

<p>Institution: QUEEN MARY UNIVERSITY OF LONDON (QMUL)</p> <p>Unit of Assessment: B11 Computer Science and Informatics</p>
<p>a. Context: The School of Electronic Engineering and Computer Science's (EECS) research activities fit within the EPSRC ICT theme, covering the wide spectrum of activity from theoretical computer science to antenna engineering. In our REF Impact preparation we worked with 12 quality cases, representing all 8 groups, these being (bold this UoA):- (A) Ultra wideband antennas and propagation (Antennas); (B) Music Informatics and Sonic Visualiser (C4DM); (C) Automatic mixing for audio and music production: MixGenius spinout (C4DM); (D) Efficient and Scalable Video Coding – aceSVC (MMV); (E) Measuring Actual Experience to Improve Networked Applications and Services: Actual Experience Ltd. Spinout (Networks); (F) Automatic memory safety verification for critical software- Monoidics (Theory); (G) Cognitive Science Research and Chatterbox (CogSci); (H) Facing up to robots (CogSci +Vision); (I) Causal Bayesian reasoning in critical decision making: AgenaRisk (RIM); (J) Multi-target tracking and scene analysis (Vision); (K) From Behaviour Analysis to Re-Identification and Vision Semantics Limited (Vision); (L) Semantic Web for Music (C4DM). Brief summaries of all these can be found at EECS Impact and are exemplars of our impact agenda which can be categorised as: (i) Direct research for industry to assist in product/service development or to take new concepts to market; (ii) EECS Academic staff engaged in spinout activities, some via QM Innovation Ltd and its investment partner IP Group; (iii) Public engagement of CS and EE, particularly aimed at young people and career opportunities; (iv) Developing the capacity for industrial collaboration in academics, postdocs and PhD's via training initiatives such as ImpactQM; (v) Leadership in industrial/creative sector activities such as Digital Shoreditch, Tech City and Creativeworks.</p>
<p>b. Approach to impact: The pursuit of impact is embedded in the design of research centres and the EECS ethos, training programmes, business development support, mentoring and appraisal schemes. Indeed QM 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 <i>QM Innovation Fund</i>. Launched in 2012, this flexible internal fund encourages industrial collaboration by enabling staff to realise the impact of their research via support of up to £10k per project. EECS has had 13 projects valued at £105k and illustrates how we encourage our researchers to find an audience beyond academia which is further exemplified by:</p> <p>1) Support for interdisciplinary research: Applying our core ICT expertise into new disciplines offers a wide range of routes to impact, and we currently work with (bold groups submitted in B11):</p> <ul style="list-style-type: none"> • Psychologists: developing mathematical models of human vision and human errors in software (CogSci, Theory). Case studies F,G,H. • Musicians & Actors: producing better music/performance (C4DM, CogSci). Cases B,C,D,L. • Mathematicians: developing theories of network traffic and other complex interacting systems (Networks, RIM, Theory). Case studies E,F,G. • Medical researchers: designing new monitoring techniques and to decision making strategies (RIM, Antennas). Case studies A,I. • Lawyers: to find ways to simplify risk and probability to juries (RIM). Case studies I. <p>Collaboration between research groups within EECS and across all three QM Faculties is also an important aspect and we encourage this through several mechanisms:</p> <ul style="list-style-type: none"> • Media and Arts Technology (MAT) Programme, an RCUK £6m Centre for Doctoral Training (Healey & Sandler as co-directors) that builds on QM inter-disciplinary links including: Business and Management; Geography; Film; Drama. • The creation of the Centre for Intelligent Sensing in 2012 bought together 30 academics from six schools within QM along with major industrial collaboration (see section 2 below). • qMedia played a key role in QM's successful £5m AHRC Knowledge Exchange hub bid 'Creativeworks' with EECS focus (led by Plumbley) on "London's Digital Economy" and "Engaging London's Audiences". Creativeworks London is a consortium of 38 London-based universities, colleges, museums, libraries and archives, led by QM to offer CPD, business advice and mentoring to arts and culture professionals, and to enhance networking and collaboration between universities, industry and the wider community. • Allocation of PhD studentships from College, EPSRC and Erasmus Mundus funding encourages bids based on <u>new</u> interdisciplinary activities both within EECS as well as College

wide. Since 2009, 19 collaborative studentships have been established with five external QM Schools, as well as five studentships forging new links between EECS research groups.

2) Support for industrial collaboration: QM's Business Development Team (comprising 9 staff) supports EECS in its relationships with businesses and other external organisations, seeking resonance between academic strengths and business needs. From 2009-13 the flagship vehicle for supporting industrial collaboration has been ImpactQM, QM's £2.9m EPSRC KTA. The distinctive aspect of this EECS-led project was its emphasis on developing the capacity for industrial collaboration in academics, as well as providing a seed-bed to support the application of technologies. This enabled PhD students to undertake industrial placements during their PhD and for staff to be released from teaching in order to engage with users and achieve industrial application for their research. For EECS it provided significant support to three early career researchers (eg Reiss: case C) as well as to enable seven more established staff to demonstrate the feasibility of a spin-out company. It helped determine the critical application path of work on security thus supporting our role in EPSRC's Institutes for Cyber Security. ImpactQM supported a range of small traditional projects with industrial partners (16 in EECS with a total spend of £1.37m). In addition to ImpactQM, EECS encourages industrial collaboration activities through its Industrial Board activities ([EECS IB](#)) as well as:

- Founding qMedia a new QM research centre of more than 20 academics and more than 100 researchers with links to researchers in commercial law, drama, geography, business & management. The Centre has developed extensive links with east London's [Tech City](#) including the qMedia Open Studios as part of the Digital Shoreditch Festival's in 2011-13 and being a founding partner for the event. Sandler (EECS) is QM's Strategic Lead on Tech City, with the remit to broaden engagement to include as many components of QM as possible.
- Founding the Centre for Intelligent Sensing (led by Cavallaro), which has attracted 18 industrial collaborators since its launch in 2012, with companies such as Philips, Thales, IBM, Ocado, Google, BBC and Honeywell. For its 2013 EPSRC CDT bid (reaching the final round) the Centre attracted £3.4m industrial support (cash, +£2m in kind), and its innovative "Smart Campus" concept will be implemented through an industry and QM joint funding initiative.
- In December 2012 QM established a strategic partnership with IBM to support existing activity and horizon scan for opportunities in research, teaching and recruitment, and this is one of 12 such IBM partnerships with UK universities. For EECS, the main collaborative activity is in the area of Cloud Computing and Big Data within the Networks group. With the support of IBM, EECS is currently developing a new MSc in Big Data to be launched in 2014.
- Supporting staff to apply for Royal Academy of Engineering Industrial Secondment Scheme: Bryan-Kinns in 2012 (six months Togeve Ltd); Alomainy in 2013, (six months NPL).

3) Support for knowledge transfer: QM Innovations (QMI) drives the knowledge transfer strategy and promotes enterprise and innovation, with investment support from the [IP Group](#). Its 11 staff, including two technology transfer specialists focused on the Faculty of Science & Engineering, identify and protect new IP, help to secure proof of concept funding to develop new technologies, and support the commercialisation of research-derived technologies through licensing and new spin-outs. Since 2011 staff seeking to commercialise research are able to access QMI's Proof of Concept fund (£400k pa) for projects that lead to commercial milestones and EECS has had 6 awards totalling £167k. In the REF period, QMI has supported 267 (EECS=68) new inventions identified across the College and 79 (EECS=26) new licenses of technology to industry. QMI manages a portfolio of 12 (EECS=4) spin-outs which over the REF period have attracted more than £45m (EECS=£8.2m) in external venture capital investment. Of these EECS spin-outs Actual Experience (AE) (case E) was the 2012 IET Innovation Award winner in the Information Technology category. A critical factor in the success of this and other spinouts is our support for the lead academic, via much reduced teaching duties during the initial start-up and early years of gestation. Social media is a rapidly developing industry and our Chatterbox Analytics spin-out, (case G), illustrates how rapidly we were able to propel this from company launch in 2011 through the support of QMI via both its Proof of Concept funding (£53k) and Innovation funding (£10k) programmes. In September 2013 Distefano's spin-out Monoidics (Case F) was acquired by Facebook to improve their code base quality and security. Within Facebook, the verification technology originally designed will impact over a billion users.

QMI also offers the [QM Bioenterprises Innovation Centre](#), a 39k sqft building, offering commercial lab and office space providing new ventures incubation support. A 2012 occupant is Mediwise, a

microwave medical instrument start-up created by two previous Antenna Group PDRA's, and which is currently collaborating with group members through use of their world-class laboratories. We encourage staff with "near spin-out research" to apply for the RAEng Enterprise Fellowships. In 2012 Reiss, took up a fellowship for one-year. As a direct result of this fellowship Reiss has been able to establish spin-out MixGenius (Case C) with £180k investment, and in June 2013, received an additional £960k in funding from several venture capital firms, based on a valuation of £1.9m.

4) Support for public engagement (PE) and media relations: EECS are national and international leaders in CS outreach with Curzon and McOwan's "CS for Fun" www.cs4fn.org, at £661k EPSRC's largest-ever grant in science PE. With a magazine print run of 31,000, it is distributed in the UK, and to 80 countries, with partner universities in the UK and overseas. Since 2008 cs4fn has been supported by awards from Google totaling >£120k, with the website having over 1 million visits with >890,000 PDF downloads. Specific beneficiaries are secondary school students and their teachers with over 1000 UK schools requesting physical magazines. We have given STEM inspirational talks to >20,000 children in schools since 2008 and interacted with >10,000 more at science festivals. We have used cs4fn to tackle specific issues such as under representation of girls on computing courses. In a 60-page booklet we use women as role models by describing their research in an exciting, accessible way. In the 2010 year of publication, the PDF version was downloaded 52k times (now >75k times). Nationally we were founder members of the Computing at School initiative and were actively involved with the DoE in changes to schools ICT curriculum. We run local CPD courses for teachers plus invited sessions at teacher CPD workshops. This leadership is recognized by McOwan's £3m project Teaching Enquiry with Mysteries Incorporated (TEMI) to teach enquiry-based learning across Europe and his 2011 IET Mountbatten Medal for "Excellence in communicating Computer Science to diverse audiences". In 2013 we received a £450k grant from the Mayor of London's School Excellence Fund (in collaboration with KCL) to support CPD and cs4fn activities. EECS's full-time publicity officer works with the QM Centre for Public Engagement (CPE), headed by McOwan in his role as Vice-Principal for Public Engagement and Student Enterprise. CPE is an initiative to grow, support and embed PE across QM, supported by a RCUK Catalyst award to McOwan (£300k) and earmarked HEIF5 funds, there is now around £1m set aside for PE from 2011-2015, with dedicated support staff team. QM'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 via press releases, and social media. It provides media training and coordinates '[Find an Expert](#)', a QM web searchable database of staff research expertise.

c. Strategy and plans: EECS's headline strategic aims are to broaden and deepen our major research strengths. A significant part of our research is integrated within, and a contributor to an innovative cultural sector, and we want to make QM the premier institution for digital economy research. Through continued investment we will orientate more of our research activity closely with the creative industries exploiting our position in London (see REF5). The Media & Arts Technology CDT, Tech City and *Creativeworks* are expected to lead to further collaborations between EECS researchers and the cultural and creative industries. We will also exploit and encourage assistance from QM structures (Public Relations, CPE, QMI, Business Development Team).

We will widen our interdisciplinary reach through the creation and participation in new centres and institutes such as our Centre for Intelligent Sensing and QM's new Life Sciences Institute, covering key EPSRC priority areas of Data to Knowledge, Next-generation Interaction Technologies, Autonomous Systems & Robotics, Engineering for Life & Health. To get early access to industrial thinking to "shape" our research we will widen the activities of our Industrial Board Panel and our industrial visiting academic body as well as increase (eg through credits for research and impact-related activities on the staff workload model) the already significant input from EECS academics on standards bodies, professional societies, and funding bodies. Within QM Impact and public engagement are now recognised as criteria for promotion.

d. Relationship to case studies: The Monoidics spinout exemplifies both our long-term commitment to working on industrial problems in theoretical CS in collaboration with industry (eg Microsoft). The Chatterbox spinout exemplifies the value of QMI support including its Proof of Concept funding. The Semantic Web for Music case study exemplifies our leadership in this rapidly growing industrial/creative sector of the UK economy. The AgenaRisk case study highlights our strong commitment to interdisciplinary collaboration, leading to both economic and societal impact.