Impact template (REF3a)

Institution: University of Reading
Unit of Assessment: 13 Electrical and Electronic Engineering

a. Context

The UoA's applied research has a wide range of beneficiaries including SMEs and large corporations, the health and public sectors, government, charities, and museums. The UoA works closely with companies from a wide range of industrial sectors to achieve economic impact (e.g. 40 Knowledge Transfer Partnerships (KTPs) in the REF2014 impact period amounting to gross profit (£1.35m), exports (£3.17m), and spend to support R&D (£1.83m) within the KTP project periods, and further estimated benefits to the UK economy of gross profit (£12.2m) and exports (£16.2m) within three years of the project ends.

The UoA's coherent approach to achieving impact exploits the output of the UoA's three research groups: (1) Systems Neuroscience (2) Cybernetic Intelligence, (3) Information and Communication Technologies, and two special-purpose research units: (4) Centre for Intelligent Systems and (5) Infrared Multilayer Laboratory (IML). These groups work together to reflect national and international priorities in four cross-disciplinary themes:

Digital Society: the main impacts are in industry (e.g. through higher profits and cost savings in the media industry and in the NHS) and across society and cultures (e.g. through assistive technologies and through e-learning resources deployed in both developed and developing countries.)

Energy and the Environment: the main impacts are in the energy sector (e.g. through development of control methods for next generation energy networks, more efficient power electronic systems and carbon footprint modelling); among the general public (e.g. through improved understanding of climatic change based on new Earth observations made with the UoA's infrared optical filters for spacecraft (e.g. http://bit.ly/17QPePo); and in cultural heritage (e.g. through the study of artefacts and wall paintings using terahertz imaging).

Health Technologies: the main impact is on health services (e.g. improved rehabilitation for stroke patients, support for older people living at home via social/carer robots (http://bit.ly/Ho0Wcc), and early diagnosis tools for warning of the onset of tremors in Parkinson's disease.)

Security: main impacts are on security practitioners through improved software tools and processes for secure communications and to perform threat detection in urban environments (e.g. http://bit.ly/HCOvsP, http://bit.ly/17Kbtst).

b. Approach to impact

The UoA actively encourages staff to seek out collaborations with appropriate users, beneficiaries and audiences through a multi-stranded approach.

1. **Maintain strong links with industry through formal mechanisms**. An Industrial Advisory Board (IAB) ensures the UoA remains responsive to the needs of industry; the IAB includes representatives from Sony, Cisco, Thales, Microsoft, IBM (chair), Microchip and Eli Lilly, and meets every three months in person and monthly virtually, in addition to annual 'away days'. Active involvement of staff with the IAB has directly facilitated impact development (e.g. through invitation by Thales to the 2008 MOD Grand Challenge, which resulted in the award for the Best Use of National Talent). Staff are also encouraged to take industrial secondments (e.g. 2010-11 Royal Academy of Engineering secondment for Becerra at Ford which has directly led to improved gasoline engine operation for production vehicles.) In 2004, the University of Reading was the first UK based academic institution to be a member of the international WiMedia consortium that developed Wireless USB, and launched worldwide in consumer interface products in 2010.

2. **Research groups actively enable external engagement.** For example, by funding UK travel costs to attend specific networking events (e.g. conferences, workshops, BCS/IET, EKTN, LTN, information days, competitions) to engage with practitioners and users of the UoA's research and enhance its potential to inform practice. An instance of this is Bowen's attendance at the 2008 European Optical Society Conference. Chance discussion with Dr Bianca Jackson (then at Centre for Ultrafast Optical Science, University of Michigan, USA) on terahertz medical imagery, led

directly to collaboration with the Department of Archaeology at Reading, and the Louvre, two research awards, and impact in cultural heritage conservation in the UK and abroad.

3. **Make strong use of institutional facilities to support development of impact**. In the REF2014 impact period, 28 academics in the UoA have been involved in a total of 40 KTP projects through the University's Knowledge Transfer Centre (KTC). The KTC is one of the UK's leading KTP centres (as recognised in Regeneris Consulting (2010), Report for Technology Strategy Board – Knowledge Transfer Partnerships Strategic Review (http://bit.ly/18krTJg). UoA's staff expertise is listed by the KTC and used to brief external organisations on staff research and to target potential partners, ranging from charities to SMEs. Successful KTPs have led to continuing and enhanced collaboration and further impact development; for example, a KTP set up with charity Riding for the Disabled Association (RDA) stemmed from discussions after another highly successful KTP project with GAP Activity Projects (which won a Computing for Excellence award) and in itself led to the knowledge gained from this KTP being embedded into other organisations undergoing radical IT transformation. McCrindle won a KTP academic excellence award in 2010, for promoting KTP; this raised the UoA's profile, helped establish links with industry, and encouraged both industry and academics to pursue new projects.

Through the University's Communications Office, members of the UoA receive media training to enable effective and regular engagement with television and radio (e.g. 14/6/13: BBC Radio 4: Nasuto – "Build me a Brain"), social media, the Web (e.g. 13/08/08: BBC News website: "Can robots 'think' like humans?"), print media and public events such as public lectures, Café Scientifique (e.g. 8/6/10: Ferryman – "CCTV: Who's watching you?") and BCS events (e.g. 15/11/11: Warwick – "The Cyborg experiments"). A New Scientist video on Warwick's 'Robot with a rat brain' has attracted 1.85m visits since being uploaded to YouTube in August 2008 http://bit.ly/P1HrC. Staff seek funding for organisation of public engagement events (e.g. Shah: 23/6/12: Turing 100 at Bletchley Park (http://bit.ly/J5FKCP), sponsored by seven companies.

Through the University's Research and Enterprise Development (RED) office, the UoA is supported in funding bids and to follow through research activity to identify impacts; e.g. follow-up activity of EPSRC research by Harwin on haptic visualisation (originally funded in 1997 and 2001), which impacted on teaching of clinical (veterinary and dental) skills, has led to the set-up of a unique laboratory at Kings College Dental School to train students using a skills training system, which won two awards (Bett, Medical Futures), and is being developed into a commercial product.

4. **Collaboration strategically and effectively with other units to meet user's needs.** For example, joint expertise between Virtual Reality in the UoA's Visualisation and Interactive Technologies Centre (VIT-C) (Sharkey) and the University's Department of Meteorology (Gurney) was exploited in the development of a 30 megapixel visualisation wall for the Visualisation Centre at the International Space Innovation Centre (ISIC) at Harwell in 2012. The wall has directly facilitated the exploration and visualisation of the vast amount of earth observation data coming on-stream for scientific, commercial and outreach purposes.

5. **Dissemination of open source software and datasets**. The PSOPT (Pseudo-Spectral Optimal Control) software (Becerra) implements computational optimal control. To date the software, which is currently in 3rd release, has been downloaded 1406 times and is being used for the first Brazilian deep space mission to a triple asteroid system, launching in 2016. The PETS2009 Dataset (Ferryman) has been used extensively by industry and academia for performance evaluation of visual surveillance algorithms and in product development (>40k Google hits on 'PETS2009 Dataset').

6. **UoA staff membership on relevant committees**, enabling research to be utilised and valued by policy makers, as evidenced by, for example, Warwick on Nuffield Council for Bioethics Working Party on Novel Neurotechnologies, Walker as founding member of the Science and Heritage sub-committee at the Royal Society of Chemistry, and Hadjiloucas as Secretary of Instrument Science and Technology Committee at the Institute of Physics.

7. **Specific funding sought to facilitate impact**. An example is the EPSRC funded KT-EQUAL (Knowledge Transfer- Extending Quality of Life) meta-project (2010-2013), specifically set up to ensure that years of investment in high-quality research in ageing and disability is translated into real benefits that have an impact on people's lives. The consortium comprised Principal

Investigators from Sheffield (lead institute), Bath, Cambridge, Edinburgh, Loughborough, Reading and Salford. The UoA was part of the work package that organised and ran events that brought together older people and their carers, researchers, policymakers, and service users to focus on issues that are important to older and disabled people. As well as contributing to and representing the consortium at many events, the UoA had particular organisational responsibility events on Falls Prevention, Digital Identity, Nutrition in Older Age, and Deafness and Hard of Hearing in Later Life.

c. Strategy and plans

In the period 2008-13, the UoA has learnt that impact must be considered at all stages of the research process. This has informed the development of the strategy for the next five years, to include the **setting of realistic impact objectives** alongside research objectives, to **seek maximal impact** (e.g. by identifying new impact beneficiaries; to increase the amount of applied targeted research (via existing beneficiaries); to identify potential impacts early on; to maintain relationships with users and beneficiaries post project completion), and to **enhance measurement of impact** (improved record keeping of research output; reporting and evaluation of impacts as they occur against an appropriately defined set of targets and metrics.)

Strategy development is grounded in a solid management structure which includes School Directors of Enterprise and Internationalisation, training for PhD students and PDRAs on impact, and rewarding staff procedures which include assessment of an individual's contribution to impact.

The main goals for supporting and enabling impact from future research are to:

1. **Ensure impact is embedded in all levels of research** – in postgraduate and postdoctoral training, research-group strategy, and delivery via the University's Research & Enterprise Services in supporting development of research proposals with convincing impact plans.

2. **Strengthen links to user communities** – UoA will: (i) identify new impact areas and beneficiaries on a wider basis; (ii) review membership of the IAB to better share new knowledge and identify areas of research need, and thereby to ensure industrially-driven research with real industrial challenges; (iii) interface with professional societies (e.g. IET, BCS) and international networks (e.g. TSB) to further develop an understanding of business needs; and (iv) be responsive to specific calls by funding bodies for academic-industry collaboration, with a target of £3m of funding in the next five years.

3. **Promote and support enterprise activities** - UoA will establish more diverse ways of exploiting IP via spinouts, patents, license agreements, open source, applications for enterprise funding (follow on funds), and collaborative KTP projects, and aim to increase involvement in such activities, from 50% to 75% of staff by 2018.

4. **Focus on strategic research areas of interest with significant impact potential**. The University has recently expanded the UoA by creating strategic posts in systems neuroscience-related research where significant non-academic impact is expected in new rehabilitation methods and treatments of neurological disorders. The UoA will seek £2m investment in the next five years, from funding bodies, specifically to enable research impact from this and other identified strategic research themes identified under Section a).

5. **Engage with media at all levels and the public at large** - UoA aims to have 75% of research projects engage with TV/radio/print media at local/national level in the next five years to showcase research output, promote debate and inform policy makers.

d. Relationship to case studies

Case Study 1 - **Energy and the Environment (including Space)**: new understanding of climate change brought about by direct collaboration with NASA and ESA using novel IR filters designed and manufactured by the UoA. Case Study 2 - **Digital Society**: development of e-procurement system enabling significant cost savings for the NHS. Case Study 3 - **Health Technologies**: impact of research in brain-computer interfaces, including significant worldwide public engagement. The impact cases exemplify the UoA's approach to achieving impact through collaboration with industry (Case Study 2) and specialised users (Case Studies 1 & 3) as well as directly informing the UoA's approach in media engagement (Case Study 3) and approach to follow-up initiatives (Case Studies 1, 2, & 3).