Institution: University of Lincoln

Unit of Assessment: General Engineering

a. Context

The establishment of a new School of Engineering in Lincoln is the result of a strategic vision by the University; with a core mission to work with industrial companies throughout the region and much wider, and with a strong focus on energy conversion and systems engineering. The School has emerged as part of a recent (2009) brown-field development initiated in a traditional 'cold-spot' for HE engineering research, and now provides a strategic centre for Lincolnshire and the wider region with an overarching goal to improve high technology research and development through strategic links with SMEs, OEMs and others. At the heart of this cluster, and a primary contributor to the School's formation, is Siemens Industrial Turbomachinery (Lincoln), which has been manufacturing gas turbines to clients worldwide for more than 150 years.

The culmination of this investment was a new £7.5m Engineering Hub, which opened its doors in September 2011 to provide state-of-the-art facilities for research and pre-competitive development. Beneficiaries have included collaborating companies and organisations; healthcare, aerospace, energy and food manufacturing sectors; as well as home and overseas research agencies. Currently, over half of the research undertaken in the School is supported through direct industry links and funding, through the activities of two multidisciplinary research groups – the Energy Research Group (ERG) and the Systems Research Group (SRG). The generic benefits of our approach include better market understanding, commercial exploitation and protection of new products, enhanced technical achievement and practice; plus facilitating improved growth and cost benefits. These are encompassed in the School's strategic aims:

- To be a key facilitator in ensuring research outputs are disseminated in a timely manner with due consideration for IP protection.
- To act as a research conduit in order that multi-disciplinary and multi-sector research opportunities can be identified and exploited.
- To facilitate step-changes in technology to improve productivity, growth and market lead.
- To provide an integrated environment for wider intellectual inter-disciplinary debate and academic enquiry.
- To foster strategic research collaborations with regional, national and international organizations and the respective RC-UK, EU Horizon2020, and other funders and programmes.
- To be receptive to timely opportunities in high-technology commercial market sectors that the School's research outputs can penetrate. For instance, academic research has spawned spin-off companies during the REF period (e.g. ISDI Ltd, in 2011), and the impact of research contributions have been used as international steering documents (e.g. OECD ISBM978-92-18851-8).

b. Approach to impact

Stakeholder Interaction and Evidence of Reach and Significance – Direct research interaction with commercial organisations and high profile European consortia maximises opportunities for impact from research. Evidence of the success of the School's approaches to impact is that it contributed to the recent decision by Bifrangi, specialist steel forgers, to invest over £40m in the creation of a closed die forging facility at Lincoln, including the installation of one of the world's largest screw-presses, and the successful funding of a £4.8m project, in collaboration the School of Engineering, for the construction of a new advanced materials research facility. The School has attracted significant interest in the UK and abroad; it was highlighted as a best practice case study in the Government-commissioned *Wilson Review* (exploring Business-University Collaboration), received a *Lord Stafford Award* for outstanding collaboration between industry and academia, and won the *2012 Times Higher Education award for Outstanding Employer Engagement*. In 2012, Siemens announced that the University of Lincoln is one of its *Principal Partner Universities*,

alongside Cambridge, Manchester, Sheffield and Newcastle.

The School has been instrumental in pursuing and hosting local and regional cluster events for both academic and non-academic audiences, to more widely disseminate research outcomes – examples include: *Bloodhound SSC* (developing a 1,000 mph land speed car), the *Isle of Man Clean Tech Roadshow*, regional events for *IMechE, IET, IoP* and *Combustion Institute*, and the our *Engineering Business Breakfast* networking events for the region. The international dimension to the reach and significance of our impact can be seen in our strategic focus on the Energy and Systems sectors, resulting in the School representing the *British Council* in Qatar to promote UK-Qatar collaborative research initiatives for promoting energy security in the region (2011).

The School's impact is also evidenced in the industrial and commercial sectors, e.g. Owen's thermofluid modelling expertise has led to the Type 26 future Combat Ship being the first ever to be designed for optimal helicopter availability, in association with *MoD, BAE Systems*, and *University of Liverpool*. Further collaboration in the field extends to the US Navy and the national defence laboratories of Canada and Australia. Also, our research into intelligent diagnostic and prognostics techniques for industrial gas turbines is being adopted by Siemens to monitor their global fleet for the reduction operational downtime (Bingham). More widely, for the healthcare and security sectors, the emergence of two spinout companies (Allinson) during the review period: *ISDI Ltd* (large area CMOS imager design and supply; provides imagers for international healthcare companies) and *Immersive Forensics Ltd* (digital workflows for forensic examinations; remote transmission of scene of crime lifts used by 70% of UK Police Forces). Research in computational neuroscience has led to breakthroughs in thalamocortical circuitry neuro-modelling that will facilitate the detection of EEG anomalies found for conditions such as Alzheimer's and Parkinson's disease.

Collating and Recording Impact – As well as traditional outputs for reporting key research findings and potential impact, we make extensive use of blogs and other social media outlets. Public dissemination of impact is also recorded through broadcasting (radio and TV), periodicals and the news media. Academics record potential impact during the writing of research bids, tangible impact in intermediate and final project reporting for industry and other funders, patent applications, research advisory boards (e.g. *TRB's 2nd Strategic Highway Research Programme (SHRP 2) Report S2-S09-RW-1*), and international committee documents (e.g. *2012 Nuclear Energy Agency's OECD-IEA report, ISBM978-92-18851-8*).

c. Strategy and plans

Impact is considered a primary gauge of the value of research undertaken within the School, and is actively pursued in its broadest sense, in both the non-academic and academic arenas. Following the School's recent emergence, a second phase of expansion is proposed to extend the School's research reach, through the building of a new electrical and automation-engineering centre to complement our current activities. In recognition of the importance of engineering research for the wider health and social sectors, plans are in place to link with the *National Centre for Food Manufacturing* to provide enhanced focus on food technology engineering.

Impact through Academic Support – A goal of the School is to provide a greater degree of support for staff and guidance on how best to promote, disseminate and exploit the impact of their research. Representatives from the University's Press Office, as well as colleagues in Marketing and Enterprise, regularly attend School staff meetings. The aim is to promote research-dissemination opportunities beyond normal academic output, i.e. social media, press releases, professional society meetings and open-access events for the public.

Impact through Undergraduate and Postgraduate Engagement – The School is already seeing the initial benefits of initiatives such as the *Kawasaki BBR motorsports* team sponsoring undergraduate research-based projects to improve vehicle performance (through data capture and analysis) and structural robustness of their motorbikes, and in return are placing the School of Engineering's logo on their livery – providing exposure of the School's outputs to a over 40 million global audience. Based on this initial success, the School will pursue focused engagement with University Marketing, Events and Enterprise teams to further such activities for student engagement. We firmly believe that impact should be prominent throughout the School's activities.

Impact through Expansion of Academic-Industry Knowledge Transfer – The School considers knowledge transfer to the commercial sector as a key mechanism for generating impact. Collaboration through existing KTPs is already strong exemplar of impact generation (*Napier Turbochargers*, for example). This has provided a demonstrable route to generating short-term, high-value impact benefits and there will be a strategic focus on substantially expanding the School's portfolio of TSB funded projects. To facilitate this, the Impact Officer and Director of Research have monthly meetings with the University's KTP officer, who is also invited to attend the University/Lincoln City Council jointly run 'Breakfast Meetings' with regional companies to identify opportunities.

Impact through Strategic Staff Appointments – The School continues to facilitate integration of new staff appointments into its impact philosophy and provide them with accelerated routes for generating impact—more than 30% of School academics are from outside the UK. The School, under the College of Science umbrella, ring-fences a dedicated funding stream to provide material, media and travel support for dissemination events, and staff will continue to individually pursue initiatives to engage with the widest possible audiences and expand our global research reach and routes for dissemination.

Impact Expansion through Growth – Finally, as the School of Engineering continues its expansion, it plans to substantially widen the scope of its multi-disciplinary research and its reporting. External stakeholders have already been identified for generating impact from improved energy technology integration, bio-fuel yield, control of the built-environment, behavioural studies of drivers and intelligent in-car technology for improved safety and crash-avoidance, use of materials surface processing for enhanced stem-cell control research for implants, healthcare imaging technology, and manufacturing processes to reduce bacterial growth in food products. This is supported by a University commitment for the establishment of a £12m second phase of Engineering 'new-build' expansion to substantially enhance the current research and development base. This is in addition to the University's recent announcement to support a £14m Science and Innovation Centre for the co-location of academics and commerce.

d. Relationship to case studies

The two case studies are indicative of the scope of demonstrable impact across commercial, healthcare and military sectors. They demonstrate how our strategy of developing a culture of stakeholder engagement, intellectual influence and informed change is fundamental to our research aspirations. Firstly, the Case-Study: *Modelling and simulation of the ship-helicopter dynamic interface – impact on pilot training and ship design*, provides an exemplar of impact significance; to improve the operational envelope of maritime helicopters, and leading to the Type 26 future Combat Ship being the first ever to be designed for optimal helicopter availability. Direct beneficiaries include UK MOD, BAE Systems Surface Ships and Flight Systems and NATO. Though initially supported through the military, we recognise the civilian sector – not only for merchant shipping, but also for the oil industry and activities in disaster zones.

Secondly, taken from healthcare sector, the cross-disciplinary Case-Study: *Giving Medicine a Better Image with Wafer-scale CMOS Imagers,* describes impact stemming from the basic technology research and then commercialization of groundbreaking medical imaging sensors. It exemplifies many key aspects of impact, namely enhanced technical achievement (DyNAMITe – *world's largest radiation-tolerant CMOS image sensor for medical imaging*), commercial exploitation (*spin-out company ISDI Ltd formed*), market penetration (major contracts with multinationals), and intellectual protection (*patent and commercialisation rights*). Moreover, in recognition of its significance DyNAMITe won the IET Innovation Award for Electronics (2012). Prof Allinson, who cofounded ISDI Ltd, has extensive experience in transferring research into the commercial world. He was described by *The Times Higher* as "one of the UK's top academic entrepreneurs."