

Institution: Queen Mary University of London (QMUL)
Unit of assessment: B15 (General Engineering)
<p>a. Context</p> <p>B15 (General Engineering) research, conducted in the School of Engineering & Materials Science (SEMS), has a diverse range of non academic beneficiaries. Impact includes economic benefit (jobs created, sales/profit linked both to spin out and existing industry) associated with the development of engineered products, tools and processes that enhance industrial competitiveness, health-related (improved patient outcomes), society (major public engagement activity), along with impact on public policy. The spin out companies ApaTech™ (Case Study CS1) and Bone Regeneration (Case Study CS2) are prime examples of mature technologies that have delivered impact that has broad reach and significance. Both are highly successful companies delivering benefit to thousands of patients who have received their implanted products. The modelling research associated with CS3 - (Fracture modelling) has enabled safer and more productive blast mining with associated reduction in costs for existing major mining companies. Societal impact is exemplified by QMUL Centre of the Cell, an award winning outreach project visited by over 40,000 schoolchildren each year that includes exhibits based on B15 (General Engineering) research. The involvement of Vadgama in the ESPRIT programme which is developing monitoring systems for elite athletes delivers benefits both to general society (improving sporting performance), and to public policy (sports governance and drug testing).</p>
<p>b. Approach to impact</p> <p>QMUL has embedded impact within its 2010-15 Strategic Plan, and impact-related KPIs are cascaded down to academic schools, with a requirement to assess progress against the KPIs on an annual basis as part of the Planning and Accountability Review. Relevant indicators include disclosure of inventions, financial support for commercialisation of research, income-generating technology license agreements and creation of spin-out companies. QMUL has an integrated and extensive approach to identifying research with the potential for impact and providing the maximal opportunities to ensure impact is realised. Mechanisms are in place within the SEMS that underpin structures and services at QMUL level to drive impact specifically relating to research within sub-panel B15 (General Engineering) remit.</p> <p>b.1. SEMS Mechanisms</p> <p>SEMS supports a range of mechanisms aimed at ensuring impact is realised. Prof James Busfield is Director of Industrial Engagement in SEMS with the remit to identify and promote new collaborative opportunities with industry that often lead to impact-generating research. A full time member of support staff coordinates our wide range of industrial partnerships. A large Industrial Liaison Forum (ILF) event is held twice a year and typically attracts more than 60 industrial partners to QMUL reviewing in excess of 100 SEMS research posters. The ILF includes networking activities providing a focal point for industrial research funding to be secured. During the REF period SEMS staff have been awarded direct funding from over 30 companies with a total value from industry of over £3M (e.g. Advanced Engine Tech., Airbus, ApaTech™, Becker Ind. Coatings, Bridgestone, Corin, Cummins Turbo Tech., DePuy, Dunlop, EADS, Electrolux, European Thermodynamics, GSK, Richmond Pharma., Rolls Royce, Sibelco, Spectrum Technologies, Tissue Science Labs). Impact-oriented follow on funding from government schemes, such as i4i and Heptagon exceeds £1.5M. In addition the Industry-facing SEMS spin-out Nanoforce (see below) has worked with over 100 companies over the REF period (e.g. Dow Chemical Company, General Electric, SABIC Innovative Plastics, DSM, L'Oreal, Shell, Transitions Optical) with turnover in excess of £3.2M for industry-oriented activities.</p> <p>Prof Martin Knight is Director of Public Engagement in SEMS and acts as liaison between individual academic staff members and QMUL structures to support the development of public engagement activities that generate societal impact. The role further supports identifying opportunities for academic staff to input into relevant technology-related public debate and foster impact on public policy. An example being Prof Shelton's involvement in the Beyond Compliance initiative, linked to the recent metal-on-metal hip implant concerns. These activities are supported</p>

by a dedicated Communications manager.

Nanoforce Technology Ltd was set up as a spin-out from SEMS in 2005, as part of the Micro and Nanotechnology Network with £3.1m funding funded by the Department of Trade and Industry (now the Technology Strategy Board-TSB) and the London Development Agency. Nanoforce aims to bridge the gap between academic and industry-led research and to enable the development of new commercial products using QMUL's knowledge-base. Nanoforce Ltd acts as an independent research and knowledge centre for applied research. Research projects can be collaborative, bilateral and, if necessary, confidential. The ability to conduct research on an industrial timescale (months) rather than an academic timescale (years) has proven highly valuable to industry. As such, Nanoforce provides a service that industry often fails to find within academia and it allows QMUL academics greater flexibility to conduct R&D projects with industry that have great potential to generate economic and other impact. Nanoforce employs a Business Development Manager provides support for all relevant industry-facing SEMS activity.

b.2. QMUL Structures

QMUL is an extremely outward-facing organisation as evidenced by the many close links staff have with businesses and other organisations both in the UK and internationally. In 2011, the College received the maximum HEIF5 funding allocation which underpins support to the academic community for a range of Impact activities including business engagement, technology transfer, public engagement, researcher development and entrepreneurial training.

Queen Mary Innovation (QMi), the Technology Transfer office for QMUL comprising 11 staff including two technology transfer specialists focused on the Science and Engineering Faculty who identify and protect new Intellectual Property, help to secure proof of concept funding to develop new technologies, and support the commercialisation of research-derived technologies through licensing and new spin-out creation. Since 2008, QMUL's outputs include 267 new inventions identified (41 from SEMS); 79 new licenses of technology to industry (7 from SEMS) generating almost £1.72 million of licence income and 5 new spin-out companies. The team manages a portfolio of 12 spin-out companies (including 4 from SEMS).

A separate **Business Development team** comprising 9 staff, including three staff focused on Science and Engineering, supports the academic community in its relationships with businesses and other external organisations, seeking resonance between academic strengths and business needs. They help to identify partnering opportunities, facilitate commercial interactions and negotiations. They also organise industry events and help to foster an entrepreneurial culture, including support for the SEM flagship ILF events.

Encouraging an Entrepreneurial Culture: QMUL aims to embed enterprise and innovation across the breadth of academic endeavour by providing academic and student entrepreneurship training activities such as workshops and bootcamps, alongside a number of funded College-wide initiatives such as the **QM Innovation Fund**. Launched in 2011, this is a highly flexible internal fund to encourage industry collaboration and realise the impact of research. Academics are able to bid for up to £10,000 per project, with seven SEMS projects funded (total £69,827), for example to support research enhancing the bioactivity of spinal cages (**Hing**), reducing noise from interactions between aircraft wing and engines (**Karabasov**) and three-dimensional dielectrophoresis assisted lithography (**Mata**).

Realising the commercial potential of research: QMUL academics seeking to commercialise research outputs are able to access substantial Proof of Concept Funds, managed by QMi, totalling £400k p.a. for projects that lead to commercial milestones. SEMS researchers have received over £170k from this fund since 2011 to support 7 projects, including for anti-bacterial silver coatings (**Vadgama**), nano-PVT systems (**Wen**) and monitoring for periodontal disease (**Krause**). In 2006, Queen Mary established a formal partnership with IP Group, an early-stage VC with a proven track record of investing in University spin-outs. Over the REF period, the College's spin-outs have attracted more than £45 million in external VC investment, with over £24 million invested in SEMS start-ups. The sale of shares in ApaTech™, a SEMS spin-out (Case Study CS-1), generated £10 million for QMUL when the company was acquired by Baxter International Inc. in 2010 for a total sum of up to \$330 million. This revenue has been used, in part, to fund significant

Impact template (REF3a)

investment in new staff (including start-up packages), infrastructure and facilities in SEMS.

Innovative Places: QMUL has built the largest incubator for BioScience and BioEngineering companies in London, with £28M investment. Queen Mary BioEnterprises is a purpose built 40,000 square foot incubator providing companies with start-up and follow-on space. Since opening 3 years ago, QMB has become fully occupied with a range of Bio-related companies and provides a route to support SEMS Bioengineering impact.

Queen Mary's Centre for Public Engagement is funded through a £300k grant from RCUK and £1m HEIF5 funding. Two full time members of staff provide training and support. An example of the College's highly innovative approach to public engagement is provided by the [Centre of the Cell](#), which is visited by over 40,000 local schoolchildren each year and includes SEMS-generated Bioengineering exhibits. SEMS staff have received funding for innovative forms of public engagement through a £214k p.a. Pump Priming Fund, for example to recreate Robert Hooke's famous experiment in the Monument to the Great Fire of London using gold fibres thinner than a human hair. QMUL's Public Relations team provides expert advice to academics seeking to maximise their communication skills and helps to build tailored strategies focused on Impact and connecting research with the right audience: for example, Dr Hing's broadcast on Actifuse™ bone grafts during an episode of BBC's 'Bang Goes the Theory' (Broadcast in March 2013) which had an audience of 4m viewers.

c. Strategy and plans

QMUL and SEMS are currently developing a new Strategic Plan for 2015-20 that builds on the approach to impact within the 2010-15 plan. Specifically, that QMi becomes financially self sustaining as a service for the commercialisation of research via licensing, generation of revenue from IP and spin-out companies. Success will be dependent on identifying a steady stream of innovative and exploitation-ready research. Over the REF period SEMS research has generated 41 patents, supported 7 licensing agreements with commercial organisations and received over £1.7 million for proof of concept studies, for example from Heptagon or i4i. Furthermore, 4 QMUL spin out companies have been supported with combined investment totalling over £24 million. This research provides a vibrant pool of technology ripe for exploitation and impact-generation in the post REF period with examples of key technology development indicated below.

SEMS staff are engaged in research currently at an early stage in the exploitation pathway that is likely to generate significant impact in the post REF period. The SEMS and QMUL mechanisms described in section b will be used to drive impact generation from these projects over next 5-10 years. Examples include Turbocardia (development of cardiac assist device - £880k funding by NIHR i4i), the spin-out Degrasense (Point of care monitoring system for periodontal disease), research to reduce aircraft noise and research to improve the efficiency and cost of photovoltaic solar cells.

The newly established Institute of Bioengineering will be key to generation of impact in the post REF period and supports an academic **Associate Director for Exploitation & Technology Transfer** to drive exploitation of technology and translation into health impact. A parallel development is the establishment of a Therapeutic Innovation Centre – a first-in-man clinical trials facility jointly between QMUL and Barts Health Trust which will enable early translation of biomedical engineering devices into clinical use.

d. Relationship to case studies

The case studies all demonstrate mature impact with major significance and reach and are examples of the successful approach taken by QMUL to support impact over the past 20 years. This and our current structures (b – above) inform our future plans (c – above). The case studies include two Biomedical Engineering & Materials spin out companies, **ApaTech™** (CS-1) and **Bone Regeneration** (CS-2) which have generated significant economic and healthcare impact. The third case study (**Fracture modelling**) provides an example of the development of engineering tools that enhance competitiveness of existing industry, namely pre-blasting fracture prediction modelling methods that are widely used in the multi-billion dollar mining and extraction industries with major economic, environmental and safety impact.