Institution: University of Surrey

Unit of Assessment: UOA 15 General Engineering

a. Context

The Unit has a strong track record of applied research, which has led to the establishment of links with an extensive range of end-users who have benefitted from its four research themes: (i) *Fluids and Vehicles* [F&V], (ii) *Infrastructure*, (iii) *Water, Chemical and Bio-Systems Engineering* [WCBS], and (iv) *Sustainable Systems*. The **main non-academic user groups and beneficiaries** of the Unit's research and the **main types of impact** include (by no means an exhaustive list);

Business and Industry: for example Rolls Royce, the petrochemical industry, Jaguar Land Rover, McLaren, Williams, Unilever and Marks and Spencer. In particular, research in *F&V*, *Infrastructure* and *WCBS* has led to reduced costs, and the development of new and improved materials, products, processes and treatments. There has also been; improvement to existing practice, ensuring compliance with new legislation and the development of new design methods, new computer codes, data-bases and standards. Research through well-established partnerships with Thames Water and Network Rail is delivering impact through new knowledge and associated methods for improving the asset management of complex, ageing, network systems (for example, cast iron pipes, masonry & steel rail bridges). Also in *Infrastructure,* work with the Society of Chemical Industry (SCI), the British Constructional Steelwork Association (BCSA) and others has promoted the use of modular steel construction and contributed to both national and international design codes.

Government agencies: for example The Home Office, London authorities, NHS and the Environment Agency. In particular, research in *Sustainable Systems* has led to economic and societal impact through improved systems and methods for life cycle assessment (LCA), supply chain management and sustainability analysis across both public and private sectors. The new LCA methods are embodied in tools developed by the UK Environment Agency and are employed by all local waste management authorities, and environmental consultancies have been established to apply the tools. Research in *WCBS* has had impact in the health sector through the development of new technologies (and a spin-out company DEPtech) and through the development of methods to predict patient cancer response to radiotherapy treatment in terms of both treatment efficacy and side effects.

Charities and Non-Government Agencies: for example The World Health Organisation (WHO), Oxfam and Médecins Sans Frontières (MSF). In particular, research in WCBS has attracted the attention of overseas governments, international agencies and relief organizations and led to initiatives which have provided economic and societal benefits across the developing world. Training projects have been completed in at least 45 countries, most recently in Africa and China. In addition, manipulated osmosis technologies patented and developed at Surrey have led to the installation of commercial desalination plants overseas.

b. Approach to impact

The Unit has various approaches to realising impact from research. The fundamental approach is to apply novel thinking and analysis to critical problems, with the aim of generating sustainable, knowledge-led solutions that provide measurable benefit to individual organisations and the wider community. This embraces multi-disciplinarity (where appropriate) and is underpinned by a commitment to deliver commercial advantage and opportunities to develop valuable intellectual property. The key impact enabling mechanisms are as follows:

Partnerships: We have benefited from a number of long-term strategic relationships. Links with Thames Water and Rolls-Royce for instance both go back 15 years, with the Rolls Royce UTC

established in 2003. As illustrations of the work being undertaken and its impact, CFD modelling of droplets in cross-flow is being used by Rolls Royce in its design method for jet engine fires, whilst work with Thames Water has had significant impact on the asset management of cast iron water mains and has led to investment in a new technology to improve energy recovery from sewage. In addition to the impact delivered through these collaborations, their high-profile nature means that other users seek to engage with staff working with these organisations. Other parts of the Unit that have achieved particular external recognition are approached similarly. For instance, within *WCBS* there is a group designated as a WHO Collaborating Centre for the Protection of Water Quality and Human Health (and part of the UNICEF WASH cluster group of relief agencies) as a Centre of excellence in water and sanitation. In addition to this the Environmental Flow Research Centre (*F&V*) is a NERC-NCAS Centre for Atmospheric Sciences. Through such connections we seek to identify the most effective way to deliver impact on an appropriate timescale, including defining appropriate internal partnerships across discipline boundaries. Modes of engagement include involvement in student projects, hosting a KTP, partnering on Research Council or EU collaborative programmes or fully funding a research programme. All of these deliver impact in terms of knowledge transfer.

Industrial Doctorate Centres: There are two EPSRC-supported Industrial Doctorate Centres at Surrey; Sustainability for Engineering & Energy Systems (SEES) and Micro- and NanoMaterials and Technologies (MiNMaT), both of which host EngD Programmes. Research Engineers (REs) are based in the sponsoring organisation working under the direction of industrial supervisors, in close collaboration with the University supervisors. This arrangement shortens the pathways to impact and strengthens the impact significantly, and is especially useful for SMEs. Almost all of the graduates from the EngD programme remain in industry (c. 35% with their sponsoring company) and these graduates (more than 100 since 1997) represent a significant impact within the sector. Many of the companies involved in the EngD scheme have provided repeat business.

Networks: External to the University, members of staff engage with our user community in many ways, e.g. at conferences, through consultancies and by membership of working groups such as professional institution committees, company advisory boards, UK government advisory boards and international committees. These links often generate more specific interactions which ultimately lead to impact through knowledge transfer and also the formulation of policy. For example, in terms of shaping policy, Jackson's report through the Sustainable Development Commission on 'Redefining Prosperity' is the most downloaded publication (>125,000) and has stimulated high level policy debate worldwide (e.g. Germany, Lithuania, China, South America); whilst in the UK it has influenced the Environmental Audit Committee and subsequently UK policy on company emissions reporting.

Knowledge Transfer Account: The University has recently formed a strategic partnership with the National Physical Laboratory (NPL), which was a partner in its successful EPSRC KTA (£3.5M) bid. This has facilitated impact by provided training and support to academics to help embed the benefits of working with companies. Support has also been provided to help deliver impact in specific research projects so that academics in *WCBS* have received funding for projects; to develop predictive modelling of patient and clinical data and to explore the use of DEP to detect oral cancer. The relationship with NPL is ongoing, in particular through support of IDC activities and through the follow-on EPSRC Impact Acceleration Account (£1M).

University Support: The UOA is supported in its approach to impact by the University's Research and Enterprise Support (RES) Team. As well as providing Knowledge Transfer expertise to ensure the commercial exploitation of research, RES also provides project management for the key partnerships and requisite commercial, legal and IP expertise to help enable the creation of impact through licensing and spin-outs. This includes having an incubation centre on the Research Park

for early stage companies.

Other Mechanisms: We invite carefully chosen representatives of the user community to be members of Advisory Boards associated with the various research themes. Visiting appointments also promote effective links with our partners; we have also hosted colleagues seconded from industry. We hold research open days, workshops and dissemination meetings to showcase aspects of our activities; introductions are facilitated by RES and meaningful collaborations often develop from an initial piece of short-term work or consultancy. There are also approaches from potential users in response to press releases from the Faculty Marketing Team.

c. Strategy and plans

We have conducted a review of impact activity since 2008, highlights of which are included in section (b), and understand the value in creating more formalised structures and support around impact. The successes in the period have informed our strategy for achieving impact going forward. The review has also highlighted activities that could be better exploited, and in some cases work has already begun on these. The key elements of the strategy are:

- To maintain and build on our long-standing relationships with industrial partners, using accumulated experience of how to manage such partnerships effectively through periodic updates, aiming to understand business needs and outlining our research plans at an early stage. In addition, we will extend our range of major industrial collaborators; in that respect we have just started a new activity with BP (£5M over 5 years), which is focused on the development of new technologies to reduce the energy required to extract heavy oil and bitumen from oil sands.
- To work closely with colleagues in RES to develop plans for more effective marketing of our facilities and expertise, to further improve our engagement and its relevance to the needs of the user communities that we support. This will also involve continuing to build our portfolio of advanced training and professional development material.
- To recognise and exploit the fact that EngD Programmes will continue to provide a particularly effective mechanism for engagement with our user communities. In our newer IDC (MiNMaT) we have clear evidence of developing impact, notably in relation to *Infrastructure*, and we anticipate there will be strong exemplars from that activity within the next REF period.
- To accelerate the impact agenda through increased internationalisation, which is within our current agenda through working with large multi-national companies and also through our work in the developing world. Collaborations through the expanding University Global Partnership Network (UGPN) will provide new opportunities for transnational knowledge exchange and accessing new user communities.
- To ensure staff receive appropriate training in Knowledge Transfer and impact, so that it is embedded more effectively into our research. Through RES we will continue to provide support for members of staff who develop patentable ideas with the potential to lead to spin-outs. The large number of 'new staff' (approximately 70% of this submission) will have a major role in developing impact from the research in the Unit over the forthcoming REF period so it is important that they understand and develop the embedded ethos of impact and its relevance.
- To utilise annual staff appraisals to recognise and reward achievements in impact, and recognise excellent impact at University level through annual impact awards.
- To appoint dedicated 'Impact Champions' to increase exposure and dissemination of impact activity within the Unit and to identify routes to impact of key research findings.
- To utilise sabbaticals as a mechanism to help staff to develop opportunities in technology transfer and commercialisation of their research.

- To strengthen our alumni programme to ensure that our graduates remain advocates for the Unit's research and technical capabilities throughout their careers.
- To support staff and students in establishing start-ups and external consultancy to companies through the mechanisms of research days and flexibility of 'time off', and through providing manpower resources to support start-ups via placement and PhD students
- To pro-actively use the Faculty Marketing Team to generate a much more widespread awareness of successes and capabilities through the use of research blogs, web video content and social media, as well as develop an independent public engagement pathway. The latter will help to raise awareness amongst the general public of the socio-economic benefits that are accruing from our research outputs.

Existing impact success stories (see section (d)) have informed our approach to impact in a number of ways. The experience of working with Rolls Royce informed the development of the relationship with Thames Water, our steps to establish other long term relationships with the owners of other infrastructure assets (e.g. concrete and steel bridges) and those charged with their operation. The success of the multidisciplinary approach to environmental strategy was fundamental to the recasting of research from disciplines to cross-disciplinary themes from 2004. The evident success of the original EngD as a vehicle for promoting impact, both through the research and the graduates, was used as an exemplar when developing the second EngD Programme, MiNMaT. Examples of ongoing activities that are expected to deliver substantial impact for the relevant user community include: (i) a major programme initiative in Africa to develop new models for low cost low carbon energy to the urban poor, (ii) sources of and the effect of nano-particles in the urban environment, (iii) new vehicle technologies and (iv) advanced methods for reducing the risks associated with network assessment and management across a range of sectors.

d. Relationship to case studies

The six cases studies exemplify the approaches to realising impact outlined in section (b). The particular mechanisms are as follows;

Case Study 1: "Advanced aero thermo–mechanical modelling for improved engine design" and Case Study 2: "Asset management of aging cast iron water distribution network systems"

These are the culmination of long-term collaborations with single industrial partners (Rolls Royce and Thames Water respectively). Working in this way facilitates the development of a mutual understanding of the needs and capabilities of all concerned, enabling the creation of innovative and flexible research programmes that meet focussed industrial needs on a realistic timescale.

Case Study 3: "Changing industrial practice through life cycle modelling" and

Case Study 4: "Prosperity without Growth: the key to a sustainable future?"

These both originate from within the *Sustainable Systems* group, reflecting their well-established multi-disciplinary approach to the environmental agenda and engagement with relevant user communities through both the EngD programme and network interactions.

Case Study 5: "Modelling of Cancer Treatment"

This originated from an EPSRC 'discipline-hopping' grant in 2003, again reflecting the multi-disciplinary approach adopted by researchers within the Unit.

Case Study 6: "Low energy production of fresh water from the sea by Forward Osmosis"

This is an example of enquiry-driven innovation, leading to patent development, followed by a successful spin-out that was supported by the University financially and with expert support from the RES Team.