Institution: University of Teesside

Unit of Assessment: 15 - General Engineering

a. Context. Teesside University has a long tradition of successfully working with industry, and has set out an ambitious institutional aspiration in its Mission and Values to achieve recognition as the UK's leading university for working with business. Substantial progress has been made towards meeting this aspiration in the current REF period: Sir Andrew Witty's "Review of Universities and Growth (2013)" reports that *"[s]ince January 2011, Teesside University has worked with over 1,000 organisations, supporting over 650 companies …and creating over 550 jobs. Over the past decade 430 new businesses have been created…"* In November 2013 the University was awarded the Queen's Anniversary Prize for our outstanding enterprise and business engagement work.

In the engineering research context the Technology Futures Institute (TFI) has taken a strategic decision to focus research on the development of practical/implementable solutions to key engineering challenges. The research prowess of TFI members and the research we produce lie at the cutting edge of applied science and engineering; the majority of our research is focussed on work at or transitioning to Technology Readiness Level 2, and on effecting successful technology transfer based on ground breaking applied research. Our decision to invest substantially in staff and research capability in order to partner with the Centre for Process Innovation and to collaborate with and complement the work of the associated High Value Manufacturing Catapult is reflective of our strategic commitment to this. The thematic research areas we have chosen reflect the congruence of clear societal/industrial need linked to a need to develop new scientific/technical approaches and solutions.

Our activities encompass a diverse range of organisations from multi-nationals to SME's, start up and spin out companies, and we have been particularly successful in exploiting knowledge and technology transfer mechanisms as a route to securing impact.

b. Approach to impact Our approach to securing academic impact is largely described under research environment. In short, we have chosen to *focus on applied, collaborative research with both industrial and academic partners, where our specific expertise is complementary and adds real value* addressing specific technological problems as part of larger areas of research. Our work with partners such as Rolls-Royce, IBM, Qatar Project Management, HOCHTIEF-Vicon and Ramboll and universities and research institutes such as Sheffield, Manchester, Oxford, VTT Finland, Tokyo etc. exemplifies this. We believe that this collaborative approach allows us to leverage the maximum impact from our research activities. Although defined in its current terms only relatively recently, the securing of other forms of non-academic impact in terms of economic, environmental and societal benefits from its activities has been central to our University's ethos since its inception and continues in our current mission as outlined below.

Work with Business to facilitate growth and wealth creation. We are accredited to the "Putting the Customer First" standard for our work with business, and almost all the research activity undertaken through the TFI is deliberately industrially driven and/or involves significant industrial collaboration. Our focus on EC framework, TSB (including KTP) and industrially sponsored research reflects this.

Teesside University leads the NE England's consortium delivering the Enterprise Europe Network comprising Teesside University, the Centre for Process Innovation (CPI) and Newcastle Science City. The TFI utilises this key network for engineering companies wishing to increase their competitiveness and productivity as a route to securing new research partnerships, facilitating knowledge transfer and achieving impact.

The TFI also includes an externally facing business unit which focuses on technology transfer and innovation activities, and projects such as the Science 2 Business Hub aimed at enhancing interaction between research and industry. Selected examples of typical impacts from these activities include assisting product development and performance enhancement of instrumentation systems (Electrochemical Sensor Technology Ltd Technical Director);"...increased speed to market…for novel oilfield chemicals" (Linchem Technical Manager); and work on the function of metallic alloys as 'getter' materials with Johnson Matthey PLC, anticipated to lead to an increase turnover in sales of ~£1 million within 3 years (Johnson Matthey Business Manager – Electronic Materials). The business unit is integral to our strategy for networking and dissemination beyond the academic community: its staff regularly attend business events to disseminate the impact possibilities provided by TFI research and to maintain close, regular contact with senior leaders from businesses including GE Wellstream, Cummins and Siemens.

Exploitation and commercialisation. The University has a number of successful mechanisms for securing commercialisation of its technologies. In particular, we utilise The Commercial Edge Initiative to help identify our most commercially promising research exploitation opportunities and to provide senior business development and management experience for our spin-out ventures. These include Hot Coatings Ltd, a spin out from the research of Hodgson and Pang into high temperature capable flexible electrical insulation for electrical machines and generators, and based on our US and World patents in this area (WO2009150463). HCL is working with a range of companies including Rolls Royce, Safran and Schlumberger to develop commercial applications and is partner in a joint TSB innovation project (28239-196187) with the university and Rolls Royce (£149,969) to facilitate this. Similarly, Ali and Islam co-founded Anasyst (http://www.anasyst.com), a start-up company to commercialise their collaborative research on Cavity Enhanced Absorption Spectrometry (CEAS) and microfluidics point-of-care diagnostics research arising from the EU DVT-IMP (FP6-2005-IST-5-034256) and InFuLoC (FP7 GA230749) projects (coordinated by Ali). Anasyst has an exclusive license from Teesside University of a US patent (US8325342B2) on the use of CEAS in microenvironments, as well as three additional patent filings as part of a patent family for the CEAS technology. Islam has a share of a patent (10%) on use of BBCEAS in the gas phase (ISIS7028) from collaborative research with Oxford University, exclusively licensed to a spinout company (Oxford Medical Diagnostics, http://www.omdiagnostics.com/). A further example is Thompson's spinout company, Anthronomics Ltd (http://www.anthronomics.com/), focussing on new measurement technologies. To put into perspective the scale of this entrepreneurial activity, one-third of the staff in this unit of assessment have been directly involved as directors of spin out companies from their research over the past 3 years.

A particular area of strength for the TFI, and which forms an important element of our impact strategy, is in utilising knowledge transfer mechanisms as a two-way route, both as a means of identifying industrial challenges which can be addressed through research programmes, and transferring the outcomes of research to generate business and economic benefits. As an example of the former, our work in the food manufacturing sector, established in Knowledge Transfer Partnerships with International Cuisine Ltd (2008), Hain Daniels plc (2009-10) and SK Chilled Foods Ltd (2011), has led to recognition of common issues of resource efficiency, and led to a successful collaborative £1m project (£353k to Teesside) in 2013 to the TSB Food Processing and Manufacturing Efficiency research and innovation programme with Sainsburys plc, Tayto and SK. An exemplar of the latter is our research, undertaken during a three year KTP project with Datum360, leading to prototype software development the implementation of which has resulted in the receipt of £500k capital funding by the company (see REF3b). The effectiveness of our use of KTP programmes can be evidenced in the assessment and feedback received, with some 41% of our KTP programmes in recent years being graded as "outstanding", compared with a figure of less than 10% for KTP programmes nationally.

Impact infrastructure and support for staff. The TFI makes extensive use of the well-established University infrastructure for interactions with business, through the Department of Academic Enterprise. This provides support for assessing and protecting IP, undertaking consultancy and knowledge exchange, the development and management of commercial contracts with industry and establishing spin-outs. The TFI provides more focussed support for our engineering research community, including the provision of specific staff development activities through annual staff "awaydays" and engagement and dissemination activities such as monthly Business Breakfasts, and our annual Research Conference. Impact activities including business engagement are recognised within the University promotions scheme, and the professorial conferments scheme includes recognition of enterprise activities. There are also a number of institutional funding schemes which are designed to support the development of impact from research including the Enterprise Development Fund, and Enterprise Fellowships.

Other Impact. This wider impact infrastructure within TFI has resulted in a range of interactions with SMEs, creating more than 80 jobs, safeguarding a further 34, and achieving the environmental impacts of a reduction of 270,000 tonnes of CO_2 emissions, 460,000 tonnes of material diverted from landfill and the avoidance of 1,900 tonnes of hazardous waste. These activities are now consolidated in Resource Efficient Manufacturing Systems research team and the EU-FP7 IDEAS project (GA600071).

Recognition of the need to capture data relating to the impact of our work is an important outcome of REF2014 and the lessons learnt in compiling our Impact Case Studies and in reflecting

on our approach to impact during the REF period have been a guide to developing our Impact Strategy and Plans.

c. Strategy and plans

Strategy. The TFI's strategy for developing and delivering research impact over the next 4 years is set out as follows.

1. Focus on applied, collaborative research with both industrial and academic partners - particularly work at or aiming at TRL 2.
2. Focus on the continued development of specific highly targeted areas of research where we can provide complementary input and add value/capability to large projects and partnerships.
3. Ensure that all research includes the development of business models, exploring routes to market and routes to impact as an integral part of the research process.
4. Ensure that research partnerships are maintained beyond the lifetime of projects, building mechanisms of tracking implementation and application of outputs beyond project lifetimes.
5. Continue to focus on Knowledge Transfer mechanisms to identify research needs and facilitate the practical embedding and application of research to secure impact.
6. Identify, protect and accelerate commercialisation of intellectual property by building IPR planning into the early stage of research project development and actively managing IPR development and protection throughout the lifecycle of research projects, utilising the University IP infrastructure to achieve this.

Plan To achieve the elements of this strategy:

1. Staff development within the TFI will focus on practical application of research outputs: utilising academe-industry networks; accessing knowledge transfer and commercialisation follow-on funding, etc. TFI members will be provided regularly with information about the support available for staff in the development of impact.
2. TFI members will be encouraged to participate in *applications oriented* research programmes – notably the TSB innovation programmes and Horizon 2020. A working group will be set up to monitor calls from these strategically important funding bodies assisting members in identifying opportunities, prospective partners and in developing projects.
3. We will continue to work with external specialists (Commercial Edge, PERA) to identify commercial/exploitable research value and develop routes to market, spin-outs and licensing.
4. The TFI will encourage staff to pursue impact activities through recognition and incentives. Staff will be recognised in any commercial agreements and profit sharing mechanisms employed, where appropriate, to encourage staff to develop impact. Internal resource allocation models will be used to fund mechanisms for this development.
5. An infrastructure will be established to enable client relationships to be maintained over the timescales needed to identify and track impact (via the university Dept. for Academic Enterprise) and a 0.5 FTE role will be created within TFI to facilitate staff in securing impact and to coordinate data capture.
6. The Institute will continue to engage closely with key partners, stakeholders and intermediary bodies such as the local enterprise partnership, CBI, NECC, NEPIC and resources will be made available for staff to travel in support of these activities.
7. Through the recently established strategic partnership with the Centre for Process Innovation, application-based research programmes related to sustainable manufacturing will be developed and linked where appropriate to the High Value Manufacturing Catapult of which CPI is a hub.
8. Research and industry links will be further embedded in the undergraduate and postgraduate curricula. The numbers of modules run by industry partners, placements and industry co-supervised projects will be increased. Students will be encouraged to consider an entrepreneurial career through initiatives such as entrepreneurs@tees.

d. Relationship to case studies The construction planning tools case study exemplifies our approach to impact generation. Underlying research was conducted between 2000 and 2006, funded by EPSRC and EPSRC/Innovation Manufacturing Centre. The outcomes of this work have subsequently been extended and applied to satisfy the needs of industry *via* a number of knowledge transfer interactions and strong networks with several companies in the UK and internationally. The Impact Case Study outlining our work with ABB and the development of PfMaster demonstrates our approach to protecting and exploiting IP through strong industrial relations.