Institution: University of Dundee

Unit of Assessment: 15 - General Engineering

a. Overview

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. The research focuses on areas including minimal access surgery tool development, ultrasound technology and imaging, MRI imaging, biophotonics, biomedical engineering, computational modelling, laser development and applications, laser materials processing and material properties ranging from the cellular to piezo-ceramics.

The work carried out in Dundee has a very applied and interdisciplinary focus. Staff have a wide range of backgrounds in physics, engineering, medical science and clinical practice, highlighting the intimate links and interdisciplinary nature of the work that is carried out. 21% of the submitted outputs have more than one author from the UoA submitted staff. Research income in UoA15 totals £15.3m over the REF period 2008-2013, with major awards from the primary funding agencies such as RCUK, EU FP7, and the European Research Council.

The 18.75 individual staff members form four larger umbrella research groups:

(i) **Biomedical Engineering** – medical devices, basic engineering and translation studies. Group: Campbell, Cochran, Cuschieri, Demore, Huang, Melzer, Zhao.

(ii) **Photonics** – development and application of optical sources and devices, especially in biophotonics. Group: Abdolvand, Cataluna, Cizmar, Huang, McGloin, Rafailov, Wilcox

(iii) **Computational Modelling** – developing models in a range of areas covering photonic instrumentation, fluid dynamics, biophysical properties of cells and membranes, extra-solar planetary motion and properties of nanoparticles. Group: Cizmar, Decent, Matsumura, Pisliakov, Sknepnek, Zachariae

(iv) **Materials Science and Engineering** – applications in laser materials processing, properties and applications of nanoparticles in medicine and ferroelectric material properties. Group: Abdolvand, Cuschieri, Keeble, Sknepnek, Zhao

Two commonly used acronyms in this document:

IMSaT: Institute for Medical Science and Technology; SUPA: Scottish University Physics Alliance

b. Research Strategy

Vision: The vision for our research groups is to translate cutting edge research to help solve challenging problems in key interdisciplinary areas. Specifically the interfaces that we concentrate on are at the borders between engineering, physics, medicine and life sciences. Our goals over the next 10 years are to develop new imaging and treatment modalities to aid clinicians, to develop new understanding of biological processes from single molecules to organs, to make in-roads into fundamental understanding of conditions such as cancer and to explore the power of areas such as computational modelling to tackle global challenges such as the quest for new antibiotics. We also intend to pursue research that will lead to broader impacts within industry, by exploring the miniaturisation of laser and lighting devices, new ways to industrially process materials using lasers, and better develop nanotechnology approaches to industrially relevant biofilms.

Implementation of RAE 2008 Strategy: These are grand challenges but they are made achievable by the processes set up over the course of the previous RAE assessment period. Research income has grown by £3.9m, and the research groups have matured into stable internationally leading research teams. In 2008 the UoA15 group was similarly structured to present, with research groups in biomedical engineering, photonics and materials engineering. At the heart of the submission, within biomedical engineering, was the newly established Institute of Medical Science and Technology (IMSaT). This was established to act as a conduit between engineering research and clinicians at Ninewells Hospital, and was equipped with a range of state of the art equipment such as a research MRI, nanoparticle growth facilities and an ultrasound development lab. Its goals have all been met by the staff who were appointed as IMSaT started up. Some key highlights have been the major awards to Cochran: £4m Sonotweezers EPSRC (Co-I 2009-13) award and £6m Sonopill (PI 2013-18); and to Melzer, e.g €2m EU Nanoporation award (PI 2009-13. Two of IMSaTs early career researchers have been awarded prestigious individual Fellowships (Demore, Royal Society of Edinburgh Fellowship (2013) and Prentice, ERC Starting Grant (2013)). The Sonopill project is a collaboration between engineers, clinicians and local and

international companies, with the goal of developing swallowable pills for ultrasound imaging of the gastrointestinal tract.

IMSaT has been so successful that it is now being more fully integrated within the University Hospital, through incorporation within the Medical Research Institute, School of Medicine, managed as the Division of Imaging Technology. This is led by Cochran and is a research group of engineers, physicists, research medical staff and clinicians.

The strategy in photonics to support and invest in new staff has also borne fruit. Rafailov's group has had extensive success in European funding leading two projects in excess of €10m and having success in a range of smaller projects at the €1m level. These projects have intimate links to industrial partners, leading to the commercialisation of the devices developed. Additionally there are growing links between photonics researchers and clinicians based within the Biomedical group and with researchers in life sciences. Two ECR staff who were part of these European projects have, since 2008, been awarded personal fellowships (Cataluna and Abdolvand) and have subsequently been recruited as permanent staff (currently Senior Lecturer and Professor respectively). This organic growth has given Dundee a significant international presence in photonics. Additionally the investment in new staff within the RAE2008 period (McGloin, MacDonald, Campbell) has also borne dividends with grant awards from RCUK funders. Campbell has had significant success as part of a £5.9m Wellcome Trust grant to study siRNA drug delivery for treating skin diseases, straddling the photonics and biomedical groups.

The plans for Materials Engineering from 2008 have led to new staff being hired (Abdolvand and Sknepnek) and this area is now much stronger, with a change in focus to materials processing and modelling of material properties. This links to research interests in the photonics groups and provides a stronger base for future development over the period of the next REF.

Future Plans: The strategic aims for the next five years for General Engineering are as follows:

(i) **Deepen the successful integration between engineering, physical science & biomedicine**

At the core of this ambition is the investment of approximately £1.8m by the University and £0.9m by the Scottish Funding Council through the Scottish Universities Physics Alliance (SUPA). Some of this funding has already been invested in new staff working at the physics and life sciences interface (Cizmar, Pisliakov and Zachariae) and the intention is to significantly increase the research focus on areas such as biophotonics and computational modelling of cellular processes. This will be accomplished through the establishment of a state-of-the-art interdisciplinary research laboratory suite within the College of Life Sciences footprint designed to bring technology developers into immediate contact with the life scientists and to build into this team computational modellers at its core. This laboratory will be a hub within the University and also for industry. We have recently been awarded a €3.7m Marie Curie Initial Training Network "Photonic tools for Quantitative Imaging in Tissues" to fund 13 PhD students over the next three years. All of the students will work in this new space on interdisciplinary biophotonics and bioengineering projects. Our staffing aim is to invest in bioengineering with a target of 4-6 staff over the next three years - in cell and tissue mechanics and in forensic engineering, linking up with our world leading forensic anthropology group, led by Prof. Sue Black, the Centre for Anatomy and Human Identification.

(ii) **Establish a new internationally competitive research group in computational modelling**

Since REF 2008 we have made a number of hires in the broad area of computational modelling and these complement other hires in UoA 10 (Mathematical Sciences) and UoA 11 (Computer Science & Informatics) as well as new staff in areas such as bioinformatics. This is an exciting time in these areas with rapid growth in computing power and a burgeoning demand from a range of disciplines to find new ways to attack complex problems. Our research expertise in such modelling lies in the area of biophysics and biophotonics, with the aim to link this with experimental groups to develop deeper understanding of cellular mechanisms and mechanics: opening up a range of new funding opportunities that have been denied to us in the past. Moreover our plan is that the development of the computational techniques at Dundee will ultimately lead to new forms of impact away from the traditional research outputs, through the development of commercial and freeware software.

(iii) **Establish an internationally leading materials research effort**

Over the next five years we plan to redevelop our materials science and engineering programme through supporting new staff members and investing in further staff. Abdolvand has been awarded a EPSRC Career Acceleration Fellowship (2010) along with a £280k Research Leaders Award

(2012) and has started a vigorous research group centred around laser material processing with a wide range of applications spanning materials engineering, processing of solar cells and jewellery manufacture through to production of nanoparticles for biomarkers. Working with new computational hire Sknepnek, biomedical engineer and clinician/technologist Cuschieri and electronic materials specialist Keeble, coupled with an indicative 2-3 hires over the next four years we aim to have a niche material engineering group that will primarily explore the production of materials based around nanoparticle and nanostructured material properties.

(iv) **To take a UK lead in global-challenge-based interdisciplinary research and teaching**

Having established a strong base line of research funding since RAE2008, a key strategic goal is to move outside our comfort zone, targeting more ambitious challenges, e.g.

- ***Physical Oncology*** – "application of engineering and physical sciences to cancer". The new Dean of Engineering (Tim Newman) is a member of the US National Cancer Institute's Physical Science Oncology Centre network. He is working with Professor of Surgical Oncology, Alastair Thompson, and the Dundee Cancer Centre to nucleate a UK-leading strength in physical oncology. Research will take diverse forms, from improved diagnostics and therapeutics to new conceptual approaches to cancer progression.
- ***New antibiotics*** This is a grand challenge that will primarily be built around our computational modelling group, and the computational investigation and design of new antibiotics. This is an impending global health challenge (or indeed crisis) as resistance to current antibiotics is growing and may vanish in the coming few decades. Dundee is a UK leader in this area through the work of the Drug Discovery Unit within the College of Life Sciences, with strong links to the major pharmaceutical companies.

(v) **Develop a research space, linking engineering and the arts**

The V&A Museum coming to Dundee in 2015 is one of the flagships of the £1bn redevelopment of the Dundee waterfront and city centre. The Museum will be on around aspects of design and has strong links with the University's Duncan of Jordanstone College of Art (DJCAD). There are clear synergies between our groups in photonics and materials and the artists and designers within DJCAD and we are developing a number of projects between the two groups looking at aspects of laser materials processing for jewellery design and smart fabrics, and are collaborating on design projects making use of 3D printing. We will foster these linkages and grow into this new research space to become a leading proponent of technology led creative design.

Central to achieving these all these aims will be a further increase in research funding, especially from the RCUK and EU. Within the REF period, the award of a range of significant (>£1m) grants, primarily from EPSRC, including the awards to staff of EPSRC Fellowships, compellingly indicates the viability of world leading research in our areas of strength. We aim to improve the number of staff holding RCUK funding at any one time, and through research collaboration across the University develop larger groupings that can gain more ambitious 'Programme' funding. In parallel with this we will make more intensive use of Horizion2020 funding mechanisms. We have been successful in some very large (>£10m) research projects over the past six years, and in smaller projects, and there is scope for expansion in this area. The award in 2013 of an ERC Starting Grant to an ECR within biomedical engineering (Prentice), gives us confidence that our new staff can emulate such awards – our staffing strategy is designed to nurture our young staff towards such end goals.

c. I. Staffing strategy and staff development

The RAE 2008 strategy to develop research expertise in a number of core areas has been supported with significant investment in new staff in each of these areas. Recruitment since has been highly strategic, bolstering existing areas of strength (biomedical, photonics) and nucleating new areas of strategic importance to the University (computational modelling), allowing new interdisciplinary collaborations to be formed. This has occurred in parallel with the appointment of postdoctoral staff who have gained personal fellowships to permanent academic posts. Abdolvand, Cataluna and Demore through the award of EPSRC, RAEng and Royal Society of Edinburgh Fellowships in key areas of research interest have been fast tracked to permanent posts (initially all to Lecturer, Abdolvand now a Chair, Cataluna now Senior Lecturer). Our other appointments have focussed on identifying researchers with significant potential in terms of their research achievements and future research impacts. Cizmar, Wilcox, Sknepnek, Pisliakov Matsumura and Zachariae, our other new hires, have all been appointed to their first academic posts.

New members of staff have been appointed with reference to the physical infrastructure of the UoA. Cataluna, Cizmar and Wilcox will develop their own photonics laboratories, slotting into the generic infrastructure that has been developed around the rest of the grouping. Abdolvand has been hired specifically with a view to invigorating the use of infrastructure such as electron microscopy and the cleanroom facilities, as well as establishing new laboratories for laser materials processing and production of nanoparticles.

The computational hires have access to the large computing cluster based in life sciences, and we have made further investment in new nodes for the cluster for the exclusive use of our staff. The new computational biophysics hires (Zachariae and Pisliakov) have been sited within the College of Life Sciences footprint to encourage interdisciplinary work, and this is in keeping with labs already housed in Life Sciences occupied by our biomedical engineers.

Career development support (RAs, early career, established)

The University is committed to supporting academic staff at all career stages. A key component of this is the OSAR (Objective Setting and Review) process, which is performed each year for all members of staff. OSAR allows year-by-year monitoring of research goals, achievements and challenges. All early career faculty are assigned a mentor (a senior academic in a closely aligned research area). The Early Career Academic Mentoring Scheme (joint with St Andrews University), ensures that researchers (typically post-docs or early career academics) are supported in developing their careers through a variety of possible career paths.

The development of researchers, both postdoctoral researchers and early career academics, is integrated into the Human Resources strategy with training and development opportunities for all staff and postgraduate researchers provided centrally by the Organisational and Professional Development unit (OPD). OPD provides a programme of training and development opportunities for all staff and postgraduate researchers at the University of Dundee. It offers more than 100 courses in areas from research project management to advanced statistics.

We support our principal investigators by providing the infrastructure and facilities they need to be internationally competitive. The OSAR meetings for PIs determines whether there are steps that could be taken to enhance research progress (allocation of more space, access to infrastructure).

The University of Dundee formally launched the ‘Concordat to Support the Career Development of Researchers’ in February 2009 and the UoA is engaged fully with the University Concordat Action Plan. The University was awarded an ‘HR Excellence in Research’, award by the European Commission, an accolade granted to universities within the EU whose policies and processes demonstrate a “stimulating and favourable working environment for researchers.“

Staff with personal fellowships

Within the General Engineering unit of assessment, seven staff (35% of those listed in REF1a) have held competitive personal fellowships over the REF period, as listed below:

Prof Amin Abdolvand, EPSRC Career Acceleration Fellowship (2010-2015)
Dr Paul Campbell, Royal Society Industrial Fellowship (2011-2014)
Dr Maria Ana Cataluna, Royal Academy of Engineering/EPSRC Fellowship (2009-2014)
Prof Sir Alfred Cuschieri, ERC Senior Investigator (2011-2016)
Dr Christine Demore, Royal Soc. of Edinburgh Caledonian Research Foundation Biomedical Personal Research Fellowship (2013–2017)
Dr David McGloin, Royal Soc. Univ. Research Fellowship (2003-2008), extension (2008-2011)
Dr Keith Wilcox, EPSRC Early Career Fellowship (2012-2017)

Additionally, Paul Prentice has a ERC Starting Investigator Grant (2013-2018), Graham Berry was a Scottish Enterprise/Royal Society of Edinburgh Enterprise Fellow (2008-2009, now working for Silberline); Nart Dagestani held the same fellowship and is now at RAL. James Cairns held a Leverhulme Emeritus Fellowship (2010-2011). Michael MacDonald was an EPSRC Fellow (2005-2010) and is currently a Senior Lecturer in Physics at Dundee.

International appointments, recruitment and visitors

The new appointments in UoA15 over the REF period have been highly international, with nearly all having spent some part of their training in countries outside of the UK. In particular, amongst our recent recruits through the Dundee Fellows initiative, which was a global search for the best new staff, Drs Soko Matsumura, Andrei Pisliakov and Rastko Sknepnek were previously at the University of Maryland (US), RIKEN Institute (Japan) and the University of Syracuse (US), respectively. Drs Zachariae, Cizmar, Cataluna, Demore and Prof. Abdolvand have all been

appointed from UK Universities but all are foreign nationals and have experience of research environments outside the UK. Indeed our research groups are highly international with 12 of the 18.75 staff coming from outside the UK. Outgoing staff have also been successful in taking up permanent academic positions (at universities in Nanjing, Beijing and Shanghai).

We have many visiting scholars, funded through sources such as EPSRC, SUPA, the Royal Society and the University. Examples include Physics Nobel Laureate Zhores Alferov in 2008, EU funded visits (Postema, Bergen; Tomizawa, RIKEN), EPSRC visiting fellows (Spalding, Illinois Wesleyan, 2009-2013; Hilgenfeldt, Illinois-Urbana Champaign, 2009) and Marie Curie Fellows. We have weekly seminars with national and international speakers, and are part of the SUPA Distinguished Visitor Scheme hosting prominent scientists at Scottish physics departments.

Supporting equality and diversity

The University of Dundee is committed to equality and diversity in all aspects of recruitment, staffing, and training. Of the 18.75 UoA15 submitted staff there are four (three appointed since REF 2008) full-time female members of staff: Drs Maria Ana Cataluna (*Senior Lecturer*), Christine Demore (*Lecturer*), Soko Matsumura *(Lecturer*) and Zhihong Huang *(Reader)*. In our recent recruitment efforts, improving the balance of male:female members of staff has been an important issue, and we have ensured good gender balance on recruitment committees, and sought to improve the number of female interview candidates. Increasing the number of female applicants will be an important part of future recruitment efforts. This will be achieved through better internal mentoring for female staff and postgraduate students and better undergraduate recruitment and schools outreach to promote science as a career for female students. Staff are required to be familiar with equality and diversity issues in the workplace and undergo mandatory training through a series of online modules, e.g. *Diversity in the Workplace*.

c. II. Research students

Studentships are available through a range of mechanisms, including pooling exercises such as the SUPA, the Northern Research Partnership (NRP), an EU ITN (Integrated Interventional Imaging Operating System), an EPSRC DTC, embedded studentships within EU grants as well as through our allocated EPSRC Doctoral Training Account (DTA). We also receive a number of students through the Chinese Scholarship Council, which selects the very best students from leading Chinese Universities for overseas PhD awards.

Each scheme is managed according to the requirements of the funding source. SUPA appoints students after an international search: only the most outstanding candidates get positions. NRP studentships are awarded after a competitive review of applications from across the three member organisations. The other routes are more traditional, but our DTA account is split to fund only 50% of a studentship, and these are then awarded in open competition with others who can match the award, leading to improved numbers of interdisciplinary and industrially linked research projects. The UoA has graduated 44 PhDs in the REF period with 50% of those in the past two years.

The University of Dundee has developed its own “Code of Practice for Supervised Postgraduate Research” and this underpins research student support and progress oversight. Each student is assigned at least two supervisors from the UoA, sometimes three when dealing with inter-disciplinary research. Additionally each has a ‘Thesis Monitoring Committee’ (TMC) comprising two further academics from outwith the research project area, to act as pastoral and impartial overseers of the work. Students meet with their TMC twice a year and discuss achievements and goals and any issues with supervision. Students and supervisors receive feedback from this process. Students formally pass into the PhD programme at the end of first year after satisfying supervisors and TMC, after review of a project plan, report and oral examination.

Because the UoA is part of the SUPA Graduate School, which has over 500 registered students across Scotland and offers a suite of more than 50 modules via video conferencing facilities in each of the eight member departments. All students within the UoA have access to these, and those registered with SUPA directly must complete 40 hours of credit bearing taught courses within their first two years of study. Students also have access to video conferencing seminars, opportunities for work-based research placements, and residential study courses in, for example, practical skills for life sciences research. They must additionally attend 20 hours of generic skills training, typically delivered on campus by the Organisational and Professional Development Office.

d. Income, infrastructure and facilities

Provision/operation of specialist infrastructure/facilities

UoA15 research at the University of Dundee requires significant infrastructure for its day-to-day operations. The research laboratories contain a wide range of state-of-the-art photonics infrastructure, including laser systems spanning all temporal regimes, and associated measurement and characterisation equipment. The materials laboratories have had significant new investment in equipment to fabricate, characterise and print nano-materials, including nano- and pico-second lasers for industrial processing. Characterisation is carried out in the Analytical Electron Microscopy (AEM) laboratories, which have scanning and transmission electron microscopes with in-built analysis techniques such as EDX. The AEM facility also contains AFM and Scanning Capacitance devices. Additional materials and device fabrication is carried out in the cleanroom suite which contains e-beam writing, photolithography and wet chemistry infrastructure.

The biomedical research laboratories have a range of highly specialised equipment, including a 1.5T research MRI machine (part of the GE European Centre of Excellence for MRI guided Interventions and Surgery), a PET/CT scanner, an X-ray arm, an MR compatible robotic arm and an ExAblate focused ultrasound surgery system. Additionally there is a suite of ultrasound fabrication equipment. The labs include facilities to handle soft-embalmed cadavers prepared in the Dept. of Anatomy, which are used to test research techniques in medical imaging and therapy.

The computing cluster used by computational group is based in the College of Life Sciences and is a high end facility comprised of 57 nodes, each with between 8 and 48 64-bit cores and 16 to 128Gb memory. The cluster is also used by some of the biophotonics staff for image and data analysis. UoA15 resource has been used to provide £170K of funds, for expansion of the cluster.

Investment in infrastructure and facilities

Investment in infrastructure surrounding and pertinent to UoA15 is extensive. The provision of new laboratories for existing and new hires has led to a new suite of photonics, materials and biomedical engineering labs through investment of £3m (including a £2m ERDF grant). This has led to new materials labs (Abdolvand), new photonics labs (Rafailov, Abdolvand, Cataluna, Cizmar, Wilcox) and new biomedical engineering ultrasound labs (Cochran, Demore).

The UoA is also investing approximately £1.1m in new laboratories, computing infrastructure and laboratory equipment as part of an investment in the biophotonics and biomedical engineering areas through the SUPA initiative. The main outputs of this will be a new suite of imaging laboratories within the College of Life Sciences and refurbished cleanroom equipment. The new lab suite is designed to allow the intimate collaboration between physical and life scientists/engineers, with our engineers providing cutting-edge technological development in imaging technologies, and life scientists providing the application context, key questions and need. It is further being supported by the University through investment in postdoctoral support staff and technical staff.

The University is completing construction of a £25m building, the Centre for Translational and Interdisciplinary Research, designed for interdisciplinary life science research. The second floor is dedicated to computational approaches, and staff members Drs Pisliakov and Zachariae, who lead our computational modelling effort, will be located there on opening in January 2014.

The UoA is currently developing plans to make use of a scheduled £3m University capital funds investment. This will be used in further refurbishment of laboratory space to develop more integrated approaches to our research. It will also be used to deliver more effective interdisciplinary research spaces, with highly configurable areas that will allow researchers to come together to tackle bigger challenges in much more flexible ways than is currently possible.

Research funding portfolio and future plans

Our current research portfolio is a healthy mix of EU, RCUK, Charity and Industrial funding, totalling £15.3m in *income*, up from £11.6m in RAE2008. Major awards have been secured from the EU (€13.7m FASTDOT project 2008-12, €11.8m NEWLED project, both led by Dundee 2012-16 are key examples) and EPSRC (£6m Programme Grant, 'Sonopill' 2013-2018, the highlight). The spread of research income is fairly even with RCUK supplying 49% and EU funding 34%.

Key goals in the next five years are to grow research income further, and to develop the grant portfolios of our ECR staff. With an influx of new staff, many from junior roles and from overseas, there is significant scope for personal fellowships (ERC and ESPRC being key targets) and to take

advantage of funding through Horizon 2020. Our emphasis on interdisciplinary work fits very well within the proposed Horizon 2020 thematic areas. Developing critical mass in our four research groups will open significant funding routes, especially in Programme level funding, targeting areas in biophotonics, imaging, cell membrane computational biophysics and ultrafast laser systems.

With the emphasis on securing more Horizon 2020 funding comes the need to develop much better links with industry. Currently 7% of our income is derived from industry sources, and ideally this should increase, to better develop our research impact. We will achieve this through H2020 funding and also through more targeted use of funding streams through the TSB and KTP schemes, and University investment through dedicated SUPA knowledge transfer funding.

Consultancies and professional services

Within the Tayside area, the research infrastructure of UoA15 provides a professional service to local companies. Electron microscopy and analysis is used regularly by local companies such as Flint Group, Berwin Polymer Processing, and Siberline. We have also established a 3D printing centre that offers rapid prototyping services to external users, working primarily with local companies, such as the St. Andrews Gold Company. A significant professional service is offered by the Cuschieri Skills Centre, which offers professional training for surgeons in minimal access surgery techniques. This offers courses to hundreds of surgeons each year from all over the world.

Additionally the University has a service called the “Innovation Portal” which offers consultancy, within the UoA, on biomedical devices, photonics and materials. This is specifically for engagement with SMEs. A number of consultancy services have been provided through this mechanism, often using innovation Vouchers. The Innovation Portal helped fund work with M^2 Lasers, for example, that led to a €1.2M EU project to develop new lasers based on a technique called ‘conical refraction.’ A further example of funding was the project for plastic building products specialists, Clear Amber looking at anti-microbial coatings for their products made for medical environments.

e. Collaboration and contribution to the discipline or research base

Research collaborations and interdisciplinary research

The work carried out by the UoA is highly collaborative. Our major EU awards involved multiple UK and overseas partners, both academic and industrial. The FASTDOT project to develop new ultrafast laser systems based on quantum dot technology, for example, included 10 academic partners, including ETH Zurich, KTH Stockholm and ICFO Barcelona as well as 7 industrial partners including Philips. National level funding is also typically carried out with external collaborators. The EPSRC Sonotweezers project to develop micromanipulation techniques using ultrasound, funded by EPSRC, was a collaboration between Glasgow, Bristol and Southampton and the Sonopill project involves Glasgow and Heriot-Watt Universities and 15 local, UK and international companies covering the gamut from micro-company to multinational.

Interdisciplinary research is at the forefront of our UoA. The establishment of IMSaT has been key to developing our approach in this area, through the idea of embedding researchers from one environment into another to facilitate translation. This has been highly successful and IMSaT based members of the UoA have garnered significant funding (>£7m from EPSRC, >€6m from EU, personal fellowship awards) through this approach. This has focussed mainly on ultrasound and MRI research areas, but more recently has also had success in developing new interdisciplinary research programmes in photonics, especially the new €2.3m ABLADE project designed to develop new laser sources for treating bladder cancer, which is a collaboration between UoA photonics engineers and surgeons based at Ninewells Hospital.

This approach is now being successfully extended to other areas. The University supports interdisciplinary workshops, with a recent example in biophotonics leading directly to a €3.7m EU ITN awarded jointly between the UoA grouping and the University College of Life Sciences. We have, as mentioned, embedded staff within the new Centre for Translational and Interdisciplinary Research, and have other laboratories within Life Sciences. For example Campbell has a lab within Molecular Medicine that has led to work on novel forms of drug delivery to the skin, playing a key role in a £5.9m Wellcome Trust Strategic Award to Molecular Medicine. The new award of the £1.3m MRC project, “Dynamics of Fundamental Cellular Processes by Live Cell and Tissue Imaging”, focusing on super resolution and light sheet microscopy and joint between this UoA, Computing and Life Sciences is evidence of the approach we are taking to maximize the expertise of staff to tackle new and important interdisciplinary research questions.

Research with users

Many of the research interactions discussed above, due to their interdisciplinary nature, are with the end users of the research, especially clinicians and life scientists. This has an impact on how we use these interactions to better inform research activities and strategy. The closer alignment of the UoA work with life sciences and medicine has been the most immediate consequence, and this has led to a focus on this interface in our recent hiring decisions, and the decision to further develop research labs for future collaboration, funded through SUPA. The aim is to open up new research avenues, different funding streams and to help train a new generation of interdisciplinary thinkers.

Our significant interaction with end users through the many EU projects we have been involved with has helped to shape our research thinking and direction. In some cases, such as collaborations with laser companies, (e.g. M Squared) Lasers, we have seen projects move from research to proof of concept work, through TSB funding. In other cases it has led to re-thinking research directions – for example, the focus of the photonics group has very much been on the development of laser sources, but interactions in the FASTDOT project to develop quantum dot based lasers, led on to the NEWLED project to develop consumer light sources.

The work by the Cuschieri group in surgical technology has been supported over a significant period by industrial connections to Karl Storz GmbH, and the creation of a UK subsidiary Karl Storz (UK) in Slough. This UK branch is expanding its manufacturing on the Ninewells medical campus. Photonics innovation, has led to a number of agreements between the University and laser manufacturing companies, in particular with M^2 Lasers and Innolume.

Leadership

Editors-in-Chief: Surgical Endoscopy (Cuschieri); Physical Biology (Newman)

Editorial Board Membership: J. of Appl. Mathematics (Decent); IEEE Trans. Ultrasonics, Ferroelectrics and Freq. Control (Demore); Advances in Optics (Cataluna); Surgical Innovation; Intl J. of Medical Robotics and Computer-assisted surgery; Minimally Invasive Therapy and Allied Tech. (Cuschieri); Minimally Invasive Therapies and Allied Technologies; Journal of Focused Ultrasound Editorial Board (Melzer); Bubble Science, Engineering & Technology (Campbell)

Guest Editorships Optics Express (McGloin); Advances in Acoustics and Vibration (Campbell)

Conference Chairs: OSA Optical Trapping Applications, 2009, 2011, 2013 (McGloin); Fraunhofer-DGBMT-SMIT Symposium (2008-2013), 2nd European Focused Ultrasound Therapy Symposium, Rome 2013 (Melzer); IEEE Ultrasonic Symposium, “Transducers and Materials” (Cochran)

EPSRC College Memberships: Abdolvand, Campbell, Cochran, Rafailov, Wilcox, Zhao

Notable review board memberships: ERC Starting and Consolidator LS7 panel 2011-12 (Melzer)

Plenary/Keynote Lectures (Exemplars) 23rd SMIT Conference, Tel Aviv 2011 (Melzer); Intl. Symposium on Bioelectronics and Bioinfomatics, Suzhou 2011, 9th Bergen Conference on Cancer Research 2008 (Campbell); German Biophysical Annual Meeting 2012 (Zachariae); SMIT Congress Vienna 2008 (Cushieri); Heat Exchanger Fouling and Cleaning X 2013 (Zhao)

Awards: Thales Scottish Technology Prize (Abdolvand, 2010); Philip Leverhulme Prize – Engineering (Cataluna, 2011); International Steven Hoogendijl prize (Cushieri, 2012); Life-time achievement award, Endoscopic and Laparoscopic Society of Asia (Cushieri, 2013)

Fellowships: Inst. of Physics (Campbell, Cochran, Newman); Royal Astro. Society (Campbell); Inst. of Mathematics and its Applications (Decent); Optoelectronics College (Cataluna)

Learned/Professional Societies: Elected member Inst. of Physics Scotland Committee (McGloin); Board member: Campaign for Science and Engineering (Cataluna); Governor: Dundee Cancer Centre Board (Newman); General Secretary: Intl. Society for Surgical Innovation and Technology; Member: IEEE Piezocrystals Standards Committee (Demore); Elected Council member: Inst. Maths and its Applications (Decent); Executive Secretary NASA Cassini Rings Panel (Matsumura)

Other: Advisor to International Federation of Surgical Endoscopic Societies (Cushieri).