Institution: University of Portsmouth
Unit of Assessment: 12 Aeronautical, Mechanical, Chemical and Manufacturing Engineering

a. Overview

Rapid expansion of research in Engineering at UoP has allowed us to submit staff to three UOAs (11, 12, 19), which better represent the breadth of our research activities. This submission comprises 18 FTEs Cat A staff from the School of Engineering (16FTEs) and the School of Civil Engineering and Survey (2FTEs), working in the following themes:

- *Materials and Structural Integrity: Tong; Simandjuntak; Karabela; Lupton; Lin*
- *Biomechanical Engineering: Tong; Buick; Huang; Figiel; Bucchi; Tozzi; Anssari-Benam; Lupton; ZhangQH*
- *Polymer and Composites: ZhangZY; Chen; Figiel; Barnett; Anssari-Benam*
- *Thermo-Fluid, Energy and Manufacturing Engineering: Buick; Jadhawar; Radulovic; Dotcheva*

There has been strategic recruitment of research-active staff to enhance and complement the UOA's research priorities. Overall, 78% of the submitted 18FTEs joined UoP in the last 4 years. This has significantly strengthened our research capacity, influenced our approach to research development and provided an excellent opportunity for future growth.

b. Research Strategy

Our ambitions are to develop *research excellence in the areas of our strengths* and to use it *to benefit key industries and user groups*. Our strategy for meeting these goals is to appoint talented new staff from engineering and physical science disciplines, and to nurture multi-disciplinary teams in an inspiring and supportive environment.

Since 2008 the UOA has enjoyed significant expansion in our research capacities both in infrastructure/equipment and in research staff, leading to a vibrant research culture and greater interaction with industries and user groups. We aim to significantly raise our research profile by the next REF, by developing cutting edge, multi-disciplinary research in response to challenges of national/international importance.

b.1 Evaluation of the current submission with reference to RAE2008

The Unit entered 11.2 FTEs in RAE2008 and achieved a quality profile of 5:40:40:15 (4*:3*:2*:1*). With 45% of the submission rated as world leading or internationally excellent, this was a significant improvement over RAE2001 (Grade 4). The main objectives set out at RAE2008 were to build on our strengths in applied research and to explore new and exciting opportunities in Aerospace Materials, Bioengineering and Manufacturing Engineering. The strategic plan involved recruiting early career researchers (ECRs) aligned to these key areas, who were expected not only to strengthen our existing areas of research, but also to bring with them new directions and fresh approaches that would promote new collaborations and further opportunities within and beyond the UOA. A major drive from 2008 to 2013 was to bring a range of activities in research and knowledge transfer together in a concerted effort to strive for excellence, as measured by high impact international journal outputs and increased research income.

Almost all of our 2008 objectives have been met in full and some have exceeded expectations. In particular, a record number of ECRs have been recruited since 2008, and this is reflected in the high percentage of ECRs in the current submission (61%, as opposed to 27% in RAE2008). In addition, there has been an overall increase in the number of research-active staff, consequently, a significant increase in FTE staff submitted (18FTEs Cat A, with further 5FTEs in *Design, Control* and *Artificial Intelligence* being entered in other UOAs, as opposed to 11.2FTEs Cat A in RAE2008). The overall quality of outputs has also significantly improved, with increased numbers

of joint outputs with either industrial or academic partners.

As a result of strategic staff recruitment, *four* research themes have been developed, as opposed to *two* at RAE2008. New research themes have been formed in *Thermo-Fluid and Energy Engineering* and *Biomechanical Engineering*, whilst *Polymer and Composites* has grown to be a distinctive theme of its own. New directions of research are being developed in the studies of aneurysm, soft tissue mechanics and multi-scale modelling of biological systems. Significant strategic investments by the University have been made in research infrastructure, including buildings, facilities and equipment. The key laboratories, such as Mechanical Behaviour of Materials and Advanced Polymer and Composites, have been equipped to offer facilities of international excellence in their capacity, range and quality. During 2011/12, all research laboratories underwent a major refurbishment to meet the increasing demands of new research projects, as well as to upgrade and modernise. A total university investment of over £2.5m represents a significant increase over the last assessment period (£1.1m). In addition, significant investment has been made also on postdoctoral researchers and research bursaries (£850k) from the University and the Faculty Research Fund, the latter being set up specifically to support fundamental research in priority areas. Highlights of the progress include the improved quality of research on specialist topics, as evidenced by the publication of high impact journal papers, and major research funding obtained from RCUK and UK government bodies. Scientific highlights include:

- The development of a new crack growth criterion based on crack tip mechanics using novel experimental and computational approaches. The work has resulted in the publication of high impact papers (*Tong*[1,3]) and international collaborations involving both partners from academia (Huazhong University, China; Ecole Polytechnique, France and the University of Manchester) and industry (Rolls-Royce).

- Characterisation and modelling of fatigue crack growth in a complex residual stress field due to laser-shock-peening and foreign object damage, work jointed funded by the EPSRC and the MoD and in collaboration with Rolls-Royce, QinetiQ and the University of Manchester, which has achieved significant impact (REF3b, UOP12FOD), as well as high impact papers (e.g. *Lupton*[4]).

- Long-term structural integrity of cemented acetabular replacements using unique experimental facilities and a multi-scale modelling approach. The work was carried out in collaboration with NHS hospitals with significant impact on surgical practice (REF3b, UOP12ORTHOPAEDIC), as well as high impact papers (*Tong*[4]*; Tozzi*[1]*; Lupton*[1-3]*; ZhangQH*[1]).

New interdisciplinary collaborations have been developed with other academic and non-academic organisations, nationally and internationally, as evidenced by the joint projects and joint research outputs. The total RCUK research income during this assessment period is an increase of 26% over that returned in RAE2008 by comparable staff in the same category; whilst income from UK government bodies has increased by 40% compared to that in RAE2008. These figures demonstrate a real term increase in like-for-like income for this UOA. Income from UK industry and commerce is, however, down by 8% from that in RAE2008. This is addressed in our future income generation strategy (REF5d) as a priority area for development. Furthermore, most of the research endeavors of the newly appointed staff (78% of FTEs submitted) have yet to come to fruition in terms of research income and PhD awards, hence quantitative measures may not reflect the vitality and the progress made during the assessment period.

b.2 Strategic plan for 2013-2020

A comprehensive review of research across this UOA has been conducted and a strategic research plan has been developed. The significantly increased new staff members have enabled a more coherent research grouping with critical mass, and laid an excellent foundation for substantial research development for 2013-2020. With 61% ECRs in the UOA, a new and dynamic phase of our research has arrived, signalling new ideas and interdisciplinary approaches. A critical first step

is to nurture, guide and support these staff as well as to provide them with space and freedom for critical thinking, innovation and interaction within and beyond the UOA, so that new and emerging research initiatives may be developed. Provision of infrastructure, facilities and equipment is vital to enable such new developments, for which the Faculty has earmarked funds for support.

Our long-term ambition is to become *one of the leading exponents* in the area of *mechanical behaviour of engineering and biological materials*; and a strong exponent in biomechanical engineering and energy engineering. We aim at *a significantly enhanced research profile* in the next REF. Strong support will continue for our established research areas, such as *Materials and Structural Integrity*, whilst *Biomechanical Engineering* and *Thermo-Fluid and Energy Engineering* have been identified as priority areas for further development. The aim is to increase significantly the volume of high impact outputs across all research themes, and increase the volume and diversity of external research income. A concerted effort will be made to develop new industrial links and knowledge transfer initiatives, utilising a network of contacts of our placement students and consultancy users. We also aim to enhance our PGR provision and its population via effective recruitment of overseas (self/government-funded) students and new programme development including MRes in Engineering/specialist Masters and Professional Doctorate.

More specific objectives include:

- To further develop our high quality research in *Materials and Structural Integrity*, particularly in fatigue and fracture of aerospace materials, focusing on fundamental aspects of crack growth and modelling strategy, in collaboration with key national/international partners, both in academia and industry. A continuing key theme will be the further development of our original work on crack tip mechanics (*Tong, Lin, Lupton*); but also to diversify our research into materials for power generation and other related industries (*Simandjuntak, Karabela*).

- To develop multidisciplinary research in *Biomechanical Engineering*, utilising the diverse approaches and complementary expertise now available in the group, in collaboration with researchers within and beyond the University, including clinicians and industry partners. A multiscale computational approach will be developed for micro- and nano-structures of biological materials and biomaterials (*Figiel, Anssari-Benam, Bucchi, Tong*), to address a range of topics, including the development of a stenosis and the onset of atherosclerosis (*Buick*); onset (*Bucchi*) and rupture (*Figiel*) of aneurysm; prediction of vertebral fracture due to impact and vibration (*Tong, ZhangQH, Huang*); vertebral augmentation (*Tozzi*) and soft tissue response to shock and vibration (*Huang*).

- To grow areas related to *Thermo-Fluid, Energy and Manufacturing Engineering*, including analysis and simulation of blood flow using analytical and numerical approaches (*Buick*), fluid-structure interaction (*Bucchi*), organic Rankine cycle (*Radulovic*), enhanced oil and gas recovery, CO_2 sequestration and storage (*Jadhawar*); also in meso-scale prototyping (*Bennett, Dotchev*), laser metrology (*Dotcheva, Dotchev*) and CAD/CAM/CAE (*Dotcheva, Dotchev*).

- To support an integrated approach in research on *Polymer and Composites* by combining efforts of experimental (*ZhangZY, Barnett, Dhakal*) and numerical modelling (*Chen, Figiel, Anssari-Benam*) to explore fundamentals and applications in both Mechanical and Civil Engineering, including design and manufacturing of prosthetic substitutes (*Anssari-Benam*); optimum design of composite pipes for off-shore applications (*Simandjuntak*); smart and functional coating using nano-technology (*ZhangZY*)**;** sustainable composite and hybrid materials (*ZhangZY, Dhakal*) and evaporation dynamics and aggregation mechanisms of nanoparticles (*Radulovic*).

c. People

c.1 Staffing Strategy and Staff Development

Staffing Strategy

Strategic planning has been made to ensure a sustainable staff structure, where retirement, recruitment and retention of staff are managed to provide stability and continuity. Our recruitment strategy has been focused on attracting research active staff in priority areas of research, which has resulted in the appointment of *16 FT* academic staff since 2008, of whom 76% are entered in REF2014. At least *three* senior academic appointments are planned for 2013-2020 in *Materials and Structural Integrity (*advertised), *Biomechanical Engineering* (advertised) and *Thermo-Fluid and Energy Engineering*, to provide research leadership in these areas and a suitable balance between senior staff, mid-career and early career researchers. Our strategy has been to recruit the best researchers at an early stage in their career, and provide mentoring and support to enable them to establish their own successful research and build research groups. A significant proportion of potential future research leaders were appointed as lecturers or research fellows in the REF period to strategically promote greater interaction between our main research strengths in *Materials and Structural Integrity* and *Biomechanical Engineering* (*Tozzi, Lin, Karabela, ZhangQH, Simandjuntak*), and to expand into new areas of research that complement our existing strengths and map onto research priorities of the major funders, such as in *Thermo-Fluid and Energy Engineering* (*Buick; Jadhawar; Radulovic*); soft tissues mechanics (*Figiel; Huang; Bucchi; Anssari-Benam) and multi-scale modelling (Figiel; Bucchi; Anssari-Benam)*.

Research excellence is one of the key criteria in academic staff appointment and promotion, as evidenced in the appointments of *Buick; Huang; Simandjuntak; Barnett; Jadhawar; Radulovic; Figiel; Bucchi and Anssari-Benam;* promotion to Principal Lecturer (*ZhangZY*); University Lecturers (*Tozzi, Karabela*) and Research Fellows (*Lin and ZhangQH*). The unit has a diverse staff profile, with staff submitted originating from ten countries and 33% of the submitted FTEs are women (as opposed to 18% women at RAE2008).

We have also appointed a number of personnel from industry and hospitals as visiting academics to advise on future research directions and to promote industrial collaborations. These appointments include: Visiting Professor G Harrison, formerly QinetiQ and an authority on creep fatigue; Dr A Cossey, consultant surgeon and a knee specialist at Queen Alexandra (QA) Hospital, Portsmouth; Dr G Hussell, consultant surgeon and a hip specialist at QA Hospital and Dr P Heaton-Adegbile, consultant orthopedic surgeon at Pilgrim Hospital, Lincolnshire; Dr MS Huang, Professor of Huazhong University, an internationally recognised specialist on discrete dislocation dynamics (DDD) and Dr C Cornet, Senior Engineer at Airbus. International visiting research fellows include Professor MS Huang, Huazhong University, China, who has extended the DDD method to model polycrystalline nickel based alloys, a major research interest at UoP (*Tong, Lupton, Lin*). Professor SK Wang, Chang Chun University of Science and Technology, China, funded by Chinese Government, has contributed to the development of digital image correlation method in crack problems, a continuing interest of the MBM group (*Tong, Lin, Lupton*).

Mechanisms for Promoting Research

The research of the UOA is led by a Professorial Associate Dean for Research (*Tong*), who serves also on the Faculty and University Research Committees. The coordination of research is carried out through the School Research and Knowledge Services (RKS) Committee, which consists of Associate Dean for Research, the Head of School, senior academic staff, and representatives of academic staff, research fellows and students. The committee is responsible for developing strategic plans in line with the University and Faculty strategies, distributing internal funding and monitoring delivery in terms of research outputs, funding, studentships and PhD completion; these are reported quarterly to Faculty Research Committee.

Internal research support has been vital in pump priming emerging research themes and

supporting ECRs. Special provisions from internal sources have been made for equipment and facilities as well as PhD bursaries. During the period 2008-2013, over 65% of internal bursary allocations went to ECRs. The Faculty has setup a *Strategic Investment* fund in early 2012 to provide support for sabbaticals, specialist software and PGRAs in key areas of research. More recently a *Network Fund* and a *Start-Up* grant for ECRs have also been setup by the Faculty to provide additional support for networking activities in response to the growing number of new appointments and new calls for collaborative research. At the University level, a *Research Development Fund* has been made available to all staff on a competitive base to encourage new interdisciplinary collaborations both within and beyond the University.

Staff Development

The University of Portsmouth has created an excellent working environment for its research staff. Induction conferences are run to introduce new staff to the University and highlight the opportunities available to them. The University has its research staff representation at University, Faculty and School Committees, providing a mechanism of raising awareness of research staff issues to senior colleagues in order to action change. The University's *Research Staff Forum* serves as a platform for communications between the researchers and the university management, as well as being a source of advice, guidance and information for researchers. The forum, which meets quarterly, and is open to all research staff, also provides a means of reporting back to the UK Research Staff Association to represent Portsmouth's researchers at a national level. The forum hosts visiting speakers on a range of topics of relevance to research staff, such as leadership in research and career opportunities for researchers as well as personal development. These activities have created a strong sense of community amongst the researchers and supports networking. Professional development of researchers is through a tailored research staff training and development program aligned to the *Vitae Researcher Development Framework*. The University is a member of the *Athena SWAN* charter and is committed to the advancement and promotion of careers for women in the disciplines of science, engineering and technology in both higher education and research. Since 2008, women academic appointments have increased from two to seven in the UOA, representing a considerable increase in a traditionally male-dominated discipline.

A strong research culture has been developed, and is sustained by making research and knowledge transfer one of the top priorities in the School's affairs. Research is one of the key elements in our annual *Professional Development Review (PDR)*, when discussion of research and professional development plans are carried out so that individual staff plans are aligned with those of School, Faculty and University. The Head of School and PDR reviewers encourage and facilitate the engagement of staff in CPD opportunities. Following a gap analysis against the principles of the *Concordat*, the University has committed to design, develop and implement career development workshops as part of a development framework for all staff.

A mentoring system has been established in the School, where experienced academic staff are "paired" with new members of staff to assist the latter in their research career development. Arrangements have also been made to pair some ECRs in Mech Eng with some of the experienced researchers in other departments, such as Applied Maths who achieved outstanding performance in RAE2008. All ECRs have also been given reduced teaching, with at least one day per week completely free from teaching, so that they can devote more time to establish themselves in research. Arrangements have also been made to sharing teaching and administrative duties so that research active staff are supported within the constraints of the School. The School has provided facilities for key retired staff so that they may visit the School on a regular basis to provide mentoring support and contribute to research discussion.

The University runs support schemes such as *Grant Hothouse*, where a panel of experts and referees run mock proposal reviews. This scheme has now been extended to all eligible 1st grant EPSRC applicants by the Faculty to offer peer review and guidance on how to prepare EPSRC proposals. The University has a Peer Review College formed by senior academics and PIs that offers peer reviews of grant applications to RCUK and charities, an essential internal process

before bids can be approved for submission.

The School research seminars are held fortnightly, at which both internal and external speakers present their latest research, thus exposing all levels of researchers to the latest developments across subject areas. In addition, group seminars are held regularly in which all researchers present their latest work and stimulate further discussion.

c.2 Research Students

The School has a thriving postgraduate population through external/self-funding and University bursaries. We have a current cohort of *34* PhD students and *25* students have successfully completed their PhDs in the REF period. Although the overall number of PhD awards during this period appears to be reduced compared to RAE2008, this is mainly due to the submission of our staff to three UOAs (see Overview). In fact, the level of PhD awards is comparable to, if not slightly improved, over that in RAE2008 for staff submitted to UOA12. Nevertheless a new initiative has just been introduced, specifically targeting self-funded and externally funded students in priority areas of research. Research opportunities are advertised prominently on research web pages as well as research group web pages in order to attract these students in strategically important areas of research.

PGR students are recruited through a rigorous selection process, involving interviews of shortlisted candidates with the supervisors plus a trained interviewer, following advertisement in national press. Induction courses are provided for all research students, covering health and safety, research methodology and experimental design, project management, record keeping, report writing, word processing skills and intellectual property rights, together with specific technical training. The provision of training for research students is regulated by the University Research Degree Committee and administered by the Graduate School. All research students are required to take relevant modules provided by the Graduate School during their studies, ranging from essential Research Methods to Statistics for Engineers.

Weekly meetings between a research student and the supervision team are documented electronically, and monitored in the *Annual Research Student Appraisals*, which is critical in the approval of student's progression. From 2013, a new *Annual Review* system is in place to replace the *Major Review* that previously ran at the end of first year. To continue their studies, all students must satisfy a panel of experts that they have made sufficient progress in the previous year. Research students are required to make regular presentations at group research meetings; and encouraged and supported to present at national and international conferences. All students should have refereed journal papers published/accepted prior to the submission of their PhD thesis.

The School Postgraduate Tutor supports the research students and their supervisors with regard to admission, progression and examination arrangements. Annual prizes are given to the best poster, oral presentation and journal paper by PhD students at the Annual Research Conference organised by the Faculty. Office facilities for PGRs have been further improved, with now dedicated postgraduate rooms for studies and meetings.

Most of our PhD students complete their studies within 3-4 years, and have gone on to successful academic and professional careers.

d. Income, infrastructure and facilities

The provision of research facilities is often a vital factor in decisions taken, especially by relatively new staff, on research directions and projects. We have made significant commitment to improving the range and the quality of our facilities. During 2011/12, all research laboratories in the Unit underwent a major refurbishment to meet the increasing demands of new research projects, as well as to upgrade and modernise. The total university investment in the area is over £2.55m and

includes building/infrastructure (£1.85m) and equipment (£700k), representing a considerable increase in investment over the last assessment period (£1.1m in RAE2008). The development of a *Biomechanical* testing suite, including a latest microCT with *in situ* loading facilities; an upgraded electrodynamic shaker system for nonlinear biodynamics analysis and new facilities for *Thermo-Fluid and Energy Engineering* are amongst the highlights of the new facilities. More recently, a further £300k was invested to support further development in *Thermo-Fluid and Energy Engineering* and *Biomechanical Engineering* research. These investments have been vital in developing cutting edge research such as image-guided failure assessments in complex structures/interfaces (*Tozzi*[1]*; Lupton*[1,2]*; Tong*[4]) or new research such as soft tissue response to vibration (*Huang*). The new facilities have also allowed effective interactions and collaborations both within UoP and beyond, most notably collaborations with Cranfield University (Dr Zioupos) on the prediction of vertebral fracture due to impact and vibration (*Tong, ZhangQH, Huang*); and collaboration with the University of Bologna (Prof Cristofolini) on novel cementing techniques in vertebral augmentation (*Tozzi*). Within UoP, collaborations have been developed with Biomedical Sciences (Prof Gorecki) on microCT studies of muscular dystrophy (*Tong, Tozzi, Lupton*); and on gene function in development (*Tong, Tozzi*) using Xenopus model (Prof Guille). Preliminary results from the former is being prepared for a letter to *Nature*, with a joint bid planned for RCUK in the near future. The new vibration suite has allowed collaboration with Universities of Southampton (Dr Ferguson) and Sheffield (Dr Manson, Prof Worden) and Royal National Lifeboat Institution (RNLI) on nonlinear biodynamics and modelling base-excited interface human soft tissue in response to shock and vibration (*Huang*).

Although some of the investments have yet to come to fruition in terms of research income, good progress has been made on several fronts with high quality outputs from the key areas of research, particularly in *Materials and Structural Integrity* and *Biomechanical Engineering*. During the REF period, major awards have been obtained from the EPSRC, TSB, the Royal Society and The Leverhulme Trust. Notable research awards include:

- Developing Improved Service Propagation Lives in Arduous Cyclic Environments, TSB, £300,615 (01/2009-12/2011)
- Fatigue Crack Growth in Complex Residual Stress Field due to Surface Treatment and Foreign Object Damage under Simulated Flight Cycles. EPSRC/MOD, £277,947. (10/2007-06/2011)
- Physical Approach To Grain Refinement. EPSRC, £208,932. (10/2007-09/2010)
- A Mirco-Mechanistic Study of Oxygen-Diffusion Crack Growth in a Polycrystralline Nickel-Based Superalloy. EPSRC, £197,000. (10/2007 – 9/2010)

The total income from RCUK (26%+) and UK government bodies (40%+) has increased over that in RAE2008, although income from UK industries has declined slightly over that in RAE2008 (-8%). In addition, more time is needed for new staff, particularly ECRs, to develop their research and secure funding. Nevertheless income generation is one of our *top* priorities in the strategic plan of the UOA. We aim to gain access to a range of diverse research funding sources such as NIHR, EU and TSB, as well as EPSRC. We will target collaborative research funding streams that address key national and international strategic priorities, such as RCUK Energy, Lifelong Health and Wellbeing programmes and relevant topics within the EU Horizon 2020 Societal Challenges and Industrial Technologies programmes and TSB competitions. A major drive in 2013-2020 is to diversify and target collaborative research and knowledge transfer opportunities. The emphasis is to further engage with the industrial/end users and to utilise the excellent research tools we have developed to address challenges of national importance with high impact. Plans are being made to utilise the university thematic networks such as University of Portsmouth Ageing Network (UPAN), University Research and Innovation Services as well as our industrial contacts through placement and consultancy, to increase significantly income from other sources as well as from research. The most recent awards of sKTPs (*Buick/Bucchi; Simandjuntak/ZhangZY*) are some examples signaling such an approach. Thematic workshops, research lab open days and site visits by academics are being planned in a concerted effort to showcase our capacities and facilities to stimulate new RKT projects and serve local and regional industries/user groups.

e. Collaboration and contribution to the discipline or research base

New interdisciplinary collaborations have been developed within the University and beyond, as evidenced in the increased number of joint projects and joint research outputs. The University fully supports interdisciplinary research, and arrangements have been made to accommodate external visitors by providing offices and computing facilities, as well as supporting network activities of research staff by establishing a *Network Research* fund.

A short summary of major collaborations is given here to include *only* those which led to either *joint journal outputs* or *RKT/consultancy grants*:

International collaborations:
Buick: l'université du Maine, France; *Chen:* University of Cincinnati, USA; *Tong/Tozzi/Lupton:* University of Siegen, Germany; *Tong:* Ecole Polytechnique, France; *Tong/Lupton/ZhangQH:* Beijing Huatuo Biomechanical Laboratory, China; *Tong/Tozzi/Lupton:* Smith & Nephew, USA; *ZhangZY/Dhakal:* NATO funded project in collaboration with Universities of Beira Interior & Coimbra, Portugal; Ecole Nationale d'ingénieurs de Monastir, Tunisia; University of Roma, Italy; Universiti Teknologi MARA, Malaysia; University of Beira Interior, Portugal and University of Saskatchewan, Canada.

National collaborations:
Barnett: Universities of Liverpool and Sheffield; VSL Infrastructure Protection; *Buick:* University of Edinburgh; *Buick/Bucchi: Medway Fibreglass Ld; Dotcheva*: Cardiff University; *Chen:* Rolls-Royce (RR); BAE Systems; Universities of Bristol and Southampton; *Karabela:* Cranfield University; *Huang:* Universities of Southampton and Sheffield; Royal National Lifeboat Institution; *Simandjuntak:* European Technology Development Ltd; Magma Global Ltd; *Tong/Lupton/Lin*: RR, MoD, QinetiQ, Universities of Birmingham, Manchester; *Tong/Lupton/Tozzi:* Queen Alexandra (QA) Hospital; University of Southampton; *Tong/ZhangQH/Huang*: Cranfield University; *Tong/Lupton:* GKN Aerospace; *ZhangZY/Dhakal:* Safeguard Europe Ltd; consultancies for VT; Thales; Pall Europe; LaFarge; GlaxoSmithKline; Gurit; Xyratex; PERA; Material Technology Ltd; Magma Global; Guit; Elta Fan; McMurdo; Property Care Association; Spur Electron Ltd; Wartsila; UniVar Europe; Brett Landscaping and Bac 2.

Contributions to subject disciplines:
Editorial board – *Tong:* International Journal of Experimental and Computational Biomechanics (IJECB) and Fatigue & Fracture of Engineering Materials and Structures (FFEMS, 2008-2012); *ZhangZY*: Journal of Materials Engineering Innovation (JMEI).
Conference Chair/Editor – *Barnett:* The 33rd Cement and Concrete Science conference (IOM3) 2013; editor of the conference proceeding (ISBN 978 1 86137 642 8); *Simandjuntak:* High Temperature Defect Assessment (HIDA-5) (IOM3) (2010).
Keynote lectures & invited speakers – *Tong:* Plasticity'12, 14; Fatigue Congress 2010; Int Conf on Fracture, 2013; Fatigue Congress 2014; First and Second IJF & FFEMS Joint Workshops (2011 & 2013); *Simandjuntak:* The Society of Material Science, Japan (2010).
Review board – *Figiel:* National Science Centre, Poland – Panel ST8. *Tong:* Romanian Ministry of National Education Joint Applied Research Projects - PCCA 2013 (international panel member).