Institution: De Montfort University

Unit of Assessment: UoA15 – General Engineering

a. Overview

Research in the Unit addresses three societal challenges formulated in the strategy section. It is based predominantly in the School of Engineering and Sustainable Development and is organised around the following research centres:

- **Advanced Manufacturing Processes and Mechatronics Centre (AMPMC)**: www.dmu.ac.uk/AMPMC
- **Centre for Electronic and Communications Engineering (CECE)**: www.dmu.ac.uk/CECE
- **Centre for Engineering Science and Advanced Systems (CESAS)**: www.dmu.ac.uk/CESAS
- **Emerging Technologies Research Centre (EMTERC)**: www.dmu.ac.uk/EMTERC
- **Institute for Energy and Sustainable Development (IESD)**: www.dmu.ac.uk/IESD

Over the census period the Unit has produced in excess of 400 research outputs, including 214 journal articles, 172 conference papers, 4 book chapters, 4 books and 7 patents.

b. Research strategy

The current submission is a continuation and further enhancement of engineering research at DMU. There were five engineering submissions in RAE2008, with most staff being returned to either UoA 24 – Electrical and Electronic Engineering, UoA 25 – General Engineering or UoA 28 – Mechanical, Aeronautical and Manufacturing Engineering.

Following RAE2008, a strategic decision was taken to restructure research in engineering to facilitate a subject based grouping that encourages collaborative and discipline-crossing research. This has resulted in a number of research Centres being created: **AMPMC** was formed from the Lean Engineering Research Group, the Mechatronics Research Centre and the Additive Manufacturing Group to concentrate on processes and operations for autonomous, intelligent and customised manufacturing supply chains. **CECE** was developed from part of EMTERC (in the 2008 return) which has, at its core, data collection, manipulation and transmission in electronic and communications systems. **EMTERC** now concentrates specifically on micro and nano-technology. **CESAS** brings together the previous mechanical engineering research group, the Water Software Systems team and the Textiles Engineering and Manufacturing group to concentrate on analysis, simulation and measurement associated with predominantly mechanical, civil and environmental engineering systems. **IESD** is responsible for research in engineering aspects of building and energy systems, including low or zero carbon technologies (and staff from the IESD are returned both to this unit and to UoA 16, depending upon their specific area of research).

This structure provides a more sustainable environment with a better culture for post graduate research (PGR) students, more support of early career researchers (ECRs) and improved succession planning. The objectives formulated in RAE2008 have been largely achieved – there has been a significant increase in research activity and the outlined research programmes have been implemented and expanded. The new paradigms inspired by biological systems proposed by AMPMC have resulted in a number of EPSRC/TSB projects leading to new autonomous manufacturing concepts. Research into nonlinear flight dynamics has been enhanced through European Union (EU) projects with significant impact on flight safety. EMTERC has progressed significantly its research on organic electronics and nanotechnologies resulting in 39 journal papers and 2 patents. Electromagnetic compatibility research has led to the definition and introduction of new IEEE standards for EMC. The thermal imaging laboratory established itself as a centre of excellence for this technique and developed interdisciplinary collaboration with textile engineering (Shen) and environmental engineering (Huddersman) teams through a joint TSB project. Media communication work has resulted, for instance, in the creation of effective communication protocols facilitating multiuser games across the internet (Hamzaoui). Shen has advanced his research for enzyme-based textile technologies to replace traditional chemical processes with low environmental footprint alternatives – this research has impacted industrial practice in Europe through EU projects and industrial collaborations. Ulanicki's team has continued to develop efficient algorithms and software for energy management, pressure control and bursts detection in water distribution systems and developed a new membrane biological reactors research stream. Greenough has contributed to the modelling of energy efficient factories of the future through a TSB project and two 7th Framework projects.

Over the next five years, our strategy will be to maintain and build upon existing infrastructure and capability (described below and in section d) and to define clear research challenges in each area of the current submission. Specific areas of research focus include (but are not limited to): 1) research into 'beyond next generation Ethernet' aiming to develop channel characteristics to allow 100+Gbps on twisted pair cabling; 2) developing tools to enhance sustainable and efficient manufacturing with decreased environmental impact through the entire life cycle of products; 3) to develop efficient and cost-effective experimental and computational technologies for the creation of non-linear flight dynamics models in extended flight envelope that can enhance the safety of future civilian and military aviation; 4) to create analytical, modelling and measurement approaches that will reduce energy and water footprints on a local and global scale; 5) to further enhance our reputation to become "researchers of choice" in developments for smart and secure cities, including civil infrastructure, utilities, transport and communication.

Each research centre has prepared long term and short term research plans with measurable objectives in terms of published outputs, grant applications and PhD student recruitment/completion. The plans are reviewed and updated annually. All researchers have an individual research plan, co-ordinated with their teaching load. This mechanism supports and develops our researchers to give them time to undertake high quality research. Additional support is provided for ECRs and includes mentoring (each ECR has a named senior mentor), reduction of teaching load and financial support for conference participation. All researchers are able to bid for competitive funding provided by the University, including funds for: research infrastructure; pump priming projects; scholarships; and research leave (sabbaticals).

Each research centre receives financial incentives, based on its plans and performance. This gives a degree of autonomy to researchers to maximise the inputs to and outputs from their research. Interdisciplinary research is encouraged in the Unit; for example, several recent FP7 grant applications involved at least two research centres listed in section a).

The Unit is working towards the position where all members of staff have an opportunity to supervise, and lead to completion, research students in their field. In order to increase the number of research students, two Doctoral Training Programmes have been created within the Unit; a DTP in Engineering and a DTP in Resource Use and Sustainable Development. It is anticipated that this initiative will improve the overall experience and environment for research students, including developing training and employability skills. The programs are supported by the University Graduate School Office.

To enhance impact and visibility of the Unit, the Unit encourages collaboration between different centres and is proactively establishing strategic partnerships with industry, commerce, charities, government and professional bodies on both national and international levels. Collaborations are outcome-focused and will result in high quality outputs and different forms of impact. Our international collaboration is facilitated by the wide ethnic diversity of our staff and their professional international links.

The Unit allows flexibility for staff to be associated with more than one research area or centre and facilitates organisation of ad hoc multidisciplinary teams to solve specific problems and challenges (which can be within the Unit, within the faculty or across different faculties). To further enhance our reputation, staff are encouraged to represent the Unit externally, particularly on boards and committees that are relevant to their areas of activities. This also ensures that we are aware of the widest range of opportunities available and able to direct and influence our wider professions.

c. People, including:

i. Staffing strategy and staff development

Staff at each stage of academic career development receive support and guidance from the university and from the Unit. Senior staff objectives are set annually. Objectives cascade down the line-management structure such that all staff understand their own career development paths and what they are expected to achieve. The Unit follows DMU's commitment to equality and diversity for staff and students. For example, seed corn funding is open to staff on part-time and fixed term contracts. DMU has been awarded an Athena SWAN Bronze Award and is encouraging female researchers to apply for available positions. AMPMC will be applying for a departmental bronze award. More than 50% of staff selected to be returned in this Unit are from BME backgrounds.

Recruitment – All recruited members of staff are research active and already undertake research that aligns to, complements and extends our existing research strengths (details given in section b). Four junior appointments (Ahmad, Gammon, Greenough and Skworcow) and two senior

appointments (Lee, Collop) have been made in the Unit since January 2008.
Researcher Development Support Programme – The Unit supports and develops research-active staff through Individual Research Plans and the use of associated research allowances to give time to undertake high quality research. Additionally, all staff within the Unit are offered a variety of competitive research support to help them develop their research careers. Amongst these we have: **(a)** Higher Education Innovation Funding (HEIF) to support and develop a broad range of knowledge exchange activities between universities and the wider world, which result in economic and social benefits to the UK (since 2011); **(b)** Research Investment Fund (RIF) to support new initiatives to build our research capacity, performance and reputation (since 2010); **(c)** DMU-wide research leave scheme (since 2011) and a Faculty research leave scheme (since 2012) – three colleagues have benefitted from this to date: Goman, Duffy and Menzies-Gow; **(d)** PhD Scholarships (full bursary and fees only); **(e)** the VC's Future Research Leaders Programme to raise the strategic research competence of a cohort of selected 'future research leaders' within the University by equipping them with the skills and the sense of responsibility to act subsequently as champions and inspirations of research in their own research groups; **(f)** regular Faculty Research Away Days (since 2012) to allow staff to meet colleagues in the School with the aim to encourage internal new research collaboration activities and links – the research away day on 21/09/2012 for instance had an audience of over 100 colleagues; **(g)** A significant part of research centres' budgets are used to support colleagues attending/presenting at conferences and international visits with the aim of developing or building on existing, research collaborations; **(i)** A number of staff are undertaking DMU PhD programmes with the full support and authorisation of the Faculty. DMU is fully committed to the principles of the 2008 Concordat to support the development of researchers, and this is being incorporated into the Unit's plans at the research group level.
Mentoring – In the Faculty it is estimated that 60% of staff are involved in peer mentoring as either recipients or mentors (or both), although the opportunity exists for all staff. ECRs are mentored from their first day in the Faculty by experienced research colleagues in their field and are given peer observation opportunities. All academic staff receive a local induction and ongoing training throughout their careers from DMU's Academic Professional Development Unit (APDU). A regular programme of courses is produced which colleagues can, and are encouraged to, attend. In 2012/13, the Faculty provided a bespoke training programme for new Subject and Research Group Leaders. Each year there are two important events related to the development of the research culture: the Research Away Day (described previously) and the Technology Showcase**.** The benefits for individual staff include networking opportunities and providing public recognition for the work they do. This in itself has a very positive staff development impact.

ii. Research students

As described in section b) in order to improve the recruitment process and the student experience, DMU has created a system of Doctoral Training Programmes (DTPs). PhD students are accepted onto Doctoral programmes based on the quality of their application and area of interest. In all cases PhD applicants are interviewed and aligned to a research group working in the area. The Unit recruits a number of students from our Master's programmes and DMU supports strategically important research areas by funding student bursaries each year.
PhD students are supported with a mix of self-funded, DMU bursaries and funded from grants. The population of international students in AMPMC has increased by 80% in the last five years. The recruitment of PhD students within the Unit also benefits from the creation in 2013 of the High Flyers PhD Scholarships scheme that aims to encourage the retention of our highest quality UG/MSc students to study for their PhD.
Postgraduate research students have a significant training programme over the four-year period with compulsory and optional modules (monitored via the Researcher Development Programme). The DTPs complement this with domain specific modules on research methods, mathematics, statistics and business aspects.
There are a number of rigorous procedures in place to maintain and improve the quality of research degree programmes, including: regular progress meetings between research students and supervisors; a monthly progress report, which must be completed by the student and signed off by a member of the Supervisory Team – the Faculty Head of Research Students reviews the progress of the research students and checks that regular discussions between supervisors and their students are taking place; progress is subject to a positive formal annual review by the

supervisory team and at least one researcher independent of the supervisory team.

d. Income, infrastructure and facilities

Income: Over the census period the Unit has secured research funding in excess of £6 million, primarily from the EPSRC, EU, TSB and KTP. The Unit has also maintained strong links with UK industry and this has resulted in a significant number of contract research and consultancy projects over the same period.

Examples of completed projects: **1)** EPSRC "Neptune" (2007–2010, Ulanicki), (DMU £260k), a strategic partnership of six leading UK universities and three industrial partners (Yorkshire Water, United Utilities and ABB Ltd) with the aim of improving management and control of water supply systems. **2)** EPSRC- EP/G029423/1 "Multiwavelet Evaluation for Stereo Correspondence" first time grant, (2009–2011, Serdean), (£180k). **3)** EU FP7 "Supra", (2009–2012, Goman), (DMU 180k EUR), to create models in extended flight envelope; now used in flight simulators to train pilots in the Upset Recovery manoeuvres. **4)** TSB iCare, "Distributed Integrated Care Services and Systems" (2009–2012, Goodyer), (DMU £412k), the project has developed a distributed integrated care system (iCARE) for elderly and disadvantaged people. **5)** EU FP7 "Community Network Game" (2010–2012, Hamzaoui), (DMU 328k EUR) to develop new techniques for P2P video streaming that are "friendly" to the MMOG client-server traffic. **6)** EPSRC "THERMAL MGT"; (2010–2013, Oxley), (DMU £184k), the project targeted the development of innovative thermal management concepts for semiconductor power devices, for the UK economically important Gunn diodes.

Examples of current projects: 1) EU FP7 **"**KAP (Knowledge, Awareness and Prediction)" (2010–2013, Greenough), (DMU 397k EUR), the project conducts a detailed analysis of energy management across multiple manufacturing sectors. **2)** EU FP7 collaborative project SAFEPROTEX to develop high-protective clothing for complex emergency operation (2010–2013, Shen), (DMU 242k EUR) **3)** EPSRC "Development of an innovative Autonomous Model Development Tool (AMDT) for boosting manufacturing process competencies" (2012–2015, Stockton), (DMU £230k), aimed at ensuring that manufacturing processes remain sustainable and efficient. **4)** EPSRC "Moisture Damage" (2012–2015, Collop), (DMU £225k), in this project, for the first time, the micro-mechanical processes that result in moisture induced damage at meso and macro-scale in asphaltic pavements are analysed in a comprehensive manner.

Examples of new projects: 1) EPSRC "ESCO Box: "Smart monitoring, billing and control for pro-poor access to energy services" (2013–2016, Gammon), (DMU £220k), which addresses financial and practical barriers to electricity access by enabling local agents to act as small (but expandable) Energy Service Companies (ESCos) in Africa. **2)** TSB "AIDMT" (2013–2016, Khalil), (DMU £253k), a strategic partnership with five industrial partners (Zest Produce Ltd., Apprise Consulting Ltd., The Food Storage and Distribution Federation Ltd., MSA Software Systems Ltd. and Centre for Factories of the Future Ltd.) with the aim of providing autonomous and intelligent demand management processes for reducing waste and inefficiency within refrigerated and shelf-life constrained food supply chains.

Infrastructure: The Unit is supported by the University's Research and Business Innovation (RBI) directorate and the Faculty's Research and Innovation Office (RIO) who assist with bid preparation and information about the research landscape. The Faculty's Research Committee is headed by the Faculty Head of Research (FHR) and has members from all research Centres. Outputs are supported through DORA – the De Montfort Open Research Archive. The infrastructure and facilities for all research areas are listed below.

Facilities: State-of-the-art facilities available to the Unit include (amongst others):

AMPMC: A reverse engineering inspection lab; elective laser melting machine; SLM125 & 250; Renishaw; N-script bioplotter 3Dn-300; selective laser printing rig; ZCorp 3D Printing machine; and Spectrum Z510; automation systems and industrial robots; Automated Guided Vehicles and conveying systems; virtual engineering suite and virtual reality platform; a broad range of embedded system development platforms for various types of applications including telemetry, smart appliances with life-cycle data acquisition and communication capabilities and e-Home technologies/smart home demonstrators for energy management and assisted living.

CESAS: uses four labs. 1) General purpose mechanical lab which includes engine test cell and specialised dynamics equipment. 2) General purpose chemical lab. 3) Specialised water lab that contains a bespoke multi-configurable pilot plant wastewater plant together with the instrumentation allowing real time monitoring and testing automatic controllers and control

strategies based on dSpace computer system (built in 2009). 4) Earth and Planetary Remote Sensing Laboratory computer lab with a network of Linux workstations, complemented by a library of in-house software and databases with geospatial data.
EMTERC: activities are in the areas of micro and nano-electronics and textile engineering. The most important are fabrication and metrological facilities. Fabrication facilities include: a three-chamber PEVCD/RIE system, custom-made low temperature remote gas heating PECVD chamber, a double-sided EVG 620 mask aligner, RF/ DC magnetron sputtering equipment, a wafer grinder, two vertical 6" furnaces, three evaporators, Langmuir-Blodgett trough, dip-coating, spin-coating and wet benches. The major instruments for the textile engineering research are: electrochemical corrosion testing unit; sliding wear test machine; micro hardness & Rockwell hardness tester; an eddy current non-destructive tester; Laserscan fibre diameter analyser; AHIBA dyeing machine; Roaches hank dyeing machine; SDL automatic fibre length machine & Micro Dust and Trash Analyser; SDC tensile tester; DSC; colour measurement; DMA, Weather station; etc.

CECE: has four specialised laboratories. 1) Communications Laboratory (CL) for multimedia communications and signal processing with systems for network simulations, channel coding, video compression, video transmission. 2) Physical Layer Laboratory (PHYlab): this is the home to EMC testing, data cable design and analysis and antenna system design and a reverberation chamber. 3) The Device Thermography and Microwave Laboratory (DTML): houses a state-of-the-art quantum focus infra-red (IR) microscope, with the capability extended by proprietary IR micro-sensor technology. Microwave design and characterisation work is also undertaken to THz frequencies. 4) The Power Electronics Laboratory.
IESD has laboratory equipment to underpin research projects in analysis of the visual environment and the acquisition of data on the physical environment and energy systems plant operation in a range of building types, it includes a High Performance Computing facility. IESD also has access to a hydrogen microgrid and to Fraunhofer IWU's battery storage research facility in Chemnitz with the REEMAIN project.

e. Collaboration or contribution to the discipline or research base
Visiting scholars over the census period have included: Helen **Zhong** (Associate Prof. of Engineering, California State University); Martin **Ziarati** (TUDEV Institute, Turkey); Liam **Quinn** (Senior Manager, Royal Mail); Alyina **Allsdo** (Polytechnic University of Timişoara, Romania); Patric **Eriksson** (Managing Director, Gothia Science Park AB, Sweden); Philip **Moore** (PVC (Research & Innovation), Falmouth University); Karol **Aniserowicz** (Bialystok Uni, Poland); Gang **Zhang** (Harbin Inst of Technology, China); Marwan **Al-Akaidi** (Arab Open Uni); Errol **Salih Tez** (EST Drives Technology LTD); Ibrahim **AlQadi** (King Abdulaziz University, KSA); Jianming **Lie** (Department of Mathematics, Jiangsu Normal University, China); Maxim **Demenkov** (Bauman Technical Uni, Russia); Iulia **Salaoru** (Imperial College).

Information on support for, and exemplars of, research collaborations: Each centre and each individual in the centre has links with other academic institutions and industry in the UK and overseas. Typically, collaboration results from joint UK projects such as EPSRC, EU, TSB, industrial contract research, international reputation through publications and networking at conferences, and through professional bodies. The initial stage of collaboration is typically funded by DMU, each research centre has allocated funding to support such activities, and subsequently funding comes from joint projects. Two typical examples for collaboration are described in some details, followed by a list of academic and industrial partnerships for each remaining individual; each collaboration resulted in at least one joint publication or a joint project.
The Faculty of Technology has a long standing collaboration with the Bauman Moscow State Technical Uni through joint PhD supervisions and the Central Aerohydrodynamic Institute (TsAGI), thanks to Goman's (CESAS) professional links. DMU and TsAGI signed a new Memorandum of Understanding (MoU) in 2012 and Goman is currently leading a Joint Research Group in Nonlinear Flight Dynamics, supported by a £3million grant from the Russian Ministry of Education and Science RUB (2012). His international reputation as an expert in nonlinear flight dynamic also led to a long-term collaboration with the National Aerospace Laboratories (CSIR-NAL), Bangalore, India. The MoU between DMU and CSIR-NAL covers the period from 2010 to 2015 and so far has materialised in three research projects – 2011 (£105k), 2012 (£50K) and 2013 (£174K) – funded by CSIR-NAL plus additionally two PhD students funded by CSIR-NAL and supervised by Goman.
Another example is the collaboration network developed by Goodyer. He has invented the Linear

Skin Rheometer (LSR) to measure the rheological properties of human tissue. The device was initially developed for the cosmetic industry but is now widely used in fundamental research programmes in medicine. This development led to him receiving an invitation from Harvard Medical School to work with their tissue engineering research programme, and also from **Universitätsklinikum** Hamburg-**Eppendorf**(UKE), Hamburg, Germany. Both collaborations resulted in numerous publications and successful development and deployment of a device to measure the biomechanical properties of the human vocal fold during surgical procedures and was also the subject of Dr Goodyer's patent (GB24 46447A In Vivo Laryngeal tensiometer. UK, 13th August 2008).
Other ongoing research collaborations include: M Kuball (U. Bristol), D. Cumming (U. Glasgow), G. Dunn (U. Aberdeen), and S. Cripps (U. Cardiff) (**Oxley**); Technical U. Denmark, U. Newcastle Upon Tyne, Technical U. Vienna, STARLAB, National Oceanographic Centre Southampton, SatOC, Queensland Climate Change Centre, Research Institute for Geo-Hydrological Protection (Italy), Surrey Satellite Technology Ltd. (**Smith**); Molecular Biology Research Group (Manchester U.), the Advanced Planning & Scheduling Research Group (Nottingham U.), Systems Biology Group (U. Hertfordshire) (**Stockton**); U. York, Oklahoma State Uni (USA), UPC (Spain), U L'Aquila (Italy), Harbin Institute of Technology (China) (**Duffy**); Honorary Professorship by the Harbin Institute of Technology (China) (**Ulanicki**); Delft University of Technology, University College Dublin (**Collop**); Ecole Polytechnique Federale de Lausanne, Telecom Bretagne, Computer Technology Institute & Press "Diophantus" (**Hamzaoui)**; Cardiff U., The Centre South Uni and Technology, ChangSha (China), U. Central Florida (USA), U. Oxford (**Li);** Warsaw U. (Poland), Grodno State U. (Belarus) (**Moroz)**; National Physical Lab, Rice Uni (USA), Imperial College, Athens Technical Uni (Greece), King's College London, Institute of Physics, Wroclaw Uni of Technology (Poland), Ruhr-Uni Bochum (Germany), Penn State Uni (USA) (**Paul**); Kumasi Polytechnic (Ghana) (**Rajakaruna)**; Tampere U. Technology, Graz U. Technology, U. Minho, Technical U. Catalonia, U. Maribor (**Shen**); Polish Academy of Science, Birmingham U. (**Sun**); Harvard, Warwick, Teesside universities (**Khalil**).

Information on support for, and exemplars of, interdisciplinary research: Interdisciplinary research is strongly encouraged at DMU and particularly, within the submission Unit. Practical problems in engineering are typically multi-faceted and require skills and collaboration from specialists in different areas. It is especially encouraging that young researchers undertake such challenges. For instance, Cross (**EMTERC**) is developing knowledge in interfacing nanomaterials with biological systems. DMU supported him with a RIF project: 'Towards investigating the cell wall of baker's yeast cells using atomic force microscopy'. Subsequently he submitted his First Grant Proposal to EPSRC in 2013 at the interface of material science and microbiology, 'Multibranched Nanowires for Cellular Interfacing'. Greenough's (**IESD)** work has all been interdisciplinary as this is the nature of research into sustainability. He brings building modelling and energy monitoring expertise to the EU FP7 KAP project and manufacturing and renewable energy knowledge to the EU FP7 REEMAIN project. Examples of other interdisciplinary work include: Virtual Learning Environment for Surgical Teams (**Chong**); 'The Common Extremalities in Biology and Physics**:** Maximum Energy Dissipation Principle in Chemistry, Biology, Physics and Evolution' (Elsevier Insights) (**Moroz)**; Applying ideas present in biological gene transcription, immune and hormonal control principles to manufacturing processes to create truly autonomous manufacturing systems; applying lean manufacturing principles to other domains such as service environments and higher education (**Stockton)**; MO Scase, M Shafiulla & AP Duffy "On the psychological process of decision making in displays of electromagnetic data", presented at the Progress in Electromagnetics Symposium (PIERS) Marrakesh, Morocco, 20–23/03/2011 (**Duffy)**; SUPRA 'Simulation of Upset Recovery in Aviation', EU 7th Framework programme where test pilots and aviation physiologists were involved in the specification process of the pilot training software (**Goman)**; the TSB project, 'Microwave Assisted Catalytic Treatment of Agriculture Waste Water (MICROCAT) (**Huddersman** and **Oxley**).

Information on how research collaborations with research users, including industry users, have informed research activities and strategy: Research in all five centres is inspired and strongly affected by the needs of respective industries. Work carried out in **AMPMC,** led by Stockton and Khalil, on optimisation of manufacturing processes, was motivated by the needs of such companies as: Preactor; Tata Steel; and Unipart; currently they have 18 industrial

collaborators. Research led by Goodyer, on intelligent transport systems (ITS) was driven by the need to improve transport in Leicester and has developed to such an extent that Goodyer is now helping the EU Commission and UK regional bodies on the future priorities of research funding in the ITS area. **CESAS** is dedicated to solving fundamental engineering problems and is inspired by many industrial sectors. The aviation industry needs to understand behaviour of aircraft in an extended flight envelope was addressed by the EU FP7 SUPRA project (**Goman**). The developed model and software are used at AMST-Systemtechnik GmbH, Austria; TNO-Desdemona, the Netherlands for training of the Netherlands Royal Air Force pilots. The burst detection methods and software for water supply systems were developed in collaboration with Affinity Water (**Ulanicki** and **Skworcow**); the work on improved performance of industrial wastewater plants was initiated by needs of Aquabio Ltd (**Janus**); treatment of landfill leachate to reduce environmental impact of landfill sites was done in collaboration with the Environment Agency (**Huddersman**). Collop, who specialises in pavement and rail track engineering, served as Director of a joint venture with Scott Wilson Pavement Engineering and his research is inspired by important challenges in this area of engineering. The geospatial work has been driven by contracts from the ESA, ensuring that research is end-user led (**Smith**). The textile industry (Speedo, Camira Fabrics, Teresa Green Design) searches for new environmentally friendly technologies let to the AHRC-funded LEBIOTEX interdisciplinary research project, investigating the colouring and patterning of textiles using enzymatic and laser processing technologies and their combination (EMTERC **Shen**). Greenough **(IESD)** has introduced improved energy management to manufacturing organisations through his work on THERM (TSB) with Toyota and Airbus, and on KAP with Volvo, Intel, Nissan and Infineon. Menzies-Gow (**CECE**) collaborates closely with the music instruments industry, he has two patents (GB2475372 and US8,492,641) granted for an electronic musical interface and instrument in the REF period (publicised in Wired, New Scientist, Daily Mail, Telegraph, etc).

Exemplars of leadership in the academic community: Chair of a Panel on Technology for the Built Environment for an International Research Assessment Exercise, The Royal Institute of Technology (KTH), Stockholm, Sweden; Appointed as the first overseas member of the Science and Technology Committee of the Shanghai Municipal Commission of Urban and Rural Construction and Transport in 2011 (**Collop**); Member of the Consortium of UK University Manufacturing Engineering Heads (COMEH); Member of the International Committee for Lean Manufacturing Research; Member of the Saudi Scientific Committee Conference; Member of MBA progression board, Harvard Business School (**Khalil**); Visiting Professor in Centre South Uni and Technology, Chang Sha, China (**Li**); FP7 expert evaluator for space technology for Brussels (2008–2011) (**Oxley)**; Expert Evaluator for Fondecyt National Research Funding Competition (Chile), 2012, Reader Panel for Nature (2010–2011) (**Oxley**); Invited Member of the European Technology Platform committees (http://www.textile-platform.org); EURATEX thematic expert representative on Biomaterials, biotechnologies and environmentally friendly textile processing (Group no 3) for the European Technology Platform for the Future of Textiles and Clothing; Member of expert boards for Textile Flagships for Europe in three areas; Assessor – RGC Hong Kong (**Shen**); Member of UK Manufacturing Professors' Forum; Treasurer of the Committee of Manufacturing Engineering Heads (COMEH); Committee Member – Association of Aerospace Universities (AAU) (**Stockton**); Honorary Prof at Harbin Uni in China; Reviewer of FP7 Programme; Member of Engineering Professors' Council (EPC) (**Ulanicki**); Proposal evaluator for Natural Sciences and Engineering Research Council of Canada (NSERC), 2011 and 2012; Proposal evaluator for The Swiss National Science Foundation (SNSF), 2010 (**Hamzaoui**).

Membership; leadership roles in industry, commerce, Research Councils, learned societies or professional bodies: Member, Technical & Environmental External Technical and Environmental Challenge Group for HS2 (2009); Member of the Science and Technology Committee of the Shanghai Municipal Commission of Urban and Rural Construction and Transport (**Collop**); EPSRC College member (**Duffy, Oxley, Ulanicki, Stockton**); Chair IEEE EMC Society Standards Development and Education Committee (**Duffy**); Member IEEE EMC Society Board of Directors (**Duffy**); member RAeS International Committee for Aviation Training in Extended Envelopes (ICATEE) (**Goman**); Deputy director of the International Association of Geodesy International Digital Elevation Model service (**Smith**); Member of the Manufacturing Committee of the Association of Cost Engineers (ACOSTE) (**Stockton**); Vice Chair of the Textile Institutes Sustainability Special Interest Group (**Williams**).

Conference programme chairs; invited keynote lectures: All returned researchers are members of conference technical committees or their equivalents and/or have presented invited talks at relevant technical conferences. The following draws out some highlights: **Keynote lectures** Shanghai International Forum on Road Engineering Technology and Urban Development, Shanghai, China, October 2011 (**Collop**); 10th International Conference on Sustainable Construction Materials and Pavement Engineering, Liverpool, February 2011 (**Collop**); "Advances in Pavement Technologies", University of Parma, 14th–15th June 2010 (**Collop**); 11th International Symposium on Advanced Technologies in Asphalt Pavements, Kangwon National University, Chun Cheon, S. Korea, 3rd–4th June 2010 (**Collop**); Seminario Pavimentos Rodoviarios, LNEC, Lisbon, Portugal, 25th March 2010 (**Collop**); CSIR/SAP/RMPD Seminar, CSIR, Pretoria, South Africa, 4th March 2009 (**Collop**); CNG Workshop at Gamelab Conference, Gijon, Spain, 30 June 2010; second IEEE WoWMoM Workshop on Video Everywhere, Madrid, 4 June 2013 (**Hamzaoui**); 12th International Wool Research Conference, Shanghai, China, 19–22/10/2010 (**Shen**); Plenary Lecture at Polish National Conference on Corrosion, Nov 2012 (**Sun**)

Conference chairs: Audio Technology, IEEE ICE-GIC conference London, Aug 2009 (**Menzies-Gow**); 9th International Conference on Physics of Advanced Materials (ICPAM-9), 2012, Iasi (Romania) (**Paul**); International Conference on Manufacturing Research from 5th (2007) to 11th (2013) – 7 Conferences – (**Stockton, Khalil**), Computer Control in Water Industry conferences (CCWI2009, 2011, 2013) (**Ulanicki**) and a special session organiser at European Conf. on Complex Systems ECCS'13 in Barcelona (**Ulanicki**).

Journal Editorships: Editorships: Editor-in-Chief of Road Materials and Pavement Design (**Collop**); Associate Editor of the IEEE Transactions on EMC (**Duffy**); Associate Editor of the Journal of the Applied Computational Electromagnetics Society (**Duffy**); Series Editor of the IET/SciTech Book Series on EMC (**Duffy**); Associate Editor for the Pattern Recognition journal (**Hamzaoui**); Member of the Editorial Advisory Board and Regional Editor, Journal of Computer Aided Engineering and Technology (IJCAET) (**Khalil**); Editor of proceedings: Polish-British Workshop: Computer Systems Engineering (**Skworcow**).

Guest Editorships: Special Issue of IEEE Transactions on EMC on "Validation of Computational Electromagnetics" forthcoming (**Duffy**); International Journal of Antennas and Propagation special issue on "Compact Microstrip Antenna Structures with Multi Band, Broad Band, and Band-Notched Properties, for Portable Devices" (**Duffy**); *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* vol. 367 (2009) on "Making Nano-Bits Remember: A Recent Development in Organic Electronic Memory Devices" (**Paul**); co-editor of a special issue of the Research Journal of Textile and Apparel on Textile Biotechnology for Jan issue, 2008 (**Shen**).

Editorial Boards: International Journal of Computational Methods and Experimental Measurements (**Abdalla**); Journal of Information Technology & Software Engineering (**Abdalla**); International Journal of General Engineering and Technology (**Abdalla**); International Journal of Roads and Airports; Construction, Maintenance and Rehabilitation (**Collop**); IEEE Transactions on Circuits and Systems for Video Technology (**Hamzaoui**); Journal of Multimedia (**Hamzaoui**); ISRN Communications and Networking (**Hamzaoui**); Journal of Clinical Rehabilitative Tissue Engineering Research 2005–10 (**Moroz**); '*The Journal of Textile Design Research and Practice' (formerly:* Journal for Research in Textiles and Textile Design, UK) (**Shen**); Journal of Aircraft Engineering & Aerospace Technology (**Stockton**); European Journal of Operational Research (**Stockton**); International Journal of Manufacturing Research (**Stockton**); Journal of Advanced Mechanical Design Systems and Manufacturing, (**Stockton**); ISRN Materials Science (**Sun**).
Fellowships: Fellow of Institution of Highways and Transportation since 2007, Fellow of ICE (2007–2009), Fellow, Institute of Asphalt Technology (2007–2009) (**Collop**); Fellow of the IET (**Duffy**); Fellow of the Royal Society of Chemistry (**Huddersman**); Fellow of the IET (**Oxley**).
Awards and prizes: Reed & Malik Medal, from Institution of Civil Engineers in 2008 (**Collop**). Best paper award 2nd Int Conf on Creative Content Technologies (CONTENT 2010), Lisbon, Nov. 2010 (**Hamzaoui**). American Society of Civil Engineers (ASCE), 2011 ASCE Outstanding Reviewer (**Ulanicki**). Lord Stafford Prize for Innovation, KTP with Nottingham Scientific in 2009 (**Goodyer** and **Oxley**). 2012 Best Associate Editor Award, IEEE Circuits and Systems Society (**Hamzaoui**).