Institution: University of Bath

Unit of Assessment:

13 Electrical and Electronic Engineering, Metallurgy and Materials

a. Context

The Unit has a strong culture of engagement with research users and beneficiaries. Our research is structured into three centres: the Centre for Advanced Sensor Technologies (CAST), the Centre for Space, Atmospheric & Oceanic Science (CSAOS) and the Centre for Sustainable Power Distribution (CSPD) and addresses important topics in security, the environment, energy sustainability, and healthcare. Our main non-academic user groups are industry, which covers large national and multinational corporations through to SMEs, national laboratories (e.g., National Physical Laboratory), NGOs and charities (e.g., The General Lighthouse Authorities), government agencies (e.g., Defence Science and Technology Laboratory) and professional practitioners including clinicians. The main user groups for CAST's research are the semiconductor and lighting industries, developers of solar power technology and the medical and biosensor communities. CSAOS research benefits user groups in the telecommunications industries, satellite and space companies and the Met Office. The main user groups for CSPD are the power companies and energy infrastructure providers such as National Grid.

b. Approach to impact

Our approach to impact is to place a strong emphasis on engagement with key users and beneficiary groups, whilst simultaneously exploring new commercial opportunities. The success of our approach is evidenced by three external prizes: *the 2009 Rushlight Power Generation and Transmission Award; the 2010 TSB Award for the Best KTP building on EPSRC funded research and the 2010 SET for Britain Engineering and Westminster Medal.*

The significance of our research is evidenced by our reach into industry, government policy and legislation, while simultaneously engaging public interest in science and technology. Exemplars include: the development of a novel device for GPS interference detection, commercialised into a new international product by a UK company; understanding and raising awareness at national and international level of the threat posed to technological systems by space weather; improving the pricing of electricity distribution through the development of a new pricing methodology; working with clinical providers to enhance imaging services for the healthcare sector; engaging public interest through television, radio, web media and science exhibitions.

Here we set out our main routes to impact:

(i) Partnerships with industry

Close relationships with industry are facilitated through collaborative R&D projects funded by the European Commission, the Technology Strategy Board (TSB), the University EPSRC Knowledge Transfer Account (KTA) and Impact Acceleration Account (IAA), consultancies and spinout activities. Comprehensive support and guidance is provided by the Unit and university Enterprise and Knowledge Exploitation Team (E&KET). As a result our academics have lead nine TSB Projects and Knowledge Transfer Partnerships (KTPs) during the past five years. An exemplar of such a relationship with UK SME Navtech Radar Ltd was led by Watson, winning the TSB award noted above. Two further multi-million-pound TSB projects (GAARDIAN and SENTINEL) led to the development of a fully-commercial GPS product with UK SME Chronos Technology. **Our Unit provides funding to assist staff to start new industry collaborations, demonstrating our agility to respond to new opportunities.** This has, for example, facilitated new interactions with Seiche Measurements Limited (Blondel on underwater acoustic surveying), Industrial Tomography Systems (Soleimani on new non-invasive imaging technologies) and Perpetuum (Bowen on energy harvesting technologies). Each of these led on to KTPs. The Unit also provides professional *training to industry* in power system engineering and between 2008 and 2013 it has provided Continuing Professional Development training for over 300 engineers**.**

(ii) Generation and exploitation of intellectual property

Staff work closely with the university E&KET which provides an interface between academic staff and external parties to produce and exploit intellectual property (IP). The Unit has generated patents and exploited IP through licenses, for example with Energy Companies including Western Power Distribution. This work on electricity pricing by Li was awarded the 2009 Rushlight Power

Generation and Transmission Award. **Researchers are given all of the necessary support to translate their basic research into commercial opportunities**. For example, in 2008 Wang was supported by the E&KET to develop the spinout company NanoGaN which produces Gallium Nitride wafers. NanoGaN has now joined with IQE (the leading global supplier of advanced wafer products and wafer services to the semiconductor industry) and IQE/NanoGaN provides a strong industrial focus for research activities in CAST.

(iii) Contributions to policy-making and user bodies

Staff are strongly encouraged to engage with policy-makers and user bodies. C Mitchell served on the European Space Agency Galileo Science Advisory Committee (2009-2012) and the Royal Academy of Engineering Space Weather Committee (2012-2013); Blondel serves on the British Standards Institute (BSI) committee EH/1/7 Underwater Acoustics (2013); Li is the Chair of the IEEE Working Group on Network Charging (2013). Local Enterprise Partnerships (LEP) have opened a new route for our researchers to engage with industry. Allsopp is a member of the High Technology Sector panel of the West of England LEP. Interaction with non-industry users is also encouraged – for example a university KTA Fellowship was awarded to Smith that enabled him to work with clinicians in Bath and Bristol to improve techniques for the early diagnosis of dementia.

(iv) Public engagement

Staff within the Unit have been supported by the university's public engagement team to undertake a number of high-profile projects. NJ Mitchell made a series of broadcasts in 2010 on BBC Radio 4's The Material World (the most listened-to science programme on UK radio). This was as part of the programme's 'So you want to be a scientist' competition and culminated in a finale at British Science Association festival in Birmingham. The competition cast NJ Mitchell as mentor to an amateur scientist and followed them over several months as they carried out an experiment to investigate the night-to-night variability of noctilucent clouds and interacted with the audience through Facebook. NJ Mitchell also appeared on BBC Scotland's Midsummer Live (2013). C Mitchell ran an exhibition on 'Space Weather and Antarctica' at the Science Museum in April 2013 – an 'Antenna Live' exhibition where children can hear about exciting opportunities for careers in science and engineering.

v) Mentoring, training and professional support for staff

New staff are mentored by more experienced colleagues and given additional help through an internal peer-review of all grant applications. Training is provided through professional development courses, allowing researchers to further their knowledge and perspective on impact. An example of this (in 2009) was C Mitchell attending the London Business School courses on Innovation and the Business of Science, supported by the Royal Society Wolfson Award (2009-2014). This led to C Mitchell taking the role of 'KT Champion' for the Unit – one of 17 academic staff across the university with the responsibility for promoting knowledge exchange activities. **Staff are also rewarded for impact activities by the criteria for career progression and promotion being specifically aligned to research impact.**

c. Strategy and plans

Our impact strategy is to engage, develop and deepen our relationships with end users and to foster engagement with new ones. This strategy has been informed by successes within our developing impact agenda, including those described in our submitted case studies. We recognise the value of trust in our research partnerships and for that reason a key aim is to continue to ***build and maintain long-term relationships between our research Centres and their user partners.*** Each research Centre leader is responsible for ensuring impact activities are fully encouraged and supported within their Centres. We also are keenly aware of how quickly some user needs can emerge and change. This has led to agility in our approach and we have increased ***start-up internal funding to support new impact activities.***

There are four key elements to support our strategy:

(i) Management and Training

We will create a pool of Impact Mentors, drawn from KT Champions and academics who have demonstrated impact through the submitted case studies. They will ensure that our impact strategy, plans and goals have prominence throughout our academic management structure. Within the Unit we believe that it is vital to recognise that research impact is often achieved through large multi-institution teams working towards a common goal. We provide management training and support to enable our staff to lead these large, collaborative projects that bring the user community in at an early stage to assist in research planning. Examples of such projects, already

led by our Unit staff include projects funded by the European Space Agency (with surveying company, Fugro), Technology Strategy Board (with semiconductor company, IQE), EPRSC (with global leader in communications test and measurement, Spirent) and NERC (with designer and manufacturer of satellite systems, Astrium). All staff within the Unit will continue to be offered training in research impact and will be kept aware of the University, Faculty and Departmental resources that are available to support impact-related activities. The Unit's staff are recognised in both their workload and career progression for impact related activity. **Our goal is to have all of the Unit's staff trained in research impact management by 2018.**

(ii) Early Identification and Engagement

Our goal is to identify potential for impact at the earliest possible stage through stronger engagement with the University's E&KET, which will provide a detailed review of research grant application *pathways to impact* plans. To further assist this, there is a new University of Bath web-based tool, developed in 2013, that enables the researcher to broaden their horizons on the potential impact of their research. In addition, research Centre leaders will ensure that research support funding will be targeted towards staff wishing to engage in new impact initiatives, for example to build a new relationship with a company. Staff in this Unit will also continue to be encouraged to take up consultancy opportunities to engage with new research beneficiaries.

(iii) Secondments and Fellowships

Inward and outward secondments will build closer industry links, supported through University funds and external research grants. One such activity is already underway through the secondment of Jackson from the Met Office to CSAOS. The University operates a sabbatical scheme and staff from the Unit will be encouraged to apply for sabbatical leave and for secondments and fellowships, with particular emphasis on building a closer relationship with industry and end-users. **We aim to increase the number of secondments/fellowships within the Unit, year on year, to 2018 so that each Centre will have two such activities at any time.**

(iv) Horizon Scanning

We look forward to supporting staff to lead new projects with strong user engagement through the forthcoming EU Horizon 2020 programme**. A key element to our strategy is horizon scanning for opportunities in engagement, through our KT Champion. The potential for future research impact from two of our ECRs has already been identified though this approach.** Forte has forged a strong relationship with Thales Italy and the potential for Bath's research into ionospheric mitigation for GPS navigation to impact on the next generation aircraft landing systems is being supported through Unit funding and though a new European FP7 grant starting in 2014. Yuan's superconductivity research has already been recognised by a Royal Academy of Engineering Fellowship. This has clear potential for future impact and will see investment in a new superconductivity lab to showcase and demonstrate novel low-carbon technologies in power systems. The lab is intended to attract industry partners such as Rolls Royce, Williams and EADS. **These areas are a key target for investment over the next five years.**

d. Relationship to case studies

Each of the three case studies have benefitted from our approach to impact outlined in section (b), demonstrating our ability to foster long-term relationships and to deliver high-impact results.

Case study 1 "Space-Weather Awareness" This benefitted from the Unit's support for (i) Partnerships with industry (ii) Generation and exploitation of intellectual property (IP licensing of Space Weather (MIDAS) algorithms) (iii) Contributions to policy-making and user bodies (Royal Academy of Engineering and the European Space Agency) (iv) Public Engagement (with the Science Museum) v) Mentoring, training and professional support for staff (London Business School courses).

Case study 2 "Policing the radio spectrum to protect critical national infrastructure" This benefitted from the Unit's support for (i) Partnerships with industry (maintaining the long-term relationship with Chronos Technology Ltd) (ii) Generation and exploitation of intellectual property (through the licensing of jamming detection algorithms) (iii) Contributions to policy-making and user bodies (through raising the awareness at UK Government and international level).

Case study 3 "Economically Efficient Network Charging" This benefitted from the Unit's support for (i) Partnerships with industry (including the key relationship with Western Power Distribution) (ii) Generation and exploitation of intellectual property (through the IP licensing of LRIC software) (iii) Contributions to policy-making and user bodies (including the leading role in the IEEE Working Group on Network Charging).