Institution: University of York

Unit of Assessment: 13, Electrical and Electronic Engineering, Metallurgy and Materials

a. Context

Impact in the Electronics Department is informed by the demands of industry, society, our skills base and funding opportunities. Our *skills base*, allows us to maximise impact based on excellence within the department. We collaborate extensively with relevant industrial partners to ensure the best combination of skills and increase the potential of our impact. From *a funding perspective*, we target opportunities and exploitation routes coordinated via the Departmental Research Committee (DRC), that are cognate with our skills set and often in collaboration with others (both academia and industry) and with our spin-out companies.

From an *industrial perspective*, our impact drives, for example: improvements in mobile communication provision; design and measurement of the latest technology and equipment; design and measurement of more realistic acoustic experiences; Continuing Professional Development (CPD) training to industry.

From a *societal perspective*, there are a number of drivers that our impact focuses on, for example: effective healthcare provision producing better informed clinical practice; effective national defence provision; low power, efficient electronic devices; public dissemination.

b. Approach to impact

Our interactions and subsequent impact with industry (who are both users and beneficiaries of our research) are driven by individual research expertise and contacts made through research activities and through our Research and Innovation Office (RIO). Interaction, and impact, with the wider community is achieved by actively participating in, and organising, public events such as open lecture series and National science events. For sustained impact, our approach focuses on developing these interactions and we follow-through on appropriate themes being agile, where appropriate, to align our research efforts to relevant problems and issues. We have appointed a Departmental Impact Office to co-ordinate impact related activities and report to the DRC.

Development of Relationships: We have utilised the RIO which provides rich and exciting contacts where our research can be transformed into meaningful impact. RIO funds have enabled the Department to develop relationships with important non-academic organisations. Examples of the contacts developed are outlined below.

National: Members of the Department interact with various national industrial, medical and other relevant users. As well as engaging with users through journal and conference publications, the Department encourages researchers to pursue initiatives and funding that will enable additional and innovative interactions. For example, in 2010 *Tyrrell* was awarded a Yorkshire Concept 'Proof of Commercial Concept Fund' to move work on semiconductor cell design to commercialisation and which led to discussions with a number of leading semiconductor companies including ARM, Xilinx and IBM. This subsequently led to the formation of the spin-out company ngenics Global Ltd in 2012.

European: Engagement with European researchers and industry is pursued through participation in EU projects and wider groups, for example *Timmis* participated in the development of the 'Fundamentals of Collective Adaptive Systems' proactive initiative for the EU. In addition, we encourage, through direct funded support, the use of user groups from projects that researcher are involved in at the European level. For example, in Bungee project, interaction with their user group has led to the development of communications standards - ETSI Broadband Radio Access Networks (BRAN) (*Burr, Grace*).

Internationally: Researchers are encouraged by the Department (through funding support, short term load arrangements and longer-term sabbaticals) to interact with International institutions and companies and participate in International scientific events. For example, *Grace* co-organised the Summer School on Cognitive Communication in Zhejiang, China in 2010, with support from Huawei and significant funding from RCUK.

PhD studentships: Through encouraging collaborative PhD studentships, relationships have

developed and have enabled the initiation of underpinning work that can be exploited in the future. Partners co-funding studentships have included: Dstl, NCR, BT, Roke Research and BAE Systems.

Research Fellowships: Relationships have been achieved through a number of externally appointed fellowships. For example, *Everard* held a Royal Academy of Engineering Professorship (2007–2012) with significant input and continued interactions and exploitation with BAE Systems resulting in the development of novel radio frequency equipment now in use by the US Air Force. *Smith* was awarded a RAEng Enterprise Fellowship (2013–2014) which has already led to increased clinical deployment of his work; *Hirohata* was awarded a Royal Society Industrial Fellowship (2013–2017) to further develop relationships with Hitachi; *Timmis* was awarded Royal Society-Wolfson Research Merit award in 2011-2016 which has enabled developments in relationships with Dstl, IBM and the biosciences discipline.

Sustaining Relationships: For our research to be relevant to our users and beneficiaries we put in place various methods to allow continued and fruitful interactions and for their input to assist in the drive of projects. For example, at the Departmental level we have an active Industrial Advisory Board (IAB) which includes long-term partners of the department including: Roke Research, Nestle, Oxford Digital, Electronics Yorkshire, York EMC services and BAE Systems (e.g. *Marvin* has continuously worked with BAE Systems for 10+ years). At the individual project level we facilitate these interactions with Steering Committees (SC) that include industrial members, that help guide the research, and give a strong industrial perspective to the work (for example, a recent EPSRC Platform Grant within the Intelligent Systems group has members from ARM, NMI, Roke on its SC). Beyond these "project-lead" mechanisms:

Departmental support: At their biannual meetings the IAB assist in the identification of potential impact from the research and suggest mechanisms for the Department to exploit and to move that work forward. The Department provides financial support (an average £90,000 per year for the academic and research staff) to initiate and maintain collaborations. For example, initial funding was provided to *Smith* to initiate collaborations with Liverpool hospital which helped lead to the development of collaborations for commercialisation activity. Flexibility within administration roles is given, allowing members of staff to take advantage of opportunities that can be exploited when appropriate.

Impact from Relationships: Through our Department Impact Officer, we review opportunities with the RIO on a regular basis to ensure potential impact is identified and appropriately protected and exploited.

Intellectual property: 12 patents have been filed in the period, developed from our research. Patents are one mechanism for the Department to establish a base for commercialisation of our research in the future. We exploit our IP through spin-out opportunities, which are currently at various stages of development. At present, there are 4 ventures on-going. As an example, *Xu* formed Bostech Ltd in 2011 to support the development of novel hybrid semi-conductor materials. The Acoustic Experience Company was established (2010) by *Murphy* in collaboration with Cartezia to develop license agreements (initially with Sonalksis) in the area of architectural acoustics.

Development of Standards: For example, through international networks established with National Institute of Standards and Technology (NIST), work by *Marvin/Dawson* on shielding measurement has contributed to the new IEEE Standard 299.1 concerned with measurement of electromagnetic shielding of equipment enclosures.

Facilities and technical support: In order to provide impact, the Department requires appropriate facilities and technical support. For example, the audio anechoic room was upgraded to a six-sided space. This attracted Sontia, a local audio specialist SME, to make extended use of the facility for loudspeaker testing with additional links building. As a further example, our newly refurbished clean-room, together with the JEOL Nanocentre provides facilities for device fabrication underpinning work with companies such as Hitachi.

c. Strategy and plans

Our strategy for impact to this point has been to produce research which both informs and is

informed by appropriate user groups and potential beneficiaries. We plan to continue these mutually beneficial relationships, and use our experience from building and developing these successful relationships to shape our future strategy.

We aspire to embed a culture of impact that underpins activities from fundamental research to practical application that make significant impact in industry, medicine, commerce and wider society. To achieve this, the Department Impact Officer has responsibility to monitor and promote impact activities within the Department.

Development of Relationships: We will continue to foster new relationships across industry and relevant agencies. This will be achieved by greater integration with the RIO and focused activities of the new Impact Officer. We will encourage, where appropriate, staff to focus research activity towards translational potential according to their skills and interest. Advice will be sought from research group leaders during their 6 monthly review meetings, outcomes of which will be reported to the Impact Officer. Our Impact Officer works closely with RIO, to ensure fundamental research will be given a clear route out from the lab to appropriate beneficiaries.

Sustaining Relationships: Our spin-out companies provide a natural channel for interactions with appropriate users and beneficiaries and we plan to make further use of these in the future opening opportunities for researchers outside the direct company business. We plan to continue to facilitate the IAB and SCs which will consolidate current interactions with potential users, but additionally we plan to review the membership of these groups and allow our research to guide membership. Following on from the Royal Academy of Engineering annual Soiree at York in 2013, where our impact activities were highlighted, we plan annual impact events to sustain and expand our potential user base.

Realising Impact: We will ensure that the impact agenda is nurtured in staff over time, through the use of Departmental research focussed activities (e.g. away days, meetings, sandpits). These activities will include members of the RIO to provide input relating to the impact agenda. Additionally, we will invite participation from industrial collaborators we have strong relationships with. The DRC will continue to monitor the effectiveness of these by considering industrial input on research proposals, industrially sponsored research and spin-out activities.

Pathways to impact: Six-monthly meetings will take place to assess potential pathways to impact. Identified opportunities during these reviews will be passed to the Impact Officer and RIO for further action. The success of these impact activities will be monitored by the DRC. At least once a year, all research groups will focus on impact as part of their meeting agenda, involving members of the RIO.

d. Relationship to case studies

Our impact strategy has been informed by on-going developments during the review period. For example, work through a University spin-out, York Electromagnetic Services (YES), by *Marvin* (YES Technical Director) allowed **development** of relationships with Intel to fund the creation of novel measurement equipment. Subsequent internal funding and continued collaborations through YES **sustained** these relationships and thread of work and allowing it to expand into areas of novel materials and smaller enclosures. This development over many years now sees **impact** through this work being incorporated into the new IEEE P299.1™/D5 Draft Standard Method for Measuring the Shielding Effectiveness of Enclosures and Boxes Having All Dimensions between 0.1 m and 2 m. This experience informed our strategy.

An example of demonstrating our strategy is work by *Smith* on the development of neurodegenerative diagnosis and monitoring. The relationships were **developed**, with assistance of the RIO, through a White Rose Health Innovation Project award, and **sustained** via a Yorkshire Forward Enterprise Fellowship, funding from Parkinson's UK and a Royal Academy of Engineering Enterprise Fellowship. This enabled **impact** and the work to progress from proof-of-concept to a multi-centred clinical study.