Institution: Cardiff University

Unit of Assessment: 14 (Civil Engineering)

A Overview

The Civil Engineering Unit is part of the integrated School of Engineering, one of seven Schools in the newly established College of Physical Sciences and Engineering (2012). The Unit's research is represented by the following four groups:

- Geoenvironmental Research Centre, **GRC**, led by *Thomas*
- Hydro-environmental Research Centre, **HRC**, led by *Falconer*
- BRE Centre for Sustainable Construction, **BRESC**, led by *Rezgui*
- Materials and Advanced Mechanics Group, **MAMG**, led by *Karihaloo*

Research and innovation at School level is organised in four multi-group 'Themes'. Those pertinent to the Civil Engineering Unit are the 'Environment and Sustainability' Theme, led by *Stoesser* and *Rezgui* (**GRC, HRC** and **BRESC**), and the 'Mechanics, Materials and Advanced Manufacturing' Theme (**MAMG**). The Themes bring together all researchers from their constituent Groups in bimonthly meetings, thereby encouraging and promoting cross-Group collaboration.

Research strategy is developed by the School's Senior Management Team working closely with our Research and Innovation Committee. This Committee represents all strands of research activity and brings the Senior Management Team together with the Directors responsible for innovation and post graduate research programmes, Theme Leaders, and senior members of professional services. A valuable outside perspective is provided by our long-standing Industrial Advisory Board (IAB) of 49 senior industrialists who meet our research leaders 5 times each year.

B Research strategy

The objective of our research strategy is to create of an environment where excellent and innovative research takes place. As civil engineers we look to apply our research to meet industrial and societal needs, and to provide new ways of constructing and managing national infrastructure, as well as understanding, protecting and exploiting the environment. We aim to have a mixture of research, from the esoteric to the applied; the latter often feeding the former. Central to our philosophy is that true innovations arise from gifted researchers who have sufficient freedom to explore their ideas whilst having the guidance, support and resources necessary to realise the potential of their work.

The principal elements of our 5-year strategic plan (2012–2017) are to;

- organise our Research and Innovation Themes in an open fashion which fosters a collegiate spirit amongst researchers from different Groups and Themes;
- embrace the opportunities provided by our recently formed College to enable new collaborations with mathematicians and scientists from a broad range of disciplines;
- form strategic alliances with top international institutions where there are natural synergies;
- promote and employ new leaders, and recruit outstanding Early Career Researchers (ECRs);
- make major investments in our infrastructure from Cardiff University's £250M 'Innovation System' development scheme (2014 onwards).

As part of the strategic plan, the Unit has established the following priority development areas, which build on existing research strengths and identify new fruitful research domains that accord with the EU's Horizon 2020 programme and RCUK priorities;

- **Exploitation and management of Geoenvironmental resources**: experimental and numerical research on integrated biological, physical, chemical, physicochemical processes; harnessing geo-energy; improving the resilience and durability of geotechnical infrastructure; finding means to recover resources from natural and man-made deposits.
- **Understanding and managing the hydro-environment:** including experimental and numerical research on water quality and sediment transport processes in aquatic systems; flood risk and management of rivers, estuaries and coastal basins; sea states, surges and coastal erosion; near-field simulation of oil/gas blowouts; global water security; weather systems; design and operation of disinfection tanks; urban drainage systems.
- **Exploiting the hydro-environment**: design, testing and simulation of tidal stream turbines;

simulating marine renewable energy structures (e.g. Severn Barrage).

- **Sustainable construction**: augmenting Building Information Modelling (BIM) techniques to deliver dynamic multi-aspect simulation and real-time characterization of buildings; improving governance and regulatory compliance of BIM; developing sustainable buildings and future cities via multi-objective energy optimisation in buildings and districts.
- **Materials with improved engineering properties**: developing new intelligent self-healing cementitious materials and high-performance cementitious composites.
- **Advancement of modelling techniques for new and existing materials and structures**: including multi-scale (nano to macro) computational modelling of particulate composite materials, multiple-process modelling of materials during their formation and working-life; and optimisation and damage modelling of composite laminates.

Current position with respect to RAE 2008:

Over the present REF period, research in the Civil Engineering Unit at Cardiff has continued to flourish, as evidenced by the following;

- 43% growth in PGR population (44 to 63).
- 110 new research awards in the REF period with a total value of £16.5M; which equates to a 44% increase in the value of awards per annum.
- 30% growth in annual RCUK income.
- £8.2M of EU funding from 11 new awards.
- Total number of publications: 809 (340 Journal articles).
- 7 Knowledge Transfer Partnerships (up from 2).

The research accomplishments of the Unit during the REF period have been considerable. These have satisfied the research objectives set out in our 2008 RAE submission and, with more recent work, reflect our current strategic research priorities. The principal research accomplishments are:

- The GRC (38 awards, £6.7M) has dramatically expanded its research on geo-energy and sustainability, including work on ground source heat, underground coal gasification, carbon sequestration in coal and soil, and geoinformatics, (SEREN, total funding £5.6M). Fundamental research on the physicochemical behaviour of fine-grained soils (*Tripathy1-4,Cleall1-2,4, Thomas1*) and its application to high-level nuclear waste remains a strong theme (*Thomas3-4, Case study 2*), with the centre being an integral part of the £1.4M multidisciplinary SAFE Barriers project funded by EPSRC and the Nuclear Decommissioning Authority.
- The HRC (27 awards, £3.4M) has greatly developed its work on marine renewable energy and in particular on new numerical strategies for simulating related hydrodynamic processes (*Falconer1-2, Ahamdian1*). The arrival of *Stoesser* and *Pan* has brought new expertise on turbulent flow (*Stoesser1,3-4*) and sustainable coastal protection (*Pan2*). The Centre maintains its world-leading research on modelling river basin systems, surface and groundwater interactions, sediment transport, and water quality and contaminant processes (*Lin1-2, Falconer3-4*).
- The establishment of the BRE (Building Research Establishment) Centre for Sustainable Construction (22 awards, £3.3M), with a funded chair (*Rezgui*), has brought close collaboration with the BRE on new semantic approaches (including BIM-based) (*Rezgui2,4*) for improving the resilience and adaptability of buildings; energy management at building (*Rezgui3*), district and city level and algorithms for knowledge mining (*Rezgui1*). The Centre has gained four EU FP7, two RCUK (4 with BRE) and two TSB projects.
- The expansion of the work on construction materials, including both advanced fibre-reinforced composites and self-healing material systems, has been achieved with significant industry and research council support (23 awards, £3.2M). A new shape-memory-plastic/cementitious material system has been developed (*Lark1,3*), the flow properties of fluids and healing agents in crack networks have been characterised (*Gardner1*) and Cardiff is leading the £1.7M EPSRC 'Materials for life' project on multi-scale self-healing materials.
- The MAMG have been successful in gaining a number of prestigious Royal Society awards, as well as multiple grants for research and technology transfer (>£750K). *Karihaloo* has made a

historic contribution to understanding the formation of honeybee combs with his US National Academy of Sciences (PNAS) and Royal Society papers (*Karihaloo3-4*).

- The benefits of employing micro-mechanical solutions in constitutive models for concrete have been shown (*Jefferson2-3*). Further progress has been made on the challenging problem of predicting the buckling and vibration behaviour of composite structural elements (*Kennedy3*). A new approach to predicting the viscous properties and flow of self-compacting normal and fibre reinforced concrete has been devised *(Karihaloo2, Kulasegaram4*).

C People: Staffing strategy and staff development

Our ***staffing strategy*** relies on the recruitment, development and retention of outstanding research staff. We ensure the vitality and sustainability of our research base through (i) the recruitment of high calibre early career researchers (ECRs), of which three were appointed during the REF period, (ii) the development of ECRs into research leaders (e.g. through the annual "Cardiff Futures" programme, attended by *Gardner*), and (iii) the appointment of senior staff into key research areas - this includes *Stoesser* and *Rezgui* (Theme leaders).

New appointments within the unit have been in the GRC and HRC (5 new staff), as well as in the BRESC (3 staff). Five senior staff have retired within the REF period but the recruitment of two new professors (*Stoesser* and *Rezgui*), a reader and a senior lecturer, together with the promotion of three existing staff members to chairs (*Kennedy*, *Lark* and *Jefferson*), has assured leadership succession. In addition, there have been seven further promotions during the REF period.

We are dedicated to the ***career development*** of all staff, who benefit from a strong commitment to staff training and development in accordance with the Investors in People framework (full accreditation gained in 2011, first in the Russell Group to achieve this over the whole institution). A comprehensive range of development courses, including workshops on postgraduate supervision, leadership, project management and performance management, is provided by the University and are used extensively by staff in the Unit. The University's Research Leadership course won the Times Higher Education Award for Outstanding Contribution to Leadership Development (2010).

All new academic staff are assigned mentors and their integration is overseen by their Theme leader. All benefit from appraisal procedures, which facilitate the regular review of research progress against agreed objectives and identify future training and development needs. Our workload model includes several research metrics, including generation of research outputs, grant applications made and awarded, PGR students supervised, as well as internal and external research-related management and citizenship roles. New lecturers are allocated a reduced teaching load during the first two years to allow them time to establish their research activities.

We support staff in generating high quality grant applications through administrative support from the School's Research Office. In 2011, we introduced a new rigorous internal peer review procedure involving feedback and approval from a research leader. An early indication of its efficaciousness was *Gardner's* EPSRC first-grant being approved as the highest ranked in its Panel**.** PhD studentships have been created for EPSRC first-grant holders, aimed at maximising their value for ECRs. New staff are supported by seedcorn funding (total budget £150K/year) for research studentships, academic travel and start-up activities. We distribute 40% of indirect costs to grant holders, providing a strong incentive to seek external funding, whilst empowering staff to manage the development of their research. A study leave scheme is also funded; for example, benefitting *Jefferson*, *Cleall* and *Kulasegaram*.

Cardiff's commitment to improving the working conditions and career development for research staff has been recognised (2010) and reaffirmed (2012) by the award of "HR Excellence in Research" accreditation. The Cardiff Researcher programme offers workshops, online training and coaching in over 100 topics and provides a dedicated careers consultant for researchers.

In 2010 we conducted a benchmarking exercise with the aim of achieving compliance with Vitae's ***Concordat to Support the Career Development of Researchers*** (www.vitae.ac.uk)**.** Since then, the School's Research Staff Coordinator has ensured continued adherence to the concordat via regular monitoring. We have established a budget to support research staff development activities. This funds an annual conference which provides ECRs with the opportunity to showcase their work, build interdisciplinary collaborations and undertake impact and engagement training. The School prides itself on being an ***international environment***, attracting the best staff and students from around the world, with the ambition of becoming a partner of choice. 26% of the Unit's

academic staff originate from non-EU countries The international ethos is also prevalent in its student body, e.g. 45% of our research students are from outside the EU.

We actively encourage International collaboration by providing strategic funding for staff travel and for visits from overseas scholars. This has promoted international activity and we have hosted more than 60 visiting academics. Propagation of our research culture is aided by monthly seminars in each Research Theme involving esteemed academics from UK and international universities (e.g. Northwestern, Georgia Tech., Peking, Shanghai, RWTH Aachen, Leibniz, Milan).

We promote ***Equality and Diversity*** (E&D) in all aspects of staff recruitment and management. We attained an Athena Swan Award (Bronze) for advancing and promoting the careers of women in Science, Engineering and Technology, being one of only seven Engineering School's nationally to achieve this award. The first female Director of the School (2010-12), now College Pro-Vice Chancellor, was a recipient of a WISE (Women into Science, Engineering and Construction) Excellence Award. The University consistently ranks on Stonewall's 'Top 100 Employers', demonstrating our commitment to LGBT Equality (one of six Universities to appear on the 2013 list). Staff undertake mandatory training in E&D whilst the School actively promotes initiatives and activities to support E&D, such as a College level network for female researchers.

People: Research students

Our ***PGR recruitment strategy*** is to recruit high calibre students and to develop skilled postgraduate researchers that will contribute to the research base and workforce. The Unit has increased its full-time PGR population by 43% since 2008. Recruitment strategy is agreed by the School's Recruitment Committee, working closely with the PGR Tutors Committee. The Unit promotes impact and leverages additional research funding through collaboratively funded studentships, including four of the flagship University funded President's Research Scholarships, and 12 EPSRC Doctoral Training Grant and CASE/iCASE awards. We are also a partner in the new EPSRC Centre for Doctoral Training in water informatics (with Exeter, Bristol and Bath).

Significant emphasis is placed on ***PGR training and support***, integrating students into the research community, aiding them to successful completion and providing high quality personal, professional and career development opportunities. ***Training*** has three concurrent strands, namely, transferrable skills, technical training and mentoring to achieve chartered status (optional). The training programme is structured on the four domains of Vitae's Researcher Development Framework (RDF). A managed professional development scheme is available to any member of staff interested in becoming a chartered engineer. The School has developed a programme of core compulsory courses, designed to develop competences recognised by the RDF, covering essential skills including research methods, technical writing, IPR, innovation and commercialisation, working safely and risk assessment. PGRs and supervisors are also part of the University Graduate College (UGC) which offers in excess of 300 training and development opportunities annually to develop immediately applicable skills and also focuses on broader issues such as impact, engagement and enterprise. The support available was recognised when Cardiff was shortlisted in the 2010 Times Higher Education Award for 'Outstanding Support for Early Career Researchers'. Our students have successfully bid for six interdisciplinary research awards from the UGC since 2008, enabling them to work with students from other disciplines to develop activities that enhance the research environment.

Student support is provided by tutors, who oversee progress and give pastoral care, a dedicated Research Office. There is an annual three day postgraduate research conference, held in Mid-Wales, and another one day conference organised by the students. Individual student accounts (£2.4K each) may be used to develop wider networks through events such as national or international conferences and training courses. The School's Research Student Panel is chaired by a PGR student and includes representatives from each R&I theme, overseas students, PG Tutors, library, safety and research office staff. It provides an opportunity for students to develop new initiatives, as well as a mechanism for responding to problems. The importance of ***PGR progress monitoring*** in ensuring support for students to timely completion is a high priority for the School's PGR Tutors Committee. In consultation with the PGR Student Panel, a new progress monitoring system was implemented in 2011, which provides consistent feedback to research students throughout their programme of study. These measures have been well received by students, who appreciate this regular feedback and the opportunity to raise concerns. Progress is reviewed through six monthly reviews and annual meetings with internal examiners. Dedicated

administrative support ensures that progress reports from staff and students are completed and reviewed independently by members of the PGR Tutors Committee.

D Income, infrastructure and facilities

During the REF period the Unit has consistently gained funding from RCUK, EU, industry and charities to support its strategic research. In all we have secured 110 research grants (£16.6M), including 12 RCUK awards.

The Unit encourages its academics to apply for funding from a range of sources. This provides stability for our research finances and leads to a healthy balance in our research project portfolio.

Specific funding highlights include:

- Two separate awards for the ERDF SEREN project on geo-energy of £4.6M and £1M
- In excess of £3.3M awards for hydro-environmental research, including the £390K 'Sonic characterisation of waves, turbulence, mixing and bed friction in shallow water flows' project.
- £1.7M Cardiff led EPSRC project 'Materials for life (M4L)' on self-healing materials.
- Three Royal Society awards on nano-mechanics, including a prestigious Newton Fellowship.
- Four EU FP7 projects (£1.6M) in the field of building energy management; including a £527K RESILIENT project on 'Coupling renewable, storage and ICT'S, for low carbon intelligent energy management at district level.'

The Unit has maintained its strong industrial links over the period, undertaking 30 research contracts with industrial sponsors, including 7 knowledge transfer partnerships (£1.1M).

The Unit has invested in a range of **high quality facilities and equipment** that are vital for the success of our research. Our major laboratories and the research they have facilitated include:

- **The Hydraulics Laboratory**. This well equipped hydraulics laboratory comprises a large tidal basin, a new sediment facility with two recirculating flumes, a large tidal flume and a model disinfection tank. The laboratory is equipped with a full range of state-of-the-art instrumentation for measuring flows. (Case study 1; *Lin2; Falconer1,2,4; Ahmadian1).*
- **Cardiff University Structural Performance Laboratory (CUSP).** This £2.5M laboratory has been commissioned and enhanced during the present REF period. It has an extensive range of testing equipment (including rigs for combined mechanical and environmental testing) for light and heavy structures; facilities for manufacturing concrete and fibre reinforced composite materials and a comprehensive range of equipment for capturing and processing digital images. (*Karihaloo2; Kulasegaram1,4; Lark1-3; Gardner1,3).*
- **Geoenvironmental laboratories** have received major investment via the SEREN project with (*>£150K*) the development of the 'carbon storage and sequestration rig' and a multi-purpose gas laboratory and the 'underground coal gasification rig'. In addition to a full range of conventional Geotechnical equipment, the laboratories house the Cardiff Geotechnical Centrifuge (one of only 6 in the UK). (*Case study 2*, *Thomas1,2, Tripathy1-4, Cleall4).*
- **Building Information Modelling Laboratory**. This new visualisation and high performance computing facility was established in 2012 with £100K of university strategic funding. This unique facility has since been enhanced with additional funding from a variety of EU and TSB projects *(Rezgui1,4, 4 EU projects and 2 TSB projects)*
- **Characterisation Laboratories for Environmental Engineering Research.** Comprehensive laboratory for the characterisation and measurement of a wide range of chemical and environmental processes, particularly targeted at the needs of environmental and materials engineering. This REF period has seen the commissioning and enhancement of facilities in this £2.4M laboratory, which has been used extensively for analysing field water quality field samples (*Case study 1*, *Falconer4, Lin1*), as well as on the SEREN project.

Cardiff University's Advanced Research Computing facility, comprising a "Raven" cluster of 2048 CPUs, has been used extensively by the GRC and HRC (*Thomas4; Falconer1,2,4; Lin 2,3*).

Our research in the geo-environment, hydro-environment and engineering materials requires the measurement and understanding of chemical and biological processes. In the period 2014-20, we anticipate substantial investments (from Cardiff University's £250M innovation fund) in new facilities shared with other Schools of our College, which will provide a much broader range of expertise and equipment in these areas.

E. Collaboration or contribution to the discipline or research base.

Much of our research is inherently interdisciplinary and requires collaboration with scientists, mathematicians, IT specialists and engineers from other branches. This is well illustrated by the fact that 11 of our 12 RCUK projects and all of our major EU projects, initiated during this REF period, are interdisciplinary collaborations. This reflects our long-term strategy of building up collaborative networks with organisations and other academic departments with different areas of expertise. Examples of our interdisciplinary collaborative work are provided below.

Research collaborations:

- NERC C2C CLOUD TO COAST on 'Integrated assessment of environmental exposure, health impacts and risk perceptions of faecal organisms in coastal waters'; involves 3 UK HEIs and 7 project partners from industry, government agencies and NGOs (£1.7M). The team includes engineers, economists, epidemiologists, ecologists and a range of scientists, with the aim being to develop a state-of-the-art integrated modelling tool for the real-time prediction of bathing water quality along the Ribble river basin, the only EU pilot river basin in the UK.
- FP7 KNOHOLEM aims to develop an intelligent energy management solution for buildings; includes 12 Partners from 7 countries, total budget €4.5M. This project brings together an international multi-disciplinary team in areas ranging from building physics to energy optimization. Cardiff is leading on the development of the technical concept.
- FP7 MATRANS aims to develop novel metal-ceramic functionally graded materials; involves 10 Partners from 7 countries, total budget €4.9M. This project marries our Unit's expertise in mechanics and computational modelling with material scientists and mechanical engineers from academia and industry.

Interdisciplinary research:

- The EPSRC 'Materials for life' project, involves work with Biologists at Bath University and Chemists at Cambridge University on new self-healing cementitious and geo materials.
- The EPSRC CloudBIM project 'Exploring the feasibility and potential for cloud research in the architecture, engineering and construction sector' is a collaboration with colleagues in the Computer Science School at Cardiff University.
- The EPSRC and Nuclear Decommissioning Authority 'SAFE Barriers' project, on the thermo-hydro-mechanical-chemical behaviour of engineered barriers, is a collaboration between geotechnical engineers, earth scientists, chemists, mathematicians, materials specialists from the BGS and seven UK universities.
- Two projects with Forest Research Centre Scientists, (i) on organic wastes as biofuels and (ii) on the impacts of floodplain planting regimes on downstream flood management.

How collaborations with research users inform our research:

- The need for the Environment Agency and their consultants to achieve Water Framework Directive requirements has been the impetus behind much of the research undertaken on hydro-environmental modelling.
- The motivation for our research on high performance fibre reinforced self-compacting concrete came directly from Laing-O'Rourke, Balfour Beatty and Abengoa Solar (Spain).
- The need for robust and comprehensive numerical models for concrete from the finite element company LUSAS and their clients has resulted in the Unit's research in this area.
- Peter Bonfield, Chief Executive BRE Group, has been instrumental in developing a number of collaborative projects with the Unit's BRE Centre, including the development of an online regulatory compliance checking system for energy efficient buildings (also with Skanska, Bentley Systems, RIBA, AEC3).
- Airbus's design requirements for aircraft fuselages and wings have motivated much of the MAMG's work on methods for predicting combined buckling/vibration behaviour.
- The HRC provides the scientific data and modelling predictions required by Corlan Hafren Ltd. to respond to complex questions from the UK Government on the Severn Barrage.
- The GRC's work with the BGS on carbon capture and low carbon energy production has been informed by Kyoto targets and timescales.

Exemplars of leadership. Members of the Civil Engineering Unit have shown strong research leadership across a wide spectrum of academic, governmental and industrial domains.

Learned societies and Academies:

Thomas was elected Fellow of the Royal Society in 2012, a Member of Academia Europaea in 2013, Fellow of the Learned Society of Wales (FLSW) in 2011 and Council member of RAEng in 2013; he currently serves on two Royal Society Committees; he is also FREng.

Karihaloo was elected ForMem Russian Academy of Engineering in 2013 and FLSW in 2012; he was Vice-President and member Executive Committee of The International Congress of Fracture (-2009).

Falconer was elected President of the International Association for Hydro-Environment Engineering and Research in 2011 and 2013; member of RAEng Engineering Policy Committee (2008-12), elected FLSW in 2011 and is FREng.

Distinctions and awards include: the GRC's prestigious 2013 Queen's Anniversary Prize for Higher and Further Education: *Karihaloo* - Visiting Prof. Dalian University of Technology in 2008: *Falconer* - Guest Prof. Institute of Water Resources and Hydropower Research in 2012: *Stoesser*, Hydraulic Engineer's Karl Emil Hilgart Prize of ASCE in 2012: *Gardner* 'You Heard it Here First' event, British Science Festival winner (2013): *Jefferson* Prof. Invité Toulouse (2009).

Industrially sponsored Chairs - Readers include: *Falconer,* CH2M Hill (formerly Halcrow): *Karihaloo,* Laing O'Rourke: *Rezgui,* BRE: *Lin,* Arup: *Jefferson,* LUSAS.

Expert advisory roles include: *Falconer*, Consultant to Tianjin Municipal Government, Member of EA Flood Risk Committee, Chair IAHR Task Force on Global Water Security (2010-), Member of RAEng Global Water Security Steering Group - Reporting to Government Chief Scientist, Member of the Expert Panel Severn Tidal Power Study, Govt. Dept. DECC (08-10): *Thomas*, Chair of UN International Atomic Energy Agency Technical Committee, UNESCO Chair in the Development of a Sustainable Geoenvironment: *Rezgui,* Member of working group on Energy Efficiency of EU Smart Cities Stakeholders Platform and BuildingSmart UK.

Keynotes and invited lectures include: *Karihaloo* - 17 keynotes, including; ICF Beijing (2013), Ottawa (2009), ECF Kazan (2012), Dresden (2010), ECCM Paris (2010), WCCM Sydney (2010), Vienna (2008): *Falconer* - 8 keynotes, including, ISEH, Athens (2010), Rivers Penang (2011), ICHE Orlando (2012), IAHR Europe Congress Munich (2012), HIC Hamburg (2012), IAHR Asia Pacific, Jeju (2012): *Stoesser* - keynote at Coherent flow structures British Columbia (2011).
All returned staff have given invited lectures at important international conferences.

Membership of editorial boards include: *Thomas,* Editor, Computers and Geotechnics: Stoesser, Associate Editor, J. of Hydraulic Research: *Karihaloo*, Regional Editor for the Int. J. of Fracture and Mechanics of Materials (08-): *Lark*, Editor, Bridge Engineering (09-12): *Falconer*, Founding Editor and editorial board member of J. River Basin Management (ICE), J. Hydroinformatics and J. Applied Water Engineering and Research: *Cleall*, Regional Editor, Environmental Geotechnics. Other editorial board memberships include: *Karihaloo* (9 journals) including IJNAMG: *Falconer* (7 Journals) including JoHR: *Cleall*, Geotechnique: *Kennedy* JSV: *Lin* IJSR: *Rezgui* AEI: *Jefferson* SB (ICE): *Pan* ME (ICE): *Tripathy*, IJATCE.

Prestigious lectures include: *Karihaloo,* Dalian University of Technology (2008), Peking University (2009), Tsinghua University (2009), Cambridge University (2009), MIT (2011): *Thomas,* Kwang-Hua Academic Masters Lectures – Shanghai, and Taipei (2010): *Falconer,* RAEng Severn Barrage, RAEng Extreme Flood Events, Parliamentary Scientific Committee on Global Water Security and 35th Idris Jones Lecture.

Leadership roles in professional bodies and on research committees include: *Lark*, ICE Council Member (2011-2014): *Karihaloo* member of Royal Society Panel and UK delegate to IUTAM: *Lark* and *Gardner* members of RILEM committees (195, 221 resp.) and FIB task group 4.1: *Jefferson,* committee member Association of Computational Mechanics (2008-12).

International conference organisation includes: *Rezgui,* NLDB (2010) Conference organiser: *Stoesser*, Riverflow 2008 (conference programme chair): *Kennedy,* Mini symposium on structural optimisation (WCCM8): *Lark,* Organising and scientific committees, ICSHM (2013): *Jefferson,* Mini symposia on FE concrete modelling (WCCM8, COMPLAS, BIOT): Over 60% of the returned staff have served on conference organising and technical committees.