Institution: De Montfort University

Unit of Assessment: 15 General Engineering

a. Context

The research work undertaken by UoA15 at De Montfort University (DMU) provides economic, environmental and social/health benefits, both nationally and internationally. The range of research activities spans many subject areas including manufacturing/mechanical engineering, electronics, civil, environmental and textile engineering, and environmental chemistry. Beneficiaries and audiences for the Unit's research include:

- Manufacturing and other logistic sectors such as haulage industry or administration. Impacts are mainly economic and environmental through improving operational efficiency and by reducing usage of energy and non-renewable resources for both local companies and multinationals.
- Aircraft and aviation industry, for example companies training civilian and military pilots which use the flight simulator developed by researchers in the Unit, resulting in improved pilot training and subsequently increased flight safety on an international level.
- International and national government agencies which benefit from new tools and improved global data for monitoring and analysis of inland surface water, having impact on the economy, health and societies across the whole globe.
- Water utilities which use the methods and software developed by researchers in the Unit for improved management of water systems, delivering economic, environmental and social impact (i.e. improved customer service and reduced disruption to the urban life).
- The UK National Health Service (NHS) and patients who benefit from new technologies developed by the Unit researchers, and leading to improved diagnosis and treatment of diseases, cost savings and reduction of patient suffering.
- UK Local authorities who provide care and who use the results from research on 'smart homes' and on 'assisted living' technologies to improve the provision of care for elderly and disabled people in their own homes.
- Electronic industry and consumers who benefit from the work carried out on new electronic materials, new circuits e.g. for power electronics, new instruments for medical applications and new protocols for (multimedia) communication.
- Professional bodies such as IEEE and CENELEC who benefit from the development of new standards, which subsequently influence industrial practice to the benefit of industry/consumers.

b. Approach to impact

The Unit's approach to impact during the census period has been to interact with non-academic users, beneficiaries and audiences through collaboration, partnerships, contract research, consultancy, training and public engagement activities. Significant investment has been made during the census period in staff and physical resources by a broad range of highly selective competitive mechanisms that include 'pathways to impact' as one of the assessment criteria. These mechanisms include research scholarships, research leave and pump-priming research and innovation funding. Work with international, national and regional communities to disseminate the results from our research for the benefit of society is particularly encouraged. Staff in the Unit collaborate with businesses and other professional partners to ensure that as much research as possible is turned into new services and products. Events dedicated to the promotion of KTPs and a Technology Showcase are held annually providing businesses and organisations with the opportunity to explore and experience a range of cutting edge technologies in a wide range of science, engineering and technology areas. The Unit actively seeks key local, national and international organisations that can benefit from our research. An Industrial Liaison committee dedicated to creating and strengthening mutually beneficial relationships between the School and external bodies has been in place for a number of years. Staff are encouraged to look for opportunities to exploit the Intellectual Property in their research, for instance Menzies-Gow (CECE) had recently two patents (GB2475372 and US8492641) granted for an electronic musical interface and Paul (EMTERC) had one patent (GB2482915) granted for the low temperature method for the production of polycrystalline silicon. The staff can draw upon the support of both a dedicated Faculty Research and Innovation Office (RIO) and a central Research, Business and Innovation office (RBI) when an agile approach is needed to commercialise research. Both assist with bid preparation and information provision including professional advice on how to interact with specific industrial sectors. The substantial contract research activity can be incorporated in the

Individual Research Plans (IRP) by staff while smaller contracts can be handled by the established teaching buy-out mechanism where part-time staff cover the teaching duties of the individuals involved in the projects.

The success of the Unit's approach is demonstrated by the following examples:

Relationships with **manufacturing and logistics** industries have been mainly developed via TSB and KTP projects. The research initiated by Goodyer on intelligent transport systems (ITS) was driven by the need to improve transport in Leicester and has been developed to such an extent that he is now helping the EU Commission and UK regional bodies on the future priorities of research funding in the ITS. Goman's reputation as an expert in nonlinear flight dynamics led to him being invited to participate in collaborative projects by many world-leading aeronautical research organizations, such as TsAGI (1997–to date), NLR (2009–to date), CSIR-NAL (2009–to date), NASA Langley Research Center (LaRC), USA, (2011–13) and by various **aircraft and aviation companies**. The simulation software developed in the EU FP7 Supra project is now used at Netherlands Research Organisation TNO (www.tno.nl) for 'upset recovery' training and is also installed on the Airfox® DISO disorientation trainer flight simulator manufactured at AMST Systemtechnik GmbH, Austria resulting in better trained pilots.

The global reach and impact of Smith's work in particular on **International and national government and agencies** has been achieved through long and close relationship with the European Space Agency (ESA). Monitoring inland surface water resources is an increasingly vital requirement because many catchment basins are now being stressed beyond their capacity to recharge. The data are collected and processed in near-real-time from 1341 sites and disseminated worldwide freely by Smith on behalf of the ESA for the benefit of populations of the respective regions. The pioneering work of Janus (CESAS, water software systems (WSS) team) in the area of membrane bioreactor modelling stem directly from problems encountered by the **Aquabio company** with the membrane fouling problems and has resulted in the improved efficiency of the industrial wastewater treatment plants. The WSS team participates also in the EIP (EU) Water City Blueprints action group and is a founding member of the NetwercH2O association with 300 municipalities as members to disseminate the best practice across Europe. Huddersman closely collaborates with Environment Agency (EA) and water utilities (Severn Trent). Her work on treatment landfill leachate was supported by EA and tested by Severn Trent and subsequently recommended for wider applications in order to reduce the environmental impact of landfills.

A significant body of research within the Unit impacted the **National Health Service (NHS).** Goodyer has developed the Linear Skin Rheometer (for which he has received a patent, GB24 46447A) to measure the rheological properties of human tissue, and which is now widely used in practice and in fundamental research programmes in medicine. Oxley has a successful collaboration with Addenbrooke's Hospital in making more accurate temperature measurements on diagnostic ultrasonic transducers to prevent patients' discomfort. The additive manufacturing team introduced the preoperative planning models based on additive manufacturing principles for cranio-maxillofacial and orthopaedic operations (to date 200 patients have received such treatment). This activity led to creation of Rapid Manufacturing Technology Ltd spin off company, which subsequently become independent from DMU.

Care for elderly is a top priority for **Local authorities.** The mechatronics team has been working on Smart Home Technology/Assisted Living over a number of years. The TSB iCARE (Wong and Goodyer) project has developed a standard hardware and software platform for smart home applications to facilitate the care for disabled and elderly people at home. The iCARE approach was evaluated from a technical and user perspective in a five-home trial at the end of the project with positive effects. This project featured in BBC Radio discussion about the changing role of the family in Christmas 2010; and thus influenced public discourse.

Colleagues specialising in electronics (CECE and EMTERC) used many different approaches to achieve an impact on the **Electronic industry** such as workshops, conferences, KTP projects and collaboration with professional bodies. Oxley, who specialises in radio frequency technology, organised a series of workshops for industrial partners to gain their support. The industrial support led to two EPSRC grants, one enabling the purchase of a state-of-the-art, infra-red microscope (Quantum Focus IR microscope) which is used by many semiconductor companies resulting in more reliable electronic components and devices. Goodyer led the KTP PRIMO project for NSL Ltd, Nottingham, and developed the world's first multi-constellation Satellite Navigation receiver. This new device is able to capture data from GPS (USA), GALILEO (EU) and COMPASS (China), as

well as space-based augmentation systems. The results of the Unit's research are used to define new technical standards, which are adopted by **Professional bodies** cascading subsequently to industry and society. Duffy (CECE) has developed a standard through partnership with IEEE and Chen (AMPMC) through collaboration with CENELEC. Chen is a member of TAHI Interoperability Group, active in standardisation of Home Systems and Interoperability. Chen has developed a standard called "An interoperability framework requirements specification for services to the home" – CWA 50560: 2010IFRS – which has been adopted by CENELEC (European Standards body for electronic systems) in 2011.

c. Strategy and plans

The Unit's strategy for achieving impact from research has been developed to be in line with the University's overall research strategy and an evolving understanding of 'impact'. The Unit's strategy for supporting and enabling impact from research includes the following:

- To maintain and further develop a dynamic and open research environment and to encourage a scholarly culture where staff undertake rigorous research with impact on the wider society
- To seek key local, national and international organisations that can benefit from our research
- To support staff involved in industrial collaboration/partnership projects/activities
- To ensure, through the allocation of resources and appropriate staffing, that research undertaken by researchers in the Unit is disseminated with the aim of maximising its impact
- To encourage public engagement activities with a view to increasing public understanding of research in engineering and technology, with emphasis being placed on outreach activities in applications for funding
- The appointment of a Faculty Director of Strategic Partnerships

These plans will be achieved through the following mechanisms:

- Seeking further KTP and TSB opportunities and through the use of HEIF funding
- Continuation of the School Industrial Liaison Committee, dedicated to creating and strengthening relationships and by providing advice and support to help increase levels of engagement in collaborative research and development activities
- The need to demonstrate Impact to be taken into account as part of individual research plans and teaching buy-out mechanisms
- Continuation of events such as the annual Technology Showcase
- Encouragement and support for staff to build and maintain links with industry and professional bodies such as IET, IEEE, IMechE, ICE, ASCE, AIAA, etc by having time allowance and financial support for travel, for workshops and conferences attended by practitioners
- The continual improvement of research groups' web presence and through the strategic targeting of events that engage with stakeholders, to disseminate our research and to reflect successes and impact
- Making sure that there is a pipeline of information from research groups in the Unit to the DMU press office so that any and all opportunities to enhance the research profile and successes of researchers in national, international and sector media are exploited

d. Relationship to case studies

There is a two-way relationship between our case studies and the approach adopted by the Unit, particular case studies informed the development of the Unit's approach and facilitated the uniform application of best practice amongst all research teams. The faculty is submitting three case studies: 1) in manufacturing, 2) in water engineering and 3) in electronic engineering:

1. 'Responsive Design and Operation of Flexible Machining Lines' helped the manufacturing sector to improve efficiency and reduce the cost of flexible machining lines and enables wider usage of such lines throughout the automotive supply industry. The impact has been achieved by working with the companies on KTP and TSB projects.
2. The 'Optimal Energy and Leakage Management in Water Distribution Systems' case study has had an important impact in saving drinking water and energy in the context of diminishing water resources. The impact has been accomplished thanks to long term relationships with water utilities in the UK.
3. The 'Feature Selective Validation method' study presents Dr Duffy's team achievements. The main impact of the work was facilitated by Duffy's active involvement with professional bodies, such as IEEE.