Institution: Coventry University

Unit of Assessment: 15

a. Context

The Unit's research focuses on three multi-disciplinary groups: Sensing, Safety and Control; Manufacture, Materials and Metrology; Civil Engineering. The **main types of impact derived** from this Unit's research include economic impacts, health impacts and impacts on practitioners and public services.

b. Approach to impact

The Unit has adopted two main approaches to impact: (1) working closely with industrial partners to co-design long-term research collaborations and (2) active dissemination of its research to potential beneficiaries through non-academic channels of communication. The **main beneficiaries** of this Unit's research include research and development departments in multinational corporations and non-commercial organisations. Sectors which are benefitting from the Unit's research include aerospace, automotive and civil engineering, manufacturing, healthcare and social housing.

Examples of how these approaches have led to impact are given below.

(1) Fostering long term collaboration with Industry Partners

The Unit has built strong collaborations with industrial partners over many years, reflecting the University's long-term drive to engage in applied research, collaborate with industry and work on close to market applications at higher technology readiness levels. This has led to impact as the Unit has a) worked together with industrial partners on research projects of joint interest, b) engaged in knowledge transfer, e.g. KTPs, and c) undertaken industrial-led consultancy and training. As an example, **Burnham** has been researching energy efficiency for many years. He started work in 1993 with British Gas on the modelling and control of plants producing Synthetic Natural Gas, and on industrial gas utilisation in the control of high temperature gas-fired furnaces. This led to collaborations with Inco Alloys and British Steel's (subsequently Corus, now Tata Steel) Swinden Technology Centre, and British Steel plants based at Sheffield. Research funding from the Energy Technology Support Unit (ETSU), between 1993 and 1998, an EPSRC Industrial CASE with British Steel and further funding from ETSU between 1999-2002 (£150k) led to the development of a novel four term bilinear control system which was successfully implemented on a production plant in 2003. This led to an energy reduction of 4-5%, saving the plant £300k p.a. in fuel costs. Further improvements were made through collaborative research and PhD studentships. The resulting control system, which had been in operation since its installation, has since been exported to India as part of Tata Steel. Economic impacts arising from this work include the implementation of bilinear modelling and control optimisation of a heating ventilation and air conditioning plant at Abbott Diabetes Care, Oxford, in 2010 realising an energy saving of up to 25%.

Knowledge Transfer Partnerships (KTPs) are an important mechanism by which we generate impact from our research. Since 2008, the Unit has undertaken 15 KTPs (or equivalent regional schemes), with companies including SAIC Motor Corporation Limited (SAIC), Daido Industrial Bearings and Jaguar Land Rover (JLR).

Industry investment and input The Sensing, Safety and Control Group's Industrial Advisory Board, which meets quarterly, is an invaluable network of senior figures from 15 non-academic organisations with whom industrially-relevant proposals are discussed, new research co-developed and research findings disseminated. A number of companies' researchers co-supervise PhD students e.g. Meggitt Plc and NP Aerospace which ensures that research results are fed into industry, and some studentships are directly funded by industry e.g. MIRA, Abbott Diabetes Care and JLR.

Commercial research and CPD for Industry An in-depth understanding of industry needs, together with research expertise in industry-relevant areas enables the Unit to undertake focused research to solve specific problems for its partners. Examples include a £70k commercial research project on exhaust emissions with JLR and research for Protean on vehicle dynamics, in which the modelling of torque vectoring in electric vehicles was undertaken to support the design of electric motors. The Unit has delivered further research for JLR to investigate the feasibility of on-board data capture to generate usable information on tyre performance.

Because of the Unit's expertise in low carbon vehicle technology, SAIC asked it to develop a

bespoke course on this subject for the company's senior engineering staff. The feedback showed the very positive impact of the course on SAIC, who commented: "We were delighted with the course which hit exactly the right level to the issues surrounding and technology employed in Low Carbon Vehicles. The course feedback was very positive without exception".

(2) Proactive identification of new opportunities.

The Unit actively seeks to generate impact by disseminating its research findings at industry-focussed meetings, workshops and exhibitions. This has a two-fold effect: first, it generates requests to undertake industry-relevant research and consultancy, and secondly it enables the Unit to establish new partnerships.

For example, as a result of **Gaura**'s expertise in wireless sensor networks and wide dissemination of her research, she worked with Orbit Housing Association (Orbit HA), see **case study 15.3**. The work has developed innovative approaches to the use of Wireless Sensor Networks (WSN) to assess and improve the energy and environmental performance of buildings owned by Orbit HA. The research collaboration has involved the development and evaluation of easy to deploy, scalable tools for assessing environmental quality against consumed energy in both commercial and residential buildings. The project's success was contingent upon by **Gaura**'s deep understanding of the scientific and user issues with WSN, as well as a thorough appreciation of the barriers to adoption of the technology. Key impacts on Orbit HA included £100k saved due to early defect identification on its Passiv (sic) Home site, and energy savings of £250 per tenant per year in energy costs. The impact of the work was recognised when **Gaura** and colleagues were named 'Most Innovative Consultant' by an industry panel at the Housing Innovation Awards 2013.

The success of the Unit's work for Orbit Housing Association has led to commercial research on building performance and evaluation for other housing associations, Gumpp & Maier GmbH and the UK Government's Department of Energy and Climate Change. Gaura has used wireless sensors in a very different context to give NP Aerospace commercially-valuable insights into how to improve airflow through its bomb-disposal suits. This work has enabled the company to minimise the physical stresses on bomb-disposal operatives working in Iraq and Afghanistan, and was undertaken in collaboration with Coventry University's researchers in physiology (see 'mHealth' article below).

As part of the Unit's dissemination activities, it has a strong involvement with Knowledge Transfer Networks (KTNs). For example, since 2006, **Gaura** has been co-chair of the Wireless Intelligent Sensors Interest Group within the Electronics, Sensors and Photonics KTN.

The Unit has held a series of business engagement events during 2012 and 2013. This has attracted a number of new partners, and new opportunities with existing partners, including Tata, Unipart and Rolls-Royce. Since 2008 the Unit has hosted or participated in many industry-focussed events, including the Low Carbon Vehicle Technology Project (see later) Dissemination Day, held at Coventry in 2011 and attended by over 20 organisations, the annual Cenex Low Carbon Vehicle event, which is attended by approximately 2000 delegates and the *Advanced Engineering Show* 2012 at the NEC, Birmingham, which attracted 9000 delegates.

With impact specifically in mind, the Unit publishes in practitioner magazines. Examples include **Gaura**'s work on building performance, described in: Local Authority Building and Maintenance magazine, Feb 2012 issue, pp 28-29 (with an ABC-audited circulation 2012-13 of 166,630); work on the bomb-disposal suits with NP Aerospace, published online on 'mHealth' (which receives 400,000 views per month):

http://www.imedicalapps.com/2012/02/body-sensor-networks-monitor-heat-stress/;

and **Blundell**'s work on Helisafe (see **case study 15.1**, Improving Passive Safety in Crashes) was the cover story for the Institute of Mechanical Engineers' professional magazine in March 2008.

Establishing partnerships In addition to those arising from the active dissemination of the Unit's research, it establishes new collaborative industry partnerships in a number of other ways. For example, new industry partners are frequently sought as collaborators in industry-relevant research bids, e.g. the £29M industry-focussed Low Carbon Vehicle Technology Project (LCVTP), in which the Unit played a major role, saw it working with partners including Zytec and Ricardo, as well as JLR and Tata Motors.

Responding to external requests Due to its external networks and strong reputation, the Unit

often receives a request to develop a research from a new potential collaborator, either directly via a member of one of the research groups or through the University's Business Development Office (BDO).

Use of institutional support to drive impact The University is one of only 23 HEIs to receive the maximum funding under HEIF5 in recognition of its research and consultancy activities with industry and business. The funding supports one of the largest and most successful university-industry liaison departments in UK. The department supports interactions with over 9000 SMEs and over 500 larger national and multinational enterprises, many of which are in sectors of direct relevance to Engineering. The Unit makes full use of institutionally-led support, including media training (**Blundell**, **Brusey**, **Gaura**) and the PR expertise of an external, retained agency. The agency's work has enabled members of the Unit to stimulate policy debate by informing politicians of the significance of their work. These politicians have included Peter Aldous MP, Vice-Chair of the All Party Parliamentary Group (APPG) on Renewable and Sustainable Energy (**Gaura**).

The University has co-invested £12M over the last six years with funders including Advantage West Midlands, ERDF and HEFCE in its Technology Park, which enables the Unit's researchers and companies to be co-located. Companies who have benefitted from this include Tata Technologies, part of the Tata Group, and Autoliv, a world leader in automotive safety.

Evidence of follow-through from these activities to identify resulting impact Using JISC funding (£15k) the University has developed a new research information management system, Embedding Research Impact at Coventry (ERIC), which supports the identification of impact. After a successful pilot, ERIC is being rolled out across the University and is a key part of the Unit's information management system (see 'Strategy and plans' for more information).

c. Strategy and plans

To drive even higher levels of impact from its research, the Unit will build on its very successful twin track strategy of fostering longer term collaborations with industry partners, and proactively identifying new opportunities. Specifically:

- further engage with industrial partners to develop research activities that deliver impact will remain a focus. The partnership with **Unipart** to develop a **Manufacturing Academy** (See **REF5** Section d) is a major statement of intent in this regard.
- to identify new opportunities, the Unit will disseminate research to a wider audience. To this end, all researchers will be offered media training and will be given editorial support to prepare publications for professional and practitioner-focussed publications. The Unit will be increasing its presence on social media with the help of the University's social media editors.
- extending membership of our advisory boards and support an increasing number of two way secondments between academics and collaborator companies. This approach is funded by the University and has been used successfully by other Units.
- further engagement by members of staff, particularly early and mid-career researchers, with relevant professional bodies, e.g. The Institute of Mechanical Engineers, The Institution of Engineering and Technology and the Institution of Measurement and Control.
- to ensure more efficient identification of impact, the Unit will be implementing fully the University's JISC-funded programme 'Embedding Research Impact in Coventry' (ERIC). ERIC is rigorous methodology and set of tools for defining, collecting, evaluating and recording impact. ERIC has been trialled successfully in another Unit and is demonstrably effective in enabling researchers to capture impact in a straightforward and timely manner. In brief, ERIC enables researchers to identify systematically the impacts likely to arise from a project whilst it is still being formulated, to modify the expected impacts as the project is developed and to record methodically the actual impacts as they arises once the project is underway.

d. Relationship to case studies

i. The Passive Safety in Crashes case study (15.1) developed impact by developing fostering long-term collaborations with collaborators (approach 1).

ii. The Control Engineering Applied to Radiotherapy impact case study (15.2), and **Sensing for Sustainability (15.3)** are examples of how the Unit has proactively identified new opportunities (approach 2).