Institution: Queen Mary, University of London (QMUL)

UoA Name: Main Committee B, sub-panel B15 (General Engineering)

a. Overview

Staff submitted in sub-panel B15 (General Engineering) are located within the ***Centre for Biomedical Engineering & Materials*** and the ***Centre for Modelling & Simulation in Engineering Systems*** in the School of Engineering & Materials Science (SEMS).

The Centres were created following an external review of all the School's activities, undertaken in May 2010 by individuals who were RAE 2008 panel members. The review recommended focusing research in areas of existing strength, specifically biomedical-related activity, nanomaterials and modeling applied to engineering practice. Accordingly, research within the School has been restructured through the formation of three research Centres: ***Biomedical Engineering & Materials; Modelling & Simulation in Engineering Systems*** (both submitted under UoA B15 - General Engineering)***; Functional Nanomaterials*** (submitted under UoA sub-panel B13 - Electrical and Electronic Engineering, Metallurgy and Materials).

The review emphasised the need to invest in new academic staff to build capacity in areas of research strength. As a result QMUL is investing in excess of £10m over a 5-year period from 2011 to support a vibrant programme of academic staff recruitment to the research Centres. The investment further supports generous start-up expenditure and facilities. In 2012 QMUL established two cross-faculty research institutes, the Institute of Bioengineering (which includes staff from the Centre for Biomedical Engineering & Materials in SEMS) and the Institute for Materials Research (involving staff in the Functional Nanomaterials group).

b. Research strategy

The SEMS research strategy aligns with the ***Knowledge Creation Strategic Aims*** set out within the QMUL Strategic Plan 2010-15, notably to be 'ranking within the top 10 broadly based UK universities, according to research quality, and within the top 20 according to research power'. Specifically, a clear focus on fostering research that is of the highest quality, suitable for publication in the highest impact discipline-specific journals, increasing external research grant income, PhD student cohort and commercialization of research. Key Performance Indicators are cascaded down to academic schools and progress assessed on an annual basis.

The SEMS research strategy aims to:

- Attain a reputation as a centre conducting research that is judged to be uniformly of international quality and that includes contributions that are internationally leading

To achieve this aim by:

- Aligning research in selected areas with distinctive strength and critical mass and develop multidisciplinary research themes
- Developing a profile of research outputs and activity judged to be in the top 20% in the UK in both research quality and power

Key indicators of performance are defined targets which are benchmarked against institutions with top decile performance in General Engineering in the 2008 RAE for quality of publications (increase in proportion of papers published in top-ranked journals), research income (£96k per year/FTE) and PhD student graduation (0.47 PhD completions per year/FTE).

During the REF period SEMS has focussed on the development of distinct clusters of research excellence, organised within three defined research Centres: ***Biomedical Engineering & Materials; Modelling & Simulation in Engineering Systems*** (both submitted under UoA B15 - General Engineering)***; Functional Nanomaterials*** (submitted under UoA sub-panel B13 - Electrical and Electronic Engineering, Metallurgy and Materials) that provide both a critical mass for research activity and also mechanisms for managing and supporting research excellence, including infrastructure. Each centre is based on historical core research strengths within the school, with the strategy being to focus and deepen distinctive areas with research excellence. The Centres have benefited from significant investment in new academic staff and infrastructure during the REF period, which will continue beyond the end of the REF period, with approval to recruit a further 9 academic staff. The strategy has already created a strong and vibrant research culture

within the Centres with sustainability assured by the commitment for further investment into the Centres from central QMUL funds coupled with a marked enhancement of research funding achieved since the creation of the Centres in 2011 – with doubling of award values and tripling of awarded overhead funding (2012-13 values compared to 2010-11).

b.1 Mechanisms for promoting research – ensuring vitality and sustainability

The SEMS Research committee is chaired by the Director of Research and includes research centre leads and deputies. It provides a forum for developing new research initiatives, and acts to drive the research agenda within the School in light of the strategic aims outlined above. During the REF period there has been a major focus on publication strategies to ensure that an increasing proportion of research is suitable for publication in the highest quality journals that are appropriate to discipline. Internal peer-reviewed Pump Priming funding has been available throughout the REF period via a number of mechanisms, most notably two discipline bridging schemes (MRC/EPSRC-funded *QMUL Discipline Bridging Initiative* - bioengineering, and EPSRC-funded *Bridging the Gaps* - modelling and simulation). Funding for multidisciplinary PhD studentships is also available. Annual research away-days serve as a wider forum in which all staff can participate. The Research Centres support active seminar programmes, typically weekly during term time, which attract high quality external speakers and provide the opportunity for informal research discussions between academic staff on a regular basis.

SEMS employs a Research Administrator who provides support for grant applications and grant management. A formal workload model allows staff contributions to be assessed to ensure 50% of available time is protected for research. This process is also monitored via submissions to the TRAC system which indicates 52% of time is available for research (most recent, 2011 return).

b.2.1 Centre for Biomedical Engineering & Materials:

Research in this centre has its origins in the EPSRC-core funded IRC in Biomedical Materials. In the 2008 RAE research activity was split between UoA 25 (General Engineering) and UoA 29 (Metallurgy & Materials), but is submitted as a complete centre with critical mass to the REF. The current Centre comprises 16 REF category A academic staff (14.6 FTE). Seven new academic staff (including 4 ECRs) have been appointed during the REF period (**Azevedo** – submitted under UoA B13, **Carpi, Gautrot, Gavara, Gupta, Mata, Novak**). The Centre supports 16 postdoctoral researchers, 57 PhD students and 5 technicians. Research is focussed around the following thematic domains:

Biomaterials and Bio-interfaces: Elaboration of novel biomaterials and understanding of phenomena at Bio-interfaces are essential in the development of biomedical applications such as biomaterial implants with enhanced biocompatibility and functionality, medical diagnostics and tissue engineering scaffolds. Biomaterials and Bio-interfaces may provide the biochemical cues (e.g. specific ligands for cell membrane receptors), or mechanical and topographical properties, all of which combine to regulate cell behaviours such as cell motility, extracellular matrix production, proliferation and stem cell differentiation. Biomaterials and Bio-interfaces research within the Centre covers the following areas: i) micro- and nanofabrication of biomaterials, including self-assembling systems, peptide-based, hydrogels and hybrid biomaterials (**Mata, Gautrot, Azevedo** – ERC funding); ii) elaboration of multifunctional delivery systems for therapy, in situ sensing, controlled and triggered release of encapsulated active compounds **(Sukhorukov, Vadgama –** EPSRC/BBSRC funding); iii) development of artificial composite and novel bioceramic materials for hard tissue repair and tissue engineering (**DeBruijn, Hing**); iv) Computational methods for molecular modelling and simulation of biomaterials and biointerfaces, including lipid membranes, proteins and drug permeation (**Orsi, Botto**). New generation biomaterials are being developed by QMUL-associated companies such as Progentix Orthobiology BV (**DeBruijn**) and ApaTech™ (**Hing**), the latter having recently been acquired by Baxter International.

Multiscale Biomechanics & Mechanobiology: This research area examines the influence of biomechanical stimuli on biological systems at a range of different length scales. This includes the biomechanics of cells and subcellular structures such as the nucleus, cytoskeleton and glycocalyx (**Lee, Knight, Gavara, Novak, Wang W**), the biomechanics of natural and synthetic biomaterials at the macro, micro and nanoscales (**Gupta, Screen, Shelton**). The research also covers the biological response of cells and tissues to biomechanical, topographical and physicochemical

stimuli and the associated process of mechanotransduction (**Guatrot, Lee, Knight, Screen**). Studies examine a range of cell and tissue types including cartilage, bone, tendon, epithelial cells, neurons and stem cells. The centre is further supported by expertise in advanced nanoscale techniques to visualise, quantify, and manipulate biological processes (**Novak, Gavara, Guatrot, Gupta**) and computational biophysical modelling (**Botto and Barbieri** within *Modelling & Simulation in Engineering Systems*). Our research funding focuses on the role of biomechanics in fundamental structure-function relationships (funded by Human Frontiers Science Program, BBSRC, Wellcome Trust) and how these vary with injury and disease such as tendinopathy (Wellcome Trust, ARUK), arthritis (MRC, ARUK, AO Foundation) and cancer (ERC). In addition, the group incorporates more translational applied research on electrostimulated polymer systems to mimic biomechanics (**Capri**) and implant biomechanics with particular emphasis of the wear properties of hip prostheses (**Shelton**).

b.2.2 Centre for Modelling & Simulation in Engineering Systems:
The School of Engineering and Materials Science at Queen Mary has a long tradition in simulation and modeling, with research activities spanning theoretical, numerical and experimental investigations. The establishment of the Centre for Modelling & Simulation in Engineering Systems in 2011 has provided a greater focus on core research strengths, and enabled the group to **better integrate with the Biomedical Engineering & Materials and Functional Nanomaterials groups** in SEMS. Research by the group, traditionally focused on problems of interest to mechanical, aeronautical, and civil engineering, has now branched into new application areas, such as biological systems, advanced materials, and the environment. The Centre currently comprises 15 REF category A staff (13.2FTE) and supports 9 postdoctoral researchers and 52 PhD students. Five new academic staff (including 4 ECRs) have been appointed since the group was established in 2011 (**Barbieri, Botto, Karabasov, Orsi, Sui** plus two further staff to join in early 2014 – Toropov from Leeds, Li from Penn. State).

Research is focussed around the following thematic domains:
i) *thermo-fluids* (**Botto, Munjiza, Sui, Karabasov**, **Mueller, Wang HS, Wen, Stark**), which broadly includes fluid mechanics, heat and mass transfer, and combustion; areas of research strengths are in the Direct and Large-Eddy Simulation of single-phase and multiphase systems, particularly flows with suspended particles or biological capsules, surface-tension phenomena with colloids and nanoparticles, interfacial flows and contact line dynamics (including microscale experiments by Stark on electrospray and drop deposition), acoustic generation and propagation, microstructured biofluids, heat transfer phenomena at solid walls studied at the continuum and molecular level, and fluid-structure interaction problems (including the work by **Dabnicki** on animal flight).

ii) *solid mechanics* (Barbieri, Wen, Munjiza) where interactions with the Functional Nano-materials Group has spurred collaborations to study the micromechanics of fracture and crack propagation in single-phase materials or filled nano-composites, through meshfree and boundary element methods; **Munjiza**'s pioneering work on the Discrete Element Method as applied to the mechanics of discontinua has led to new simulation methods in areas where efficient treatment of multiple particle-particle contacts is crucial, such as in environmental granular media. Numerical studies also concentrate on full body biomechanics and human locomotion as applied to sport activities (**Dabnicki**).

iii) *molecular and multi scale simulations* (Orsi, Wang HS, Karabasov, Barbieri), where fully atomistic and coarse-grained molecular dynamics algorithms are used as first-principle modelling tools, for example to study self-assembly of lipid membranes, or are integrated into hybrid continuum/atomistic models, to tackle realistic time and length scales while retaining atomistic accuracy. Multiscale simulations are applied to solids, in problems such as elastic wave propagation in damaged composites and high-strain rate shock response to impact, as well as fluids, for instance in investigations of protein motion in flowing solvents studied via a coupled molecular dynamics/stochastic Navier-Stokes solver. Coarse-grained models, which are used when standard molecular dynamics is computationally too expensive, enables studies of nanotube-membranes interaction problems, transport of drugs and hormones across lipid bilayers, and dynamics of high-molecular weight polymers (**Orsi**).

iv) *dynamics of soft and biological materials* (Botto, Sui, Orsi, Barbieri), an emerging area at

SEMS that is benefiting both the Biomedical Engineering and Materials group as well as the Functional Nanomaterial Group. In this area knowledge in the mathematical and computational modelling of continuum fluid and solid mechanics, and new expertise in interactions at the molecular level, is enabling modelling studies on the deformation of biological cells in micropipette aspiration experiments, on the dynamic failure of nano-reinforced soft elastomers, on interfacial adhesion in filled composites and on the deformation of viscoelastic capsules in shear flow.

c. People

c.1 STAFFING STRATEGY

A key element of the research environment within SEMS has been an active programme to recruit new academic staff with internationally recognised research profile or the potential to attain that level for more junior staff. During the REF period SEMS has appointed 19 new staff (12 ERCs) eligible for submission; seven into *Biomedical Engineering & Materials* (**Azevedo**, **Capri, Gautrot, Gavara, Gupta, Mata, Novak**) and five into *Modelling & Simulation in Engineering Systems* (**Barbieri, Botto, Karabasov, Orsi, Sui**). The recruitment strategy has focussed on developing research clusters with clear international excellence and critical mass. Investment of £2.8 million for start-up packages supports recruitment of the highest quality researchers and ensures that new staff are able rapidly to establish their research at QMUL. Recruitment is truly international with staff from 12 nationalities appointed during the REF period and with significant research experience (PhD, postdoc or academic position) at leading institutions in USA (e.g. NIH, Penn State, Northwestern), Canada (Univ. de Montréal), Spain (Parc Scientific Barcelona), Italy (Univ. Pisa, Univ Trento), Portugal (Univ. Minho), Germany (Max Planck Inst., Univ Goettingen), Russia, as well as the UK (Cambridge, Imperial, Leeds, Oxford, Southampton, Warwick, UCL).

c.1.1 Induction and Probation for new academic staff

Both QMUL and SEMS provide formal inductions for new staff at all levels. Due to the recruitment of a large number of new academic staff, a new induction programme for staff has been developed by SEMS that informs new staff members about the various processes at school and university levels. Themes include teaching, research support, careers and the vision for the School. The probation period is three years, during which new staff are set key research targets as follows:

- to apply for at least one project grant per year, and normally be awarded one project grant or the equivalent within 3 years.
- to publish as significant author at least 3 papers in top journals in the subject area (defined as within the top 10-15% by citation impact factor).

Probationers are allocated a *Probation Advisor* who provides advice and support for research funding applications (which are internally peer-reviewed before submission) and publication strategies. All staff recruited within the REF period have received generous start-up funding (average over £130k) with a minimum guarantee of one research studentship to start in their first year of appointment plus appropriate running costs. Initial teaching loads are light (usually about 1/3 of a full load in the first year, rising to a full load by the third year). Probationers are not allocated significant administrative duties.

c.1.2 Mentoring, support and promotion for academic staff other than probationers

Day-to-day line management of research activity by academic staff is delegated by the Head of School to the relevant research group lead. Staff are also assigned an appraiser, who is normally the research group lead or deputy lead who provides advice and support throughout the year on funding applications and publications. The appraiser and member of staff meet regularly to review progress and there is a formal annual review meeting to judge progress against appraisal targets and objectives from the previous year. Research groups operate a system for peer review of research grant applications. Leadership is supported by the QMUL wide 'High Potential Leaders' programme (residential workshop, masterclasses & coaching) to support their development with three SEMS academics participating since 2011.

SEMS has a transparent and rigorous approach to promotion aimed at supporting staff in developing applications with a high likelihood of success. Applications are considered by a SEMS Professorial Advisory Panel, comprising all professorial level academic staff to inform a statement of support that is key in driving later stages of the process involving faculty, QMUL and external

scrutiny. The process is linked to appraisal to ensure staff prioritise the key objectives needed to support a successful application. Eight submitted staff were in post on 1st Jan 2008 at Lecturer, Senior Lecturer or Reader level. Of these six have been promoted during the REF period (**Gupta, Mueller, Wang HS** to Senior Lecturer; **Screen, Wen** to Reader; **Knight** to Professor).

c.1.3 Support for early-career researchers

In 2011 the College was shortlisted for the Times Higher Award for 'Outstanding Support for Early Career Researchers'. Research fellows and postdoctoral researchers receive similar mentoring support to probationers, are appraised annually by a member of staff other than their research supervisor, specifically in order to provide support with the attainment of their career goals. The QMUL ***Centre for Academic and Professional Development*** provides a dedicated programme to postdoctoral researchers that allow them to take part in personal effectiveness training, media training and public engagement exercises that equip them for future careers. QMUL provide dedicated support officer and careers officer for postdoctoral researchers who are responsible for working with researchers to ensure that they are able to move onto fulfilling careers either inside academia or in industry. For postdoctoral researchers who want to progress into academia, annual coaching sessions about how to apply for early career fellowships are provided. QMUL was recently awarded the European Commission's HR Excellence in Research Award in recognition of its implementation of the Concordat to support Career Development of Researchers.

c.1.4 Equal Opportunities

QMUL is committed to ensuring equality and promoting diversity in all its practices and has put in place initiatives to support this goal. In 2010 QMUL renewed its Bronze Athena SWAN Award for excellence in recruiting and advancing the careers of women in science, engineering and technology, and SEMS was awarded a departmental Athena Swan Bronze Award in 2013. SEMS is engaged in the faculty based Women in Science and Engineering (WISE@QMUL) initiative, established in 2008 to provide a networking platform for female undergraduates, postgraduates and academic staff in Science and Engineering seeking encouragement and advice on managing their careers within and beyond academia. A 'Women into Leadership programme' was created, in partnership with Ashridge Business School, to develop the senior leadership potential of female academics (reader/professorial level) that has been attended by 3 SEMS academics in the past two years. QMUL is part of the Stonewall Diversity Champion programme, to promote equality for Lesbian, Gay, and Bisexual people and has partnered with leading London institutions to set a mentoring scheme (B-MEntor) for black and ethnic minorities academic staff. SEMS has a long history of supporting flexible working and family-friendly policies. Three members of academic staff have chosen to work part time due to child caring responsibilities with all three promoted recently.

c.2 RESEARCH STUDENTS

UoA 15 - General Engineering PhD students are aligned with the Centres of *Biomedical Engineering & Materials* and *Modelling & Simulation in Engineering Systems*. Cross-faculty support is provided through the *Institute of Bioengineering* (IoB) and *Materials Research Institute* to encourage interdisciplinary collaborations. Research groupings in SEMS and the IoB enhance the distinct cohort identity for PhD students, supported by seminar series as well as cohort training activities. QMUL allocates internal PhD scholarships to promote broader collaboration across the distinct engineering activities, with typically 10 per year allocated to UoA 15 activities.

Table 1. New PhD Students registering in General Engineering within the REF period 2008-13

Year	2008	2009	2010	2011	2012	2013	TOTAL
New PhD registrations	15	15	21	19	19	29	118

A total of 68 doctoral degrees were awarded in the REF period (see REF 4a), which equates to 0.55 awards per FTE/Year, well in excess of the RAE 2008 top decile level of 0.47. This represents a 37% growth compared to 51 awards in the 6.5-year RAE period and a 138% increase when normalised per FTE/year, with a similar proportion of eligible staff returned in the two exercises.

c.2.1 PhD Recruitment and progression: SEMS adopts a robust approach for recruitment of

PhD students. All funded studentships are advertised both within QMUL and externally. Shortlisted applicants are interviewed by two members of academic staff to ensure recruitment of the highest quality students. Where recruitment is to a multidisciplinary project SEMS endeavours to ensure that the interviewing academics also represent the disciplinary breadth. There has been a progressive increase in new students registering for a PhD over the REF period (Table 1).

Students are allocated two supervisors (who will have undergone recent training in current best practise in supervision, and at least one of whom will have a proven track record of supervisory success). Progress is monitored by regular meetings with supervisors and formally assessed after 9 months of registration. There is a clear expectation that the thesis will be submitted well within the four year period allowed. Workshops are available to help students prepare for each stage of their progression throughout their degree. For SEMS PhD students starting their studies within the REF period, 91% of the students submitted within 4 years and 100% completed within 5 years, highlighting the robust approaches taken to ensure timely completion.

c2.3 PhD Training

QMUL have established a Doctoral College to support both PGR students and postdoctoral researchers. Strategically led by a Doctoral College Management Group its activities are delivered and coordinated by two dedicated Researcher Development Officers (Centre for Academic & Professional Development) and a Careers Adviser for Researchers (QM Careers). These staff work in partnership with each Faculty to ensure that researcher development activities align to specific needs. QMUL operates a Points-Based Training system to support delivery of our College-wide training strategy for PGR students, based on the RCUK endorsed Vitae Researcher Development Framework. This allows disciplinary flexibility, ensuring that all students receive appropriate transferable skills and research training. The Doctoral College runs an interdisciplinary PhD induction, which is compulsory for all PGR students who are also encouraged to attend annual Interdisciplinary Cohort Training courses (Maximising the Impact of Conferences & Networking; Understanding the Impact of your Research). PhD students are provided with Science Communication Training (**Junk the Jargon**), a Competition where PhD students present their work to a public audience and are judged by an external panel and audience. QMUL Careers events support STEM researchers who are considering alternative careers options especially the transition from academia into industry (**Doctoral Transitions: Careers Beyond Academia**).

The QMUL ***Centre for Academic and Professional Development*** has an excellent track record of developing and delivering bespoke cohort training programmes to support externally funded projects. A highlight in the REF period was the £3M EPSRC funded KTA award "ImpactQM", which allocated 16 internships, corresponding to almost 10% of our completing students, including internships at GSK, National Physical Laboratory and Jaguar Cars Ltd. QMUL has received external recognition by being shortlisted for the Times Higher Education Award (2011) "Support for Early Career Researchers" for our EPSRC funded ImpactQM PhD Training and Internship Programme. We have also secured the EU Commission's "HR Excellence in Research" Award (2012) in recognition of our Concordat Action Plan and our Researcher Development Programme to support researchers and their career development. All of these training and progression aims are supported by a state-of-the-art IT system as a result of the £21M invested in the QMUL IT strategy.

d. Income, Infrastructure and Facilities

d.1 Research Grant Income:

The *Biomedical Engineering & Materials* and *Modelling & Simulation in Engineering Systems* research centres have an active research grant portfolio of £8.8 million (at end of July 2013). The annual value of awards has increased over the REF period from £1.8 million in 2007/8 to £4.4 million in 2012/13. The total value of awards during the REF period is £14.3 million, equating to £116k per annum per FTE submitted, a 75% increase compared to the RAE 2008 period with a similar proportion of eligible staff returned in the two exercises. The current REF period has seen a substantial increase in research grant spend compared to the previous RAE period. Average annual spend for the RAE period was £931k, equating to £28k per annum per FTE submitted. Within the current REF period average annual spend is £2,062k (£83.8k per annum per FTE submitted) representing a 120% increase in total spend/year and an increase of 198% in spend per

FTE/year staff submitted.

Major grants (>£500k) during the REF period include:
Centre for Biomedical Engineering & Materials

- EPSRC Platform grant – Multiscale Mechanobiology for Tissue Engineering (**Lee, Knight**) £1.1 million (2008-12)
- EPSRC Programme Grant – ESPRIT (**Vadgama**) £810k (2009-14)
- ERC Starting Grant – (**Mata**) €1.492 million (2013-2018)
- Human Frontier Science Program Grant – (**Lee**) $1.2 million (2009-13)

Centre for Modelling & Simulation in Engineering Systems

- EU Marie Curie ITN AboutFlow (**Mueller**) £899k (2012-16)
- EU FlowHead (**Mueller**) £546k (2009-11)
- NIHR i4i - Turbocardia (**Munjiza, Wen**) £882k (2013-16)

d.2 Infrastructure and Facilities:
During the REF period SEMS has benefited from significant investment in research infrastructure to support the research centres in the school. QMUL is investing in a phased programme of refurbishment of the Engineering building with a planned total investment of £30 million over 10 years from 2009. Investment in SEMS during the REF period to date has been over £5 million.

Developments in built infrastructure that specifically support research in the *Biomedical Engineering & Materials* and *Modelling & Simulation in Engineering Systems* groups include:

- Investment from Wolfson/Royal Society laboratory refurbishment grant and HEFCE and SRIF3 of £261k to create ~140 m^2 *Stem Cell BioEngineering* laboratory. Completed 2008.
- Investment from the College (HEFCE) of £455k to create a high quality PhD Student Hub for over 70 PhD students with associated break-out and meeting space. Completed 2009.
- Development of an integrated School administrative hub (HEFCE funded, £549k), that makes the provision of research support to academic staff more efficient. Completed 2009.
- Investment from the College (HEFCE and RCIF) of £150k to create a ~100 m^2 *Nanostructured Biomaterials* laboratory. Completed 2011.
- £2.68 million from HEFCE to create new laboratories (approximately 500m^2) for Bioengineering and Biomaterials research to support new academic staff. Completed 2012.

Significant investment in facilities and research equipment include:

- Between April 2008 and March 2011 RCIF investment totalling £1,301,480 in high performance computing facilities to support modelling and simulation activities.
- EPSRC £2M Midplus Consortium grant with QMUL, Warwick, Birmingham and Nottingham - a major e-infrastructure investment providing a national-level High Performance Computing Cluster. QMUL funding £250k plus EPSRC directly funding of £350k to the College.
- Institutional investment (£500k) for a super resolution microscopy system to the Institute of BioEngineering – procurement ongoing, completion end 2013.
- Institutional investment (£400k) to upgrade/replace mechanical testing facilities – completed and commissioned 2012.

e. Collaboration or contribution to the discipline or research base
Engagement by academic staff in local and/or external activities that support and enhance the discipline base are strongly encouraged and considered as part of the appraisal and promotion processes. QMUL and SEMS has a strong history for supporting interdisciplinary collaborations, particularly at the interface between engineering and medicine. During the REF period two discipline-bridging schemes were active (MRC/EPSRC-funded *QMUL Discipline Bridging Initiative* - bioengineering, and EPSRC-funded *Bridging the Gaps* - modelling) and the recent establishment of the cross faculty Institute of Bioengineering further supports interdisciplinary research.

e.1 Research Collaboration and partnership: Staff from the *Centres for Biomedical Engineering & Materials* and *Modelling & Simulation in Engineering Systems* are engaged in numerous national and international research collaborations involving leading academic and non-academic partners.

Examples of major ***international academic collaborative research programmes*** active during

the REF which are led/co-ordinated by Centre members include Human Frontier Science Program grant (**Lee**, with Ludwig Ludwig-Maximilians-Universität, Germany and University of Pennsylvania, USA), European Scientific Network for Artificial Muscles - ESNAM (**Carpi**), FlowHead and AboutFlow FP7 projects (both **Mueller**), EPSRC Programme Grant – ESPRIT (**Vadgama**), AO Foundation (**Mata**), Ecole Polytechnique Federale de Lausanne, Switzerland (**Stark**), QMUL-UC San Diego-KCL research consortium in vascular biology (**Wang W**).

Major funded ***collaborations with industry*** include: Airbus (**Wen**); ApaTech (**Hing**); BAE Systems (**Karabasov**); Bayer (**Carpi**); Corin (**Shelton**); Danfoss (**Carpi**); L'Oreal (**Sukhorukov**); Philips (**Carpi**); Progentix (**deBruijn**); Renault (**Mueller**); Rolls-Royce (**Karabasov**); Stereotaxis (**Carpi**); VW (**Mueller**), Xaar Ltd (**Stark**).

Academic staff are involved in collaborative research involving ***national facilities and pan-university organisations***, for example Rutherford Appleton Laboratory (**Stark**), Diamond Light Source (**Gupta**, member User Working Group – Beamline I14), Thomas Young Centre (**Barbieri** – member TYC Working with Industry Group; **Botto; Orsi; Sui**), National Physical Laboratory (**Carpi, Wang**), UK Sport/British Olympic Association (**Vadgama**), DERA (**Stark** – technical assessor).

e.2 Awards: Contributions to the discipline have been recognized at a individual level through the following prizes and awards:
Hing (IoM^3 Kroll Medal; Biocompatibles Prize; Royal Acad. Eng. Silver Medal)
Karabasov (Royal Society University Research Fellowship)
Orsi (EPSRC Research Fellowship)
Mata (ERC Starting Grant; Ramon y Cajal Award, Torres Quevedo Award)

e.3 **Leadership in the academic community**
Funding bodies and Professional activities: **Knight**, **Vadgama** and **Wang** are current members of the EPSRC Peer Review College and submitted staff also serve in similar roles for the Royal Society Research Grant Scheme & Newton Fellowship Board (**Karabasov**), Orthopaedic Research UK (**Hing**, **Shelton**), NC3Rs (**Lee**), AO Foundation (**deBruijn**, **Mata**), Government of Spain (**Mata**), Qatar Research Foundation (**Lee**, **Mata**), Arthritis Research UK (**Screen**). All staff are actively involved in reviewing for a wide variety of funding bodies. Staff in this UoA serve on the IOM^3 External Affairs, Nanotech. and Biomedical Applications Divisions (**Vadgama, Lee**), Royal Aero. Soc. Professional Standards Board (**Stark**), RAE 2008/REF 2014 panels (**Stark, Vadgama**), General Secretary of International Association of Computer Science in Sport (**Dabnichki**), Biomechanics Adviser for High Performance Sport, Univ. California, Berkeley (**Dabnichki**), President of the European Society for Electromechanically Active Polymer Transducers & Artificial Muscles (**Carpi**). Staff are members/fellows of professional organisations/learned societies including IMechE, Royal Aero. Soc., IOM^3, Institute of Physics, Royal Society of Chemistry Royal Microscopical Society, American Ceramics Society, Orthopaedics Research Society.

Conference organisation and keynote lectures: During the REF period SEMS staff have been involved in the organisation of over 70 international conferences. Highlights include BioEngineering 11, hosted at QMUL (**Lee**, **Wang**, **Knight**, **Screen**, **Shelton**); 2008 World Biomaterials Congress, Amsterdam (**deBruijn** – Vice Chair); EuroEAP 2011-2013 (**Carpi** – lead organiser), SPIE EAPAD 2011 (**Carpi**), TERMIS European Meeting 2011, Spain (**Mata** – Symposium CoChair); 10th International Symposium on Rock Fragmentation 2012, India (**Munjiza**). Submitted staff have given over 135 invited keynote/plenary presentations at leading international conferences, including Gordon Conferences on Biomineralisation and Composites – both 2008 (**Gupta**); Orthopaedic Research Society Annual Meeting, 2010 (**Lee**), Materials Research Society, 2010 (**Carpi**), American Chemical Society 2012 (**Sukhorukov**).

Journal Activities: During the REF period SEMS staff have served on the Editorial Boards of 39 international journals. Examples include: European Cells & Materials (**deBruijn** - Scientific Editor); Biomedical Materials (**deBruijn**); Biofabrication (**Vadgama**); Journal of Multiscale Modeling (**Lee, Wang**); Med. Eng. & Physics (**Vadgama**); Journal Mech. Behav. Biomed. Mats (**Screen**); Bioinspiration & Biomimetics (**Carpi**); Phil. Trans. Royal Soc. A (**Karabasov** – guest Editor); Int. J. Refrigeration (**Wang HS**); I. Mech. E. Proc. Part G (**Stark**).