk/go/regn

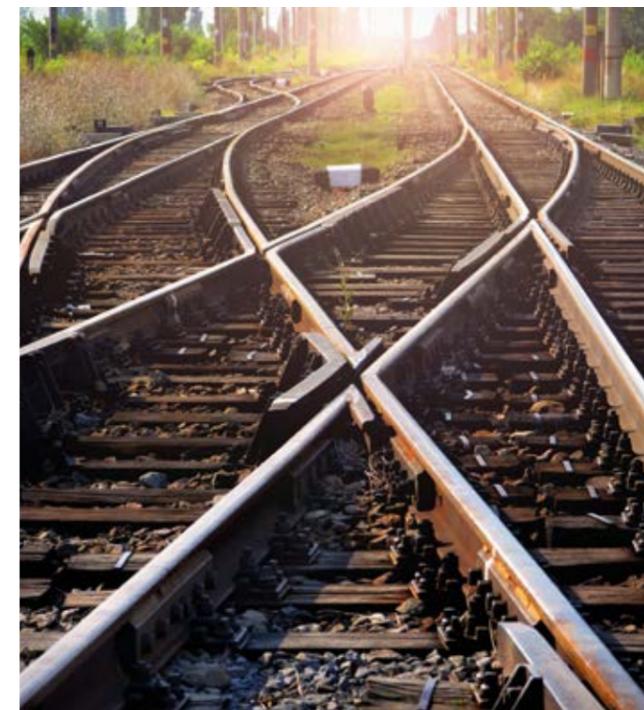
Research Funding

Our continued collaboration with Network Rail as their Strategic Partner in Infrastructure Asset Management has enabled our work on the Shift2Rail project In2Track which began in June 2017.

The group's successful performance within the Shift2Rail lighthouse project In2Rail, resulted in supplementary funding to develop our work on a European Asset Management framework for Railway Infrastructure.

Key Publications

- Yianni PC, Rama D, Neves LC, Andrews JD, Castlo D. (2017) A Petri-Net-based modelling approach to railway bridge asset management. *Structure and Infrastructure Engineering Structure* 13: 287-297.
- Andrews J, Fecarotti C. (2017) System design and maintenance modelling for safety in extended life operation. *Reliability Engineering and System Safety*, 163: 95-108.
- Chiachio M, Chiachio J, Sankararaman S, Goebel K, Andrews J. (2017) A new algorithm for prognostics using Subset Simulation. *Reliability Engineering and Systems Safety*, 168: 189-199.
- Zhang Y, Andrews J, Reed S, Karlberg M. (2017) Maintenance processes modelling and optimisation. *Reliability Engineering and System Safety*, 168: 150-160.



External Activities

Honorary Professors and External Members

- This year saw the recruitment of two new Honorary Professors associated with the Group:
 - Graham Hopkins, Group Director, Safety, Technical and Engineering – Network Rail.
 - Kate Royse, Science Director GeoAnalytics and Modelling – British Geological Survey.
- External associate members appointed to the group include: Bryan Adey (ETH Zurich), Ali Mosleh (UCLA), and Kai Goebel and Shankar Sankararaman (NASA Ames Research Centre).
- Professor John Andrews gave an invited talk at a meeting of the EPSRC funded project "Track to the Future", entitled "System level modelling approaches for railway intervention strategies" (July 2016).
- "Railway infrastructure asset management modelling", Invited talk at the 2nd International Symposium on Infrastructure Asset Management held at ETH Zurich, June 2017. (Professor John Andrews).

Strategic Initiatives

- The Group is part of the UK Rail Research and Innovation Network (UKRRIN) Centre of Excellence in Infrastructure, in collaboration with the Universities of Southampton, Sheffield, Loughborough and Heriot-Watt.
- More information can be found on the UKRRIN website: ukrrin.org.uk

International

- We have exploited our previous success in the Phase 3 Indo UK Civil Nuclear Cooperation Program with an invited talk on "Resilience Modelling in the Nuclear Industry" and attendance at the Phase 4 scoping workshop in Mumbai (John Andrews, April 2017).
- Professor John Andrews will travel to the USA to have talks with researchers at the Naval Postgraduate School in Monterey (a research university operated by the US Navy) regarding resilient systems, and potential areas for future collaboration.

Engineering Research Thematic Areas

The Faculty of Engineering seeks to benefit society, industry and academia by producing world-leading research in challenging areas, and sharing this knowledge to solve global issues.

Our research underpins the University's **Beacons of Excellence** and five of the University's Research Priority Areas (RPA's). Our Faculty also hosts three world-leading Institutes in Energy, Aerospace and Advanced Manufacturing, as well as 24 research groups.

Our Beacons of Excellence will drive significant inward investment in to our internationally renowned research areas, and support our ambitious vision by increasing collaboration, strengthening networks and partnerships, attracting diverse funding, and raising the reputation of our world-leading research.



The Faculty of Engineering leads five Research Priority Areas in Energy, Advanced Manufacturing, Aerospace & Transport Technologies, Sustainable & Resilient Cities and Healthcare Technologies. The priority areas align with the University's Global Research Themes: Cultures and Communication; Digital Futures; Health and Wellbeing; Sustainable Societies and Transformative Technologies. These five interdisciplinary themes draw upon our University's strengths: our ability to focus the depth and range of our research, international and business partnerships and, not least, the inspirational people who are dedicated to driving innovation that will ultimately change lives.

The Faculty is also home to a range of virtual and physical centres with dedicated training areas, using advanced expertise and working directly with industry.

Advanced Manufacturing

Advanced Manufacturing is one of the key research priority areas for the University. Our vision is to sustain and further establish Nottingham as the leading international research centre and preferred research and innovation partner to industry in advanced manufacturing technologies and systems. The Institute for Advanced Manufacturing (IfAM) is a multidisciplinary centre of excellence with a critical mass and expertise to support strategic UK industrial sectors.

The institute brings together all manufacturing related research activities at the University of Nottingham and provides the research environment to enable further growth by capitalising on the synergy between different manufacturing research activities, research centres and cross-sector industrial applications. The institute also connects and supports manufacturing research and teaching across the three campuses in the UK, Malaysia and China.



Key Highlights

- In 2017, the Institute moved to the new iconic Advanced Manufacturing Building. This state-of-the-art building will host several world-class research groups and laboratories conducting internationally leading research and delivering strong industrial impact in advanced manufacturing technologies including 3D printing, composites and manufacturing processes and systems. It also houses the Rolls-Royce University Technology Centre in Manufacturing Technology.
- The Advanced Manufacturing building will provide a focal point for diverse engineering and science disciplines to collaborate and contribute to pioneering developments for a range of sectors including aerospace, automotive, marine, energy generation, food and drink, chemical products and pharmaceuticals, helping to deliver economic and societal impact at both a regional and national level.
- The Composites group secured £10.3m in government funding for new research into pioneering composite manufacturing techniques. The multi-million-pound Engineering and Physical Sciences Research Council (EPSRC) grant is a major research investment for the UK community, hosted by the University's Faculty of Engineering and working closely with the University of Bristol - both of which have established reputations for composites research. The EPSRC Future Composites Manufacturing Hub aims to accelerate the potential of advanced polymer composite materials for automated manufacturing technologies, addressing automation and high rate processing; state-of-the-art simulation techniques; multifunctional materials and structures; advanced inspection technologies; recycling and re-use.

Aerospace and Transport Technologies

Faster, cleaner, safer, more efficient: aerospace and transport systems are under more pressure to deliver than ever before. By drawing on our expertise in a range of disciplines, extensive industrial partnerships and successes as a world-leading centre for aerospace research and collaboration, we aim to build an international profile for high-impact aerospace, transport and mobility research.

The Institute for Aerospace Technology (IAT) is a major centre for aerospace research with over 70 externally funded projects valued at over £75 million with an inspirational team of 400 scientists and engineers. It unites leading aerospace and engineering research across a range of disciplines, with a distinctive, current strategic focus on future propulsion and electrification. Our Marie Skłodowska Curie PhD programme attracts the world's leading doctoral students, who are working with industry to direct the future of aerospace.

In parallel, it has continued to shape the regional ambition for transport, leading the Midlands Innovation effort, embodied by the Transport Innovation accelerator project. The University is also now working with the Transport Systems Catapult to create and build joint capabilities and resources in Transport and Intelligent Mobility in order to deliver UK economic growth, impact through commercialised research and exploit international market opportunities.



Key Highlights

- Over the last year, the University has been working with the Aerospace Technology Institute (ATI) and EPSRC, as well as a network of four other leading UK universities in the field, to launch the embryo of the National Aerospace Consortium (NAC), with a focus on future propulsion. The Nottingham-led consortium has bid for a £40 million infrastructure investment with the Higher Education Funding Council for England (HEFCE) to support the vision, with industrial support from Rolls-Royce, Airbus and Siemens. The IAT has also been instrumental in forming the 'Propulsion Futures' beacon at Nottingham, as a direct spin-off from its propulsion agenda with added fundamental contributions from material science and £12.5m investment from the University.
- In 2017, the University of Nottingham has further established its position in the UK as a key partner within the Clean Sky 2 programme. The IAT has supported academics to secure €38 million of Clean Sky 2 research projects and Nottingham is involved in four core partnerships in all key areas of the Clean Sky 2 programme, and with leading industrial partners including Rolls-Royce and Airbus Helicopters.
- In September 2017, the Aerospace and Transport Technologies Research Priority Area hosted a Transport Technologies Showcase in association with the IMPETUS programme and the Transport Systems Catapult. 93 delegates attended from industry and academia including industry speakers from FirstGroup, Hitachi Information Systems Europe, Control F1 and RAC Foundation.
- Significant Collaborative R&D projects have been awarded in the following Innovate UK competitions:
 - Innovation in vehicle-to-grid (V2G) systems demonstrator – Professor Mark Gillott.
 - IDP14: accelerating the transition to zero emission vehicles – Professor Alasdair Cairns.
- Luca Bertola, an INNOVATE ESR, was awarded the Peter Kemmey medal by the 18th EML symposium committee (Electromagnetic Launch Technology). The award is conferred to the student with the most significant research achievements of the conference.
- Dafne Gaviria was awarded an Amelia Earhart Fellowship from Zonta International (one of only 36 worldwide) for her work in enhancing the performance of the new generation of aero-engines.

Energy

Our modern society has been built using carbon dioxide emitting fossil fuels to generate energy. We need to move to reliable, cost-effective and fully sustainable energy sources.

The Energy Technologies Research Institute (ETRI) unites multi-disciplinary energy research across four faculties at the University of Nottingham, with over 150 academics contributing to an impressive portfolio of research, development and demonstration projects worth over £60m and funded by government, industry and the EU.

We collaborate and form strategic partnerships with many of the world's leading energy innovators and are part of the Innovate UK funded Energy Research Accelerator (ERA), alongside five other Midlands based universities and the British Geological Survey. The GeoEnergy Research Centre (GERC), is one example that has seen us form strong international partnerships with Virginia Tech (US) and the China University of Mining and Technology.



Key Highlights

- The **Energy Innovation and Collaboration Team** engaged with 150 business and signed up 88 from the Derbyshire and Nottinghamshire regions to work with the University, as part of 'Energy for Business' an European Research Development Fund (ERDF) funded low-carbon project. The team built relationships with the Chamber of Commerce, Woodhead Construction, Nottingham City Council, the British Geological Survey, the Sustainability Research Network, and energy policy experts, amongst others.
- Energy for Life**, a project that is strengthening ties with developing nations, has funded three seed projects to enable researchers in Nepal, China, Malaysia and Nigeria to work alongside University of Nottingham academics.
- Claire Perry, Minister of State for Energy and Clean Growth**, visited the University of Nottingham in July 2017 and met with researchers at the Creative Energy Homes, a project at the forefront of the development of new smart systems technologies to change the way we store, manage and consume energy.
- As part a £20 million investment through ERA, a **new Research Acceleration and Demonstration building** is home to impressive energy research labs and testing facilities.
- The **GeoEnergy Research Centre** uniquely appointed three UK-US joint academic positions as part of our partnership with Virginia Tech.
- The **GeoEnergy Test Bed (GTB)** on the Sutton Bonnington campus has been completed. This £3.5m facility will generate large amounts of data describing properties and movements of fluid to improve future site geological models.
- The Institute delivered a series of events for **EU Sustainable Energy Week 2017**. These featured; the circular economy, energy storage, fuel poverty, energy for developing countries, smart energy communities and energy policy. 230 attendees took part in the week-long series of free events.

Healthcare Technologies

Addressing healthcare challenges by driving scientific innovation into clinical practice. The University of Nottingham's strategic alliance with the Nottingham University Hospitals NHS Trust has an international reputation for research and training and underlines our capacity to address the world's healthcare challenges.

The Centre for Healthcare Technologies (CHT) is a unique collaboration between The University of Nottingham and Nottingham University Hospitals NHS Trust. Working with all stakeholders, we address major healthcare challenges through technology innovations, creating a pathway from science through to clinical application with the aim of rapidly translating scientific discoveries into healthcare.

Key Highlights

- Francisco Ulises Hernandez Ledezma, a PhD candidate won the award for best poster presentation for his work on 'Optical fibre sensing during critical care' at the 5th International Conference on Biophotonics, Australia.
- Dr Don Sharkey and Professor Donal McNally have been awarded £872,000 by the National Institute for Health Research, working in collaboration with ParAid Medical to reduce the risk of brain injury and subsequent life-long disabilities by developing the next generation of neonatal transport.
- **Nottingham in Parliament Day.** The Centre for Healthcare Technologies (CHT) led one of the six Research Futures showcases at the Nottingham in Parliament Day "The Future of Health: What's the secret to getting better faster?" With a panel chaired by Chair of the Nottingham University Hospitals NHS Trust, Louise Scull, and high profile representatives from the National Institute for Health and Care Excellence (NICE), MedilinkEM, Philips Healthcare, and Professor Steve Morgan, a packed room heard the debate including representatives from the Office for Life Sciences (who lead on the Accelerated Access Review), the House of Commons and the House of Lords.
- The Cyclops Healthcare Network, led by Professor Steve Morgan and Dr Sergiy Korposh, aims to optimise patient care by adjusting treatment based on feedback from monitoring information. It held its first workshop in February 2017, funding three feasibility projects and has since grown to 120 members nationwide.
- Harriet Parnell won the Midlands regional heat of the Institute of Materials, Minerals and Mining (IOM3) Young Persons Lecture Competition in 2016 and came third in the national final. In 2017, she was selected to present her work to MPs and academics by poster at a Science, Technology, Engineering and Mathematics (STEM) for Britain event held at the House of Commons and won bronze medal.
- **Monica Healthcare** – a spin-out company which developed a novel technology for monitoring expectant mothers - was acquired by GE Healthcare. Monica took forward research by Professor Barrie Hayes-Gill and his colleague Professor John Crowe between 1989 and 2002.
- Spinout company Surepulse Medical has been undertaking clinical trials of its heart rate monitor for newborns at Nottingham University Hospitals, supported by CHT. Surepulse Medical involves Barrie Hayes-Gill, John Crowe and Steve Morgan and Don Sharkey.
- Best conference paper awarded at the prestigious 12th Institute of Electrical and Electronics Engineers (IEEE) conference on Automatic Face and Gesture Recognition (FG2017), with Dr Don Sharkey as co-author.

Sustainable and Resilient Cities

Creating knowledge for a better understanding of the challenges cities face. Our vision is to bring together interdisciplinary expertise from across the institution to support cities in their transition towards more sustainable and resilient futures: environmentally, socially and economically. We are developing novel ways to understand and measure urban sustainability.

Funded projects undertaken by RPA members include:

- The LUCAS project - Laboratory for Urban Complexity and Sustainability - continues to conduct transdisciplinary research focussed on complex urban systems including infrastructure, buildings, and social resilience.
- Project SCENe (Sustainable Community Energy Networks) looks to accelerate the adoption of community energy solutions, a different way of generating and supplying locally generated heat and electricity to homes and commercial buildings. At the Trent Basin in Nottingham the Project SCENe team's research ranges from planning issues to business models and new technologies.
- SOUL (Sustainable Optimised Urban Living) received phase 1 funding to develop proposals for innovative social housing provision with Nottingham City Homes, Nottingham City Council, Saint Gobain and other partners.
- Green Universities Thailand - Economic and Social Research Council (ESRC) Global Challenge Research Fund, workshop involving Thailand's Department of Environmental Quality Promotion, Suan Sunandha Rajabhat University and Rangsit University.

Key Highlights

- Sustainable and Resilient Cities **Symposium** was held with representation from 41 institutions including local authorities, businesses, research institutions and community members. The event showcased the range of themes and challenges that RPA work addresses, including transport management, smart campus operations, climate change resilience in cities, community-led sustainable development and governance.
- Dr Lucelia Rodrigues and Professor Gavin Walker have become members of the Nottingham City Council's Sustainable Development Strategy Panel, advising on a sustainable energy action plan for Nottingham for 2030.
- The Energy Research Accelerator (ERA) is supporting an innovative community energy initiative which could become a model for providing low-carbon energy solutions at residential developments across the UK.
- **Project SCENe at the Trent Basin:** The Trent Basin project demonstrates how the establishment of a community-focused energy supply company that utilises a range of renewable energy generation technologies and a battery storage facility can work as a model for future nation-wide schemes, which could provide a significant increase in the amount of renewable energy produced, while also reducing energy costs for consumers. The site incorporates the latest in sustainable development, including the largest community energy battery system in Europe (2 MWh Tesla battery) which helps to augment the energy production from installed solar photovoltaics and was designed as a full community development.



The University of Nottingham and Thailand Sustainable Campus Collaboration

Research Impact



Within the Faculty of Engineering, not only do we deliver world class research, we are also investing to ensure that this delivers tangible impact to those outside of research and academia.

In order to achieve this, the Faculty of Engineering has invested in our impact team with the recruitment of a new Impact Development Manager, Deanne Hewson. Whilst we continue to prepare ourselves for the next Research Excellence Framework (REF2021), our focus is firmly on developing knowledge exchange and impact of all varieties; not just those related to REF impact Case Studies. We are delighted to outline below a number of examples of impact delivered over the last year, ranging from the development of engineered processes and tools, to influencing visitor experience of exhibitions. We are also pleased to show examples of the various companies and organisations with whom we have collaborated in order to deliver such impact to the economy and society as a whole.

Professor Chris Tuck,
Faculty Director of Impact and Knowledge Exchange,
Faculty of Engineering

Technology Transfer

Our Innovation and Impact Manager Dr Jon Collett, works between the Faculty and the central Intellectual Property Commercialisation Office. During 2016/17 the following Technology Transfer successes were celebrated:

- In July 2017, **Build Test Solutions Ltd** licensed the patented pulse test technology for testing building air-tightness, led by Dr Christopher Wood and Professor Mark Gillott.
- **Footfalls and Heartbeats (UK) Ltd** are collaborating with the University under a unique licensing model, and are working with Professor Stephen Morgan to develop novel optical sensors for textiles. Professor Morgan has received a Royal Society fellowship for a secondment with the company to further progress the commercialisation of the technology.
- **Monica Healthcare Ltd**, a spin-out based on Technology developed by Professor Barrie Hayes-Gill and Professor John Crowe, was acquired by GE healthcare. This represents a tremendous success for the Monica team. The GE acquisition will ensure that Monica Healthcare's innovative products, based on technology developed by the University of Nottingham, can be distributed widely, benefitting thousands of expectant mothers across the world.

- **Surepulse Medical Ltd** are nearing CE mark approval for their heart rate monitoring technology for newborns. So far, more than 300 babies have been part of trials at City and QMC hospitals. An interim funding round was completed that saw a range of new investors involved in the company.
- **Promethean Particles Ltd** now has a Tonne scale manufacturing facility fully commissioned at company HQ in Nottingham and has made significant commercial progress with nano-copper based printed electronics products. Collaborations with the University are ongoing including commercialisation of nano-enhanced body armour technology.
- **Added Scientific Ltd** now employs 8 full time staff and has moved to its own premises on Nottingham Science Park with a laboratory worth around £100k. The company has worked with a wide range of industrial sectors and have carried out over 20 B2B projects.
- The Faculty of Engineering secured fifteen Hermes Fellowships and nine Impact Accelerator Account awards. This translational funding is helping to develop projects towards commercialisation and enhance business engagement activities.
- 2016/17 saw a continued success rate for new **Knowledge Transfer Partnerships** with an award value (company and grant) of just under £1million, reaching a peak of 20 live projects involving 12 of the Faculty's 24 research groups.

EPSRC Funded Networks

Connected Everything

Industrial systems in the digital age

Professor Sarah Sharples is leading the EPSRC-funded Network Plus Connected Everything: Industrial systems in the digital age.

Advances in digital technologies are transforming opportunities for manufacturing. Connected Everything's outputs will help strategic choices to be made with respect to future UK research funding.

The Connected Everything team are working with Innovate UK, EPSRC, the Institute of Engineering and Technology and the High Value Manufacturing Catapult to identify the research and innovation challenges that will be addressed to place the UK at the forefront of the 4th Industrial Revolution.

CYCLOPS Healthcare Network

How artificially-intelligent medical devices will one day treat cancer and critical care patients

Professor Stephen Morgan and Dr Sergiy Korposh, in collaboration with the Universities of Oxford and Warwick, are leading 'blue sky' research into artificially-intelligent medical devices that will improve treatment for cancer, intensive care patients and those with chronic wounds. These future technologies will continuously monitor critically-ill patients and administer medicines or adjust treatment automatically, using feedback from built-in sensors. The aim is to provide more personalised, accurate and timely care and, ultimately, to save lives. Professor Morgan and Dr Korposh lead this network of experts in healthcare technologies, sensing, clinical care, control and modelling to identify potentially innovative clinical tools and approaches.

Advances in Museum Design

During summer 2017, Wollaton Hall and the Lakeside Arts Centre in Nottingham hosted the 'Dinosaurs of China' exhibition attracting 132,000 visitors. The exhibition design was based on the Spatial Narrative research of Dr Wang Qi and Professor Jonathan Hale and presents pioneering approaches to engaging visitors and enhancing their experience of exhibition content. The opportunity to use this approach has permitted many of the world's most important and iconic dinosaurs to travel outside of China for the first time. After travelling to the UK to visit the exhibition, the China Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) reported that the Spatial Narrative principles have provided reference for future developments of the Paleozoological Museum in China.



Fighting Slavery from Space

In 2017 a new innovation in the mission to end slavery was launched: tracking sites of exploitation from space. According to the Global Slavery Index, there are 18 million slaves in India, many of whom are forced to work in the brick making industry. By tracking the sites of the brick kilns using geospatial techniques a more precise picture of the prevalence of slavery has been achieved bringing a huge benefit to on-the-ground antislavery groups, who struggle to locate slavery sites in remote and politically unstable areas. The project, co-led by Stuart Marsh (Engineering) and Doreen Boyd (Geography), being conducted with the University's Rights Lab Beacon of Excellence has been featured by Reuters, the BBC, the New Scientist and the Telegraph.

Airbus Racer Helicopter

In June 2017, the CEO of Airbus Helicopters unveiled a model of the new Rapid and Cost-Effective Rotorcraft (codenamed Racer), at the Paris Air Show. In collaboration with GE Aviation and Airbus Helicopters, and funded through the Clean Sky 2 Joint Undertaking, Professor Svetan Ratchev's research team has led ground-breaking research into the development of the new "Box-wing" structure that will provide Airbus Helicopters' Racer High Speed Helicopter Demonstrator with enhanced speed and range to complete advanced missions.



Trent Basin Community Energy Test Bed

Research into multi vector energy systems for electricity-heat generation, storage and use has been intrinsic to a unique pilot project to provide a full-scale demonstration of an integrated community energy scheme. Both solar and ground source thermal energy generation will be combined with the largest community energy battery in Europe. The scheme, which currently comprises 45 low-energy homes, with a further 100 planned, aims to demonstrate how it is possible to provide a practical, commercially viable solution which can minimise the use of fossil fuel generated energy, lower energy costs and reduce carbon emissions.

Reinventing Phase Contrast Microscopes

Dr Kevin Webb's 2015 publication on achieving Zernicke phase contrast on microscopes without bulky and expensive condensers has led to a collaboration with UK company Cairn Research Ltd. Cairn Research have developed the Aura Phase Contrast Illuminator based on Dr Webb's work. The device, which is now marketed globally as a retro-fit to existing microscopes, is enhancing the research of its users by allowing increased space around samples for additional probes and tools.



Human-Machine Interface Design for Future Vehicles

Professor Gary Burnett and his team from the Human Factors Research Group have been working closely with major automobile manufacturers to support them in the design of displays and controls (the Human-Machine Interface or HMI). The research, which aims to maximise user experience, is now influencing the interior design of vehicles currently being developed and sold. Using the faculty's state-of-the-art driving simulator, the team's research has resulted in a range of benefits for companies including analytical modelling techniques which predict the visual demand of touchscreen HMIs considerably quicker and cheaper than traditional user trials.

PhD Highlights



Harriett Parnell, PhD Student

As a third year postgraduate research student, within Advanced Materials, the 2016/17 academic year proved to be one of the most rewarding 12 months of my PhD. Specialising in mid-infrared transparent glasses, which are a promising material for early cancer diagnosis, during March 2017 I was lucky enough to be invited to the national final of the STEM for BRITAIN competition, held at Westminster in London. With an opportunity to discuss ground breaking research with Members of both Houses of Parliament, the competition ultimately saw me placed third in the UK for my research. From this, I was then invited to present at the 2017 Royal Academy of Engineering Forum, where I also had a chance to hear from Professor Dame Ann Dowling and other academy Fellows. Whilst enjoying these public engagement activities, my experimental research also hit a milestone during August 2017 when, with the support of the Mid-infrared Photonics Group, I was able to produce world leading Ge-Sb-Se chalcogenide optical fibres and publish my first journal article.



Hayden Morgan, PhD Student

I am an EngD student in the Centre for Carbon Capture and Storage and Cleaner Fossil Energy (CCSCFE). The 2016/2017 academic year has been the busiest and most exciting year yet. It all began when back in September when I was lucky enough to be selected to attend the engineering research showcase at the University of Nottingham Malaysia campus. I had never visited Malaysia before and I felt very welcome by the staff and students at the university. I also visited the French geological survey (Bureau de Recherches Géologiques et Minières) to conduct some research at high pressures as part of the ECCSEL transnational access fund. This allowed me to perform work not possible at my laboratory and gain insight from experts working in my area.

As part of my CDTs international visit module I did a poster presentation at the greenhouse gas technology conference (GHGT-13) held at Lausanne, Switzerland. I was honoured to have been this year's Engineering Research Showcase runner up. I was selected to represent my training centre in a video showcasing what they have to offer. The past year had been a great experience for me and I look forward to the new opportunities that my final year will bring.



Obinna Okafor, PhD Student

My PhD research has been a unique and although challenging, a rewarding experience. My project is aimed at developing 3D printed mesoscale flow reactor devices which will be valuable in the development of new materials. It is interesting to think that relatively new technologies such as 3D printing could be valuable for researchers in the discovery of new drugs and formulations.

It has been a challenging experience as although coming from a mechanical engineering background and I have had to learn from chemists, material scientists and chemical engineering colleagues at the University who have been supportive.

In the past year, I have had the opportunity to share the development of an advanced 3D printed flow reactor device developed at the university at various international conferences and events. Having won one of the university's poster prizes, I was given the opportunity to travel down to the University of Nottingham Malaysia Campus, UNMC. I attended the Engineering Research showcase at UNMC where I shared my experiences and gained knowledge from researchers at the campus. I not only enjoyed the tranquil environment at the campus, but also I visited neighbouring cities, engaged with the locals and enjoyed Malaysian cuisine.

Engineering Young Entrepreneurs Scheme (YES) Success

University of Nottingham Engineering PHD Students Win Tough National Entrepreneurial Competition for Researchers (Engineering YES)



Team Sygnocare: Menghao Chen, Jessica Butterworth, Enabulele Courage Ogbemor, Olufisayo Olanrewaju, Oriol Gavalda Diaz and Yang Zhang

A team of SIX Engineering PHD researchers (Sygnocare) from the University of Nottingham beat off strong competition to win the eighth national final of Engineering YES, held at Faraday Wharf on the Innovation Birmingham Campus. Six teams of post-graduate engineering researchers from universities across the UK presented their business plans to a panel of judges including senior executives from Rolls-Royce, Potter Clarkson, the Royal Bank of Scotland (RBS) and the Natural Environment Research Council (NERC).

For more information, please follow this link: <https://www.nottingham.ac.uk/graduateschool/news/2016/engyessuccess.aspx>

Engineering Research Showcase

The Faculty of Engineering hold this annual event, which allows PGR students from across the Faculty to present their work via posters or oral presentations to an audience of students and staff. The 2017 event was held on the 4 May, it included a welcome from Professor Sarah Sharples, a keynote talk from Alan Simpson (past Nottingham South MP) on the topic 'Re-designing the world, post Trump and Brexit' and concluded with various workshops aimed at PGR students and research staff. Winners and runners up of the various prizes are detailed below:

Year 1 – Powerpoint slide

- Best Powerpoint Slide – Michael Basford
- Runner Up – Maria Jose Galvez Trigo

Year 2 – Posters

Best Poster – Research Quality

- Winner – Obinna Okafor
- Runner Up – Rattaphong Meesit

Best Poster – Research Impact

- Winner – Matthew Kessler
- Runner up – Richard Evans

Best Poster (overall)

- Winner – Ben Sheppard
- Runner up – Caitriona McCarron

Year 3 – 3 Minute Thesis (3MT)

- Best 3MT presentation – Adam Dundas
- Runner up – Hayden Morgan

Best Paper – Research Staff

- Winner – Andrew Batchelor
- Runner up – Jayasheelan Vaithilingam

Best Paper – Student

- Winner – Chai Siah Lee
- Runner Up – Jasim M Ali

The event was well received by all that attended and was followed by a PGR Gala Dinner where the prize giving took place.



Professor Sam Kingman, Associate Faculty Pro-Vice-Chancellor and Deputy Head



Professor Paul Brown, Faculty Director of Research Equipment



Rachel Brereton, Head of Faculty Research Operations



Professor Stuart Marsh, Faculty Director of Postgraduate Research



Professor Chris Tuck, Faculty Director of Impact and Knowledge Exchange



Professor Sarah Sharples, Associate Faculty Pro Vice Chancellor for Research and Knowledge Exchange



I would once again like to congratulate Faculty staff and students for their tremendous efforts over the past year. Our colleagues should be very proud of their achievements, which continue to demonstrate the quality of work that is being conducted in many parts of the Faculty.

The year 2016-17 was one of significant change. Externally, we face uncertainty regarding the future of our collaborative work with colleagues in the EU; alongside this, clear opportunities for developing new partnerships, either through the Global Challenges Research Fund, or via the Industrial Strategy, present an exciting avenue for us to pursue. The year has also seen significant investment from the University in its global research strategy, and I am pleased to see such strong engagement and leadership from Faculty teams in the newly developing Beacons of Excellence.

A highlight of the year has been the completion of our new Advanced Manufacturing building. Staff are now settling into their new offices and world class laboratory facilities, and the success of the design as well as overcoming the complexity of managing the movement of so many people and so much laboratory equipment, is a credit to the collaborative work of many individuals across the University.

Excellence in research is demonstrated through high quality scientific publications, and real impact of our research. The examples within this brochure present a sense of the contributions that staff and students are making to both of these.

Thank you to all staff and students across the Faculty for their continued hard work to deliver another successful year in terms of funding, high-quality publications, strong impact and strategic partnerships. I look forward to another year of success.

Andy Long

Professor Andy Long,
Pro Vice Chancellor, Faculty of Engineering



University of
Nottingham

UK | CHINA | MALAYSIA

If you require this publication in an alternative format, please contact us:
t: +44 (0)115 951 4591
e: alternativeformats@nottingham.ac.uk

For general enquires, contact:

Rachael Duthie
Senior Research Development Officer

 Rachael.Duthie@nottingham.ac.uk

 +44 (0) 115 74 84494

Printed February 2018.

The University of Nottingham has made every effort to ensure that the information in this brochure was accurate when published. Please note, however, that the nature of this content means that it is subject to change, therefore consider it to be guiding rather than definitive.

© The University of Nottingham 2018. All rights reserved.