Institution: University of the West of England, Bristol (UWE)

Unit of Assessment: General Engineering (15)

a. Context

General Engineering research at UWE has impacted on industry, public sector bodies (e.g. NHS, Ministry of Defence, Office for National Statistics) and third sector organisations internationally, as well as the general public. It involves a **close, sustained relationship with industry**, both large companies and SMEs, as well as other **end users**. In particular, the Unit has a strong affiliation with NHS trusts and **health organizations** worldwide.

The key types of impact relating to the Unit are **economic** allied to impacts on health and professional services. There has also been impact on **public policy and services** and on society. Impact has arisen from novel techniques, technologies and processes being adopted by industry or other end users. Techniques have been applied in (i) **manufacturing** processes improving productivity; (ii) **medical** devices for analysis and diagnosis resulting in improved patient health outcomes; and (iii) **NHS service** improvements and changes in the practice of **health** professionals.

b. Approach to impact

In line with UWE's Knowledge Exchange Strategy, the Unit has strengthened and expanded the enterprise-related collaborations with business, the public sector, other organisations and the community.

The **Institute of Bio-Sensing Technology** (IBST - research group 2) aims to develop academic/industrial partnerships to address the development of novel technology for detection and measurement of biological systems and the integration of biological systems into novel sensing technology. Key strengths of IBST include its large network of industrial and public sector contacts. Its membership programme allows companies to join IBST, thus providing an **effective business network** that brings together companies and research institutions with an interest in the development or application of bio-sensing technology. A further strength is its successes at developing and coordinating novel, cross-disciplinary research themes, **targeting problems identified by end-users**. IBST has provided a **forum for academics, business and end-users to interact**, as evidenced by the International Conference on Bio-sensing Technology, founded by the IBST Directors in 2008, and the Bristol Health Partnership (UWE, Bristol University and four local NHS Trusts) series of showcase events. In this way IBST has initiated collaborations between researchers, companies and other organisations, as evidenced by:

a. a sustained relationship with **The London Orthotic Clinic** resulting in techniques for extracting facial morphology from children with plagiocephaly, and technology being trialled with patients;

b. an ongoing partnership with SME **Gwent Electronic Materials** (GEM) over a sequence of research projects that has resulted in improvements in the production of screen printed electrodes and a new electrochemical sensor currently being marketed by GEM; and

c. **Kiely**'s Enterprise Fellowship (2013) from the **Royal Academy of Engineering** to create a new business, **MIAtecht** to accelerate exploitation of the Magneto Immuno-Assay technology for commercial food testing - the resulting products are rapid, easy-to-use instruments and test kits for all important pathogens and contaminants, to be sold to food producers, processors, contract laboratories and others.

Impact has been developed and sustained through **long-term relationships** with a wide range of health professionals, through the creation and funding of posts, visiting appointments and collaborative projects and grant-funding, as evidenced by:

a. the creation in 2010 of a new post of Senior Research Development Manager in the **Centre for Machine Vision** (CMV – research group 1) that was 50% funded by **North Bristol NHS Trust** (NBT), together with an embedded Research Nurse and an Administrator who were fully funded by NBT - all positions were specifically aimed at supporting new interdisciplinary collaborative bids in medical imaging applications;

b. Visiting Professor appointments, for example, Professor Mark Tooley, Head of Medical Physics at **Bath Royal United Hospital** and Professor John Henderson, Consultant, **Children's Royal Hospital**, Bristol; and

c. grants to support collaborative research with the **NHS**, for example, a device for non-invasive assessment of respiratory function with the Department of Paediatric Respiratory Medicine at NBT (EPSRC funded), and a device for prediction of the onset of exacerbations in **Chronic Obstructive Pulmonary Disease** patients (NIHR), currently being trialled with patient samples – also collaborative research with the **Speech & Language Therapy** Research Unit (SLTRU at NBT) relating to expression analysis in speech therapy which has been implemented in new diagnostic and treatment techniques within the NHS Trust.

The Unit has successfully pursued high profile, **multi-partner knowledge exchange grants**. The European Regional Development Fund (ERDF) has funded three **iNet** projects at UWE valued at £5.5M: (a) Microelectronics and Biomedical, both led by IBST; and (b) Aerospace and Advanced Engineering, led by the **Engineering, Modelling and Simulation Group** (EMSG – research group 3). An **iNet** is a 'Networking for Innovation' initiative and aims to signpost, strengthen and support important industries. iNets support businesses in turning ideas into new products and services by **providing access to specialist information and research**, linking businesses to new markets and through sharing knowledge and expertise. As at June 2013, the iNet projects had supported 396 businesses and funded 75 University-Business collaborative projects, resulting in 130 new products, **focusing on the requirements of regional businesses**. New products to market based on UWE research include a heated glove containing novel plastic electronics (company Alago) and a novel sensor for detection of hydrogen peroxide in breath aimed at rapid diagnosis of heaves in horses (company Dart Sensors).

Much of the Unit's research has been in collaboration with industry and end users. For example, the Unit is a main partner in the high-profile **Bloodhound** Project to produce a jet and rocket propelled car to take the land speed record over 1000mph. The project director Richard Noble OBE is a Visiting Professor in the Unit. UWE is leading university-level engagement in the project, developing materials and case studies for use by partner universities, and has used its strong partnerships to provide openings for the project, including the relationship with **BAe**, and regional and local authorities. It has **excited young people about STEM subjects** through its research and educational impact on school and college curricula, teaching and learning materials and activities, and public lectures beyond UWE, to meet future skills shortages in the UK economy. The Unit helped Bloodhound's Chief Engineer establish a base at UWE for the early design work. Subsequently UWE produced the scale model of the car for the launch with the involvement of undergraduate placement students.

The Unit has input into many **specialist advisory groups** including the UK Industrial Vision Association, the Bristol Child and Adolescent Health and Social Care Research Strategy Development Group, the Human Identity Management & Biometrics Sector Consultation Group and Sensors in Water Interest Group. These have contributed or then led on to a broad range of impacts, for example, a new method of wheel alignment jointly researched with PVT Solutions (India), and a novel 3D shape intensifying technique with SEA Ltd.

The Unit has intensively collaborated with UWE computer scientists and the Office for National Statistics (ONS), to address a significant international data protection issue as more fully described in one of our impact case studies.

Unit staff have been academic partners in 9 **Knowledge Transfer Partnerships** since 2008 with industrial partners in aerospace, metrology and other areas. Examples include:

- **CFH Total Document Management Ltd** (£117k) - to research, develop and implement an energy conservation strategy to support its long term strategy to be completely self-sufficient;
- **Ecotricity Ltd** (£131k) - to build, develop, test and prepare for market an innovative home energy storage product and control system, demonstrating successful operation and achieving regulatory compliance;
- **Auger Torque Europe Ltd** (£118k) - to introduce advanced mechanical engineering capability and develop improved cyclic and epicyclic gearboxes for trenching and drilling machinery; and
- **Haley Securities Ltd** (£122k) - to research, develop, test and implement a composite structure for Radomes - the spheres surrounding communication and satellite radar equipment.

c. Strategy and plans

The UWE 2020 Strategy has **Research with Impact** as one of its four priorities. The Unit's approach to progressing the impact of its research will be to:

- obtain further funding to **interact with industry**, continuing the success of the iNet projects in generating new exploitation opportunities - in 2013, the Unit successfully applied for £1.8M of further funding from the European Regional Development Fund and matching funding from companies to extend the Microelectronics iNet (a further £4M of RGF funding has also been secured from the Department of Business Innovation & Skills (BIS) for research and innovation projects that will develop new products and enhance business competitiveness in medium sized engineering companies across the South West);
- link up with **new partners** and other end-users, for example, the EMS team's developing collaboration on nurse shift rescheduling with the Avon & Wiltshire Mental Health Partnership;
- engage group members in **reflective exchange of impact pathway development experiences** (thereby expanding a culture of critical and proactive thinking around impact alongside mentoring support);
- routinely record evolving impact and impact opportunity narratives to in turn **influence forward planning** of research and knowledge exchange activity;
- put in place further **entrepreneurship training** in association with UWE's Research, Business and Innovation (RBI) office that helps staff expand their understanding and confidence surrounding how to promote, protect and exploit their intellectual property;
- work with UWE's Science Communication Unit to ensure **creative and effective means of disseminating research** to, and engaging with, users are embedded into new projects at the proposal stage; and
- continue to engage strongly in industry-driven collaborative projects including **Knowledge Transfer Partnerships** which draw upon our research.

d. Relationship to case studies

The two case studies both reflect our approach to research with practical application. This involves establishing and evolving ongoing relationships with users that both contribute funding for research and in turn engage in taking findings forward collaboratively into addressing real-world problems.

*Case Study 1: Innovative 3D imaging for vision based metrology in manufacturing***.** Following **academic dissemination** of research outputs on 3D shape enhancement worldwide, CMV was **approached by companies** to identify potential solutions for practical problems. One example is Quantronix, a US company which **sponsored further research** for the development of an Overhead Dimensioning System for use in freight inspection. This led to a **series of projects** in which the CMV team was able to make use of photometric stereo techniques to better segment 3D data and in particular robustly isolate 3D edge features to improve measurement accuracy in challenging environments thereby **unlocking new opportunities***.* Legal support to guide the non-disclosure and contractual agreements in collaborations with companies **towards commercial products** was provided by UWE's RBI office.

Case Study 2: Better and faster guarantees of respondent privacy when releasing public statistics. The **initial invitation** from the Office for National Statistics (ONS), coupled with Clark and Smith's (UoA 11) complementary expertise in mathematical optimisation and evolutionary computing, created a new **opportunity to collaborate with a key end-user** with national responsibilities and international ramifications. The seriousness of the problem of hackability of confidential data meant that the UWE researchers maintained a **transition-supporting focus** on the end-impact, even when researching theoretical aspects to provide the breakthrough in the size of published statistical tables that could be protected from hacking. This was achieved by a close working partnership with, and **funding** from, ONS and interaction with other National Statistics Agencies (NSAs), particularly at Statistics Netherlands, the developers of tau-Argus, the SDC anti-hacking software used by ONS and most European NSAs. The result of following the UWE strategy is a **continuing and close research relationship** with ONS with whom the Unit is planning future projects that will create further impact well beyond 2013.