Institution: University of Dundee
Unit of Assessment: 15 - General Engineering

a. Context

General Engineering at the University of Dundee is centred on four research groups within the School of Engineering, Physics and Mathematics (EPM) and the Medical Research Institute within the School of Medicine located within Ninewells Hospital in Dundee. The research carried out has impacted on a range of beneficiaries and non-academic user groups, in particular clinicians (and, in turn, their patients), photonic devices manufacturing companies and scientific instrumentation manufacturers. There has been economic impact through the development of new devices and techniques, primarily within photonics technology and minimal access surgery (MAS). The translational nature of our engineering research continues to have substantial impact on patient health outcomes and professional practice within the NHS and in health services worldwide.

Of the 18.75 staff being returned for assessment, 53% have been in post since 2008.

There are two primary types of impact generated from General Engineering:

1. Economic: the development of tools for MAS that are licensed to and sold by Karl Storz, one of the world's key endoscopy and MAS device manufacturers – worth millions of pounds in income; the development of new ultrafast lasers, licensed and sold by M Squared Lasers Ltd. and Innolume; the use of novel vascular graft technology, leading to a spin-out company, Vascular Flow Technologies and the sale of these devices to an international market. Additionally Karl Storz has based one of their UK centres in Dundee as a result of the successful research carried out in the Surgical Technology and Robotics Group in the Medical Research Institute.

2. Health: The development of novel MAS technologies at Dundee has had a substantial impact on patient health, spreading to healthcare systems throughout the world. Its use for a number of procedures is embedded within UK healthcare guidelines, and recommendations by expert groups within Europe. Clinical trials of procedures at Dundee making use of such equipment, have demonstrated its effectiveness in terms of surgical time and post operative recovery, for example, when compared with previous gold standard open access procedures.

A further impact on health is in the training of surgeons in these new techniques. The Cuschieri Skills Centre in the University of Dundee Medical School is a leading provider in MAS techniques training and trains, approximately 49% of all surgeons in Scotland and 4% of those in England.

b. Approach to impact

The General Engineering UoA at the University of Dundee employs a multifaceted approach to impact, within two underpinning areas: biomedical engineering and photonics engineering.

Biomedical Engineering The establishment of the Institute of Medical Science and Technology (IMSaT), part of the Medical Research Institute, was a key element of the strategy of the University to harness the excellent research in engineering and the physical sciences at Dundee and allow it to connect to medical translation. Through much of the REF period IMSaT has been housed in a building next to Ninewells Hospital in Dundee. It is populated with academic staff from biophysics and bioengineering, along with medical imaging experts, research nurses and clinicians – these final three groups are the core end users of the research.

Additionally it houses the Surgical Devices Unit, which is key in developing new instruments for Karl Storz, and has led to more than forty patents being granted and thirty technical licenses being employed by the company. IMSaT acts as a pivotal point of contact between the academic MAS research carried out in Dundee and industry and the broader clinical community, leading to commercialisation and widespread use in the public health sector.

Academic staff members working in IMSaT and elsewhere are supported by the University to achieve this impact through flexible working practices and reduced teaching loads. Examples of this include staff with joint positions across academic units in physics and life sciences; and mechanical engineering and medicine. This "embedding" and "out of silo" approach has brought a number of key research ideas to early stage impact.

More recently it has been identified that far more impact can be created by strategically moving some facilities of IMSaT within the hospital building itself - this is designed to further and

proactively translate research activities. A range of ongoing research studies are leading to clinical trials, mostly focussed on ultrasound research, a key indicator that this approach is effective. The goal here is to co-locate research directly at the interface of medicine and biomedical engineering, thus providing an immediate path to impact.

Another example of Dundee's approach is drawn from the INSPIRE (Industry and Scottish Universities Physics Alliance (SUPA) People in Innovative Research Exchanges) project run under the aegis of SUPA. Led by Dundee, this £2m programme has co-funded 14 PhD studentships with industry at the engineering physics/life sciences/medicine interface. It has also co-funded six industrial placements for SUPA academics and research staff and has supported several successful meetings, the last one designed to assist industry in forming partnerships with the NHS.

Photonics Engineering: The strategy behind developing impact from the work in photonics engineering has been similar to that in the biomedical area, in that the principle route to impact has been the close relationship with companies in the research and development phase. This is evidenced by major FP7 and TSB funding with a range of industrial partners, including Philips, Coherent, M Squared Lasers Ltd. and Innolume. The hand-in-hand relationship between research and industry has led to the direct development of products, many of which are now on sale. These especially include laser sources for ultrafast laser applications. While the industrial links are emphasised in photonics engineering, the work here also has many other avenues of impact and the University is active in running a range of workshops to bring researchers from different disciplines together. One example within this UoA has been the pre-clinical study of new laser sources in areas of urology, an approach that is hoped to lead to full clinical studies and new medical treatments in the future.

c. Strategy and plans

The University is investing heavily in new academic staff in biophotonics, bioengineering, and computational modelling, to further strengthen the relationships described in section b). In the past year alone, seven excellent junior staff members have been recruited into these areas, all of whom have a track record of partnerships and interactions with clinicians, pharmaceutical companies and photonics companies. Central to the strategy of developing the research strengths within UoA15 is a much broader interaction with end users and one of the drivers in this recent recruitment scheme has been to consider how end impact fits into the wider role of an academic. We have identified a range of methods to help further develop our impact outputs:

i) The University has received £0.9m from the Scottish Funding Council as part of the SUPA pooling exercise. The University is contributing a further £1.8m, primarily as an investment into Physics and Life Sciences related infrastructure and staff. Around 10% of the £2.7m total will be applied to explicit Knowledge Exchange activities to develop impact activities through industrial placements for staff, innovation seed corn funding, and proof-of-concept development, and in particular to engage with early career researchers. A further £100k is being invested in developing our electron microscopy facilities to allow new research projects with local companies of metal processing to be carried out based on work from our materials processing group.

ii) A stronger push towards interdisciplinary environments that have a greater interaction with end users. Two examples of this are:

(a) the significant changes in IMSaT with the footprint of the Institute moving within the hospital from a building on its grounds. Crucially, a number of clinical academics have also recently joined the Institute. This direct linkage between engineers, physicists and clinicians will promote even greater translation of our research work to most strongly impact health outcomes. A prime example is the £6m EPSRC Sonopill programme, which has 17 partner companies as well as senior clinicians in its team, with an end goal of clinical trials on internal ultrasound imaging devices.

(b) the development of a new interdisciplinary biophysical sciences research space. Initially the University will fund this under the auspices of SUPA. However, the goal is for this to become self-sustaining through research income and industrial interactions. Progress has already been made to secure closer end-user engagement with the recent (2013) award of a €3.7M Marie Curie ITN award in biophotonics, with many industrial partners including Zeiss, Leica and Coherent.

iii) The better integration of research with industrial end users. The UoA is well placed within the clinical sphere to develop translational research, with plans to improve further the interaction of

non-clinical staff with industry. An increasing emphasis will be made on industrially-aligned research projects, especially with EU funding, which have led to early impact success within the REF2014 period. There will be further emphasis on this type of research through Horizon2020 and Dundee researchers have already identified promising research avenues and partnerships.

iv) With new staff employed within the Computational Modelling Group, the UoA focus is on developing impact in the areas of drug design, especially antibiotics. The University has significant exposure in this area, receiving in the last year alone, £1.6m from Ipsen Pharma; £1.5m from Pfizer Inc; £1.3m from GSK; and £798k from AstraZeneca. Projects with AstraZeneca and Boehringer Ingelheim Pharma are currently underway, and Dr Zachariae has already contributed to the design of pharmaceutical agents in current clinical trials. The plan is that the interface between this group and the Drug Discovery Unit at Dundee will lead to major impact in the years ahead.

v) The University offers significant support for support of industrial collaborative projects, especially with SMEs. It is part an “Innovation Portal” scheme which facilitates a wide range of proof of concept funding schemes for the academic-industry interactions at the University of Dundee, Abertay University and the James Hutton Institute. These include mechanisms such as a ‘Small Grants Scheme,’ the BioPortal scheme for life science projects (of particular interest for the Biomedical Engineering and Computational Modelling Groups) and nationally based funding schemes such as innovation vouchers and KTPs. Additionally, the BioDundee portal offers a conduit for interaction with the large biotechnology industry that is based in Dundee, as well as offering those outside Dundee a mechanism to interact with University researchers, such as IMSaT and the Drug Discovery Unit.

A number of staff have already had funding through these schemes, promoting industrial impact of our research in areas such as vascular graft technology, anti-biofouling coatings, and in the development of new laser devices.

vi) In photonics, stronger research links with UK industry are planned and Scotland is well placed to facilitate such interactions with the establishment of the Fraunhofer Institute in Applied Photonics and the Innovation Centre in Sensors and Imaging Systems (of which Dundee is an academic partner). Staff currently have projects with local photonics companies and will make use of innovation mechanisms mentioned in (v) along with engagement with the new industry aligned centres in Scotland to develop the impact of their research work in areas such as compact ultrafast lasers, laser materials processing and frequency comb metrology.

vii) A further goal is to make impacts in less traditional engineering areas – this is greatly facilitated by the presence within the University of the Duncan of Jordanstone College of Art and the first satellite of the Victoria and Albert Museum outside of London. V&A Dundee is keen to explore all aspects of design, and will have massive educational and cultural impact in Scotland. Already there are fledging collaborations on how photonic technologies can be used in jewellery design and manufacture, and staff are exploring NESTA funding for 3D printing projects to widen public participation and enhance school curriculum development in areas related to space.

d. Relationship to case studies

The strong links described above between General Engineering and Ninewells Hospital and Medical School, and the impact that results from these links, are very well illustrated by the impact case studies on innovations in MAS (led by Prof Sir Alfred Cuschieri, General Surgeon) and arterial shunts (led by Prof Peter Stonebridge, Vascular Surgeon). Prof Cuschieri has for many years formed research partnerships with General Engineering staff at the University, and these collaborations have led to both globally adopted innovations in surgical practice and a number of new devices, which have been commercially produced by Karl Storz. Prof Cuschieri is a key individual in IMSaT, maintaining and strengthening the relationships with industry upon which impact is built. The second of these impact case studies is benefitting from new collaborations with computational fluid dynamics groups in engineering, allowing optimal design of arterial shunts. Research from Photonics Engineering forms the third case study, with the development of ultrafast laser sources that have a widespread use and that have been taken up on license and turned into products. This is an interesting early stage impact result, born from recent recruitment of staff, engaging effectively with the research and innovation service within the University.