Institution: Ulster: UoA 13 The Engineering Research Institute Impact – ERI Impact

a. Context: Engineering research at Ulster was initiated just over twenty years ago and since then it has been at the heart of our endeavours to create and commercialise innovative products through knowledge transfer, technology-licensing, patents and more recently, through spin-out ventures. With research funding from Wellcome Trust, EPSRC, TSB, EU, Royal Academy of Engineering, Leverhulme Trust, InvestNI, DEL and industrial partners, our research has led to the development and market launch of numerous internationally successful medical devices, electronic components (HDD read-write head coatings and new improved ceramic capacitors), composites technologies and algorithms. Seven ERI spin-out companies have been created in the technology areas of medical devices, connected health and aerospace composites and currently account for the employment of over **150 skilled people** with a total valuation of over **£100m and over £30m annual sales**.

b. Approach to impact: Our approach to impact is to use our established technology transfer routes to bring pioneering applied research to commercialisation in technology areas that will bring considerable benefit to both the local economy and society as a whole. We have recently established two state of the art industry-led innovation centres; the **Connected Health Innovation Centre** (CHIC) and the **Northern Ireland Advanced Composites and Engineering Centre** (NIACE) which will propel our current research into future innovation. A new Mass Customisation and Integrated Platforms Centre (MCIP) is due to be built and this will enable efficient and robust one-stop rapid-prototyping of advanced products from initial design to final device. Our **Centre for Advanced Cardiology Research** (CACR) works in partnership with the **EPSRC Multidisciplinary Assessment of Technology Centre for Healthcare** (MATCH), a four-university (including Ulster) collaborative centre, to translate our collaborative engineering-clinical research into hospital practice. The infrastructure which binds research, translation and innovation was established through funding of over £40m since 1993, secured from a range of sources including: MATCH (EPSRC, £8m); Centre for **Intelligent Point of Care Sensors** (CIPS-£2m) (DEL, £3.5m); NANOTECNI (InvestNI, £4m); CACR (Charitable donations, £1.5m); UU–QUB NIACE (£6m, InvestNI) and CHIC (£5m, InvestNI).

ERI research focuses on advanced materials, materials processing and the integration of new materials into functional and structural devices. With an impact-directed infrastructure of research and innovation centres and through collaborative projects which straddle the applied sciences and engineering, ERI seeks to translate its research into innovative processes, platform technologies and new product prototypes that can be taken forward to commercialisation. ERI's mission, aligned to that of the University, is to engage fully with industry, both local and international, and with policy-makers through representation on government committees, to bring about a direct and sustainable impact on local society. ERI staff currently undertake seven joint projects with industry, have successfully completed 40 cross-border (KTP-like) Fusion projects (£1.6m) and have attracted over £1.7m of consultancy since 2008. ERI has strong academic links worldwide, including project partners in Africa and India, and has achieved significant international reach in its industrial impact through close collaboration with a range of US and EU industrial partners. Table 1 illustrates the extent of our formal ERI – industrial partnerships. Senior ERI staff participate in important government committees dealing with innovation and technology transfer such as the **NI Science and Industry Panel** (MATRIX), NI Innovation Strategy 2013, ROI Advisory groups and various KTN's. As members of the All Party Science Committee or as invitees of the professional bodies (IET, RSC, IoP, IOM^3) they regularly present to the NI Assembly, MEPs, Westminster and at the EU parliament on topics related to STEM in education and engineering innovation.

ERI's research and its direct impact in society has been highlighted in a range of public events and engagements including the NI Festival of Innovation at the **Northern Ireland Science Park** (NISP), W5 Promoting STEM, the Farnborough Air Show, at the Wellcome Trusts Window of Innovation and at our own Ulster Business Festival. Exemplar research and innovation projects have been showcased to young people as part of our STEM Forum via a programmed and intensive series of (repeat) visits to local schools, many of which are in deprived areas and thereby suffer societal problems. Pupils are introduced to an exciting world of advanced local science and technology (e.g. Ashton Community-Fab Lab). By targeting the potential of the local workforce in these areas, our aim is to instil a sense of pride and "ownership" within the communities for high technology companies that may locate here. An EPSRC-funded pilot programme with NI primary schools as part of an 'Engineering-for-Primary-Science' initiative has recently commenced (EP/I01764X/1) and a set of

EPSRC funded Bioengineering Lectures to Science Teachers has also been produced.

ERI research outcomes have had a direct positive impact on healthcare, clean technology, aerospace and electronics sectors via delivery of significant advances in: sensor based rapid diagnostic technologies at lower cost; the provision of surface engineered functionality for TERM; improved composites and nanoparticle knowledge for relevant industries. Our PhD programmes and subsequent research project experience has resulted in a supply of well-trained engineering professionals and has generated leaders for local and international industry and government. Over the past ten years our impact has been recognised nationally and internationally through winning, for example: two ITLG Awards in Silicon Valley; a Rising Star Award; numerous 25K Innovation Awards; an overall winner for best venture stemming from a university spin-out (a prestigious All Ireland Seed Corn event). In addition, the ERI Director (McLaughlin) was awarded an OBE for his services to research and economic development in NI. An invited presentation on our approach to innovation was part of the Stanford University's "Engineering's European Innovation & Entrepreneurship Though Leaders" series (2013). In addition to tangible outcomes such as patents and spin-out companies, the interaction with government, the creation of innovation-inspired graduates (recognised through the ERI McGoglan Annual Student Innovation Award) and the interaction with NI school children, have all helped us drive forward an important engineering and innovation agenda which encourages local enterprise and foreign direct investment. NIBEC research has expanded into to a large multidisciplinary centre, having evolved from its initial focus in electro-physiology conducted by Professor Anderson in conjunction with Professors Pantridge, the inventor of the portable defibrillator, and Adgey, the inventor of mobile coronary care systems. It has over 35 patents, along with proven expertise in a range of engineering technologies which has led to four spin-out companies (Intelesens, Heartsine, Heartscape and Surf-Sens) and one spin-in (SiSaf). NIBEC senior staff lead a number of major initiatives such as a university-wide and multidisciplinary **Connected Health Forum** (50 academics across the disciplines); the **NI Connected Health EcoSystem** (150 industry members) and the **European Connected Health Campus** (now Alliance - **ECHA**). The ECRE and AMFoR centres bring a unique blend of applied expertise in textiles and polymer processing, sheet metal forming and materials characterisation to drive pioneering developments in polymer composites and metal forming for aerospace applications. These centres have created two new spin-out companies, Axis Composites and LenisAer, and we recently established the £6m industry-based NIACE innovation centre, along with QUB colleagues.

Under the auspices of the ERI management and the university's **Office of Innovation** (OoI), IP and outcomes from the research centres are channelled into collaborative ventures through our innovation centres and through industry and stakeholders such as local hospitals. ERI has an **International Engineering Advisory Panel** which addresses industry engagement, STEM initiatives and skills requirements as well as delivering workshops, knowledge based seminars and elevated access to Ulster's breadth of academic expertise. OoI has responsibility for the University's commercial output via its wholly-owned subsidiary, **Innovation Ulster Limited** (IUL) who provide purpose-designed support services, management of knowledge transfer programmes and development of skills policies. Their mentoring and direct financial support is delivered through competitive and funded programmes such as Proof of Principle/Concept (ERI won 12 awards 2009-13). In partnership with business and legal experts, they assess the technology potential, establish appropriate IP protection, explore routes to market and establish a commercialisation case such that industry attractiveness is maximised. Over the past five years IUL, in conjunction with InvestNI, NISP and promoted by our **Knowledge Club**, has worked with over 200 technology disclosures, filed 70 new patent applications and invested £3.3m in Proof of Principle/Concept projects. IUL has also generated £7m in consultancy revenue by disseminating Ulster's knowledge to the public and private sectors, has leveraged £23m in venture capital investment into our spin-outs, is No 1 in Ireland for innovation vouchers and fusion projects (equivalent to KTP), and has created 266 jobs. Apsley leads NISP and as one of ERI's 15 Visiting Professors, he is an avid supporter of and invaluable mentor to the innovation environment we have created for new ventures. Spin outs, Intelesens and Heartsine, were the first of 120 companies to locate to NISP.

Ulster has developed the **Research Impact Awards** scheme, allowing academics to realise and demonstrate the impact of their high quality research. Since their establishment in 2009, 22 projects from a range of disciplines have been awarded funds representing a total investment of £180k. Impact is also promoted via the **ERI Impact Hall of Innovation**, **ERI Impact on Society Lectures**,

the **Ulster Business Festival**, W5 Exhibitions and the continuous development and integration of entrepreneurship into our undergraduate and postgraduate courses. Four staff were awarded Innovations Leaders Funding (£49k DOH-R&D Office). We have aligned with various government initiatives, examples of which include John Anderson's DTI Business Fellowship and co-organising the leading European innovation conference, EBN 2013, in N. Ireland.

c. Strategy and plans: The key aim of **Ulster's Innovation Strategy** is to promote the exploitation and application of science and engineering-based research through a range of technology transfer routes. These include licensing, spin-out company formation, support for existing industry, and involve incubation, innovation and the science research park (NISP) development. ERI's strategy is to further encourage research to innovation through (i) provision of mentoring/training to researchers and staff, from their initial engagement with the institute as early career researchers; (ii) establishing career progression routes for impact-focussed activities; (iii) facilitating interactions between staff, industry and other stakeholders; (iv) working in partnership with staff on specific technology-transfer projects to encourage the timely capture, analysis and appropriate protection of IP; (v) exploration of optimum commercialisation strategies and interfacing with funding sources. ERI's policy, in conjunction with IUL, is to aid the process of commercialisation through global market engagement and patent protection as well as to manage the licensing of all IP resulting from projects and to ensure maximum revenue generation. This translation model encourages our scientific & engineering research to focus directly on commerciality through tackling compatibility and integration with market-derived products and systems. We have plans in place to further promote innovation through, for example: extending the 'ERI Impact on Society Lectures/ Breakfast Lecture series'; secondment to industry via RAEng programmes; highlighting of research impact directly to the public through more science museums/W5 displays, STEM presentations to schools and media initiatives.

Long-standing collaborative partnerships have been established with industries such as AVX, Seagate-Veeco, Heartsine, GE Healthcare, Intel, Bombardier and numerous SME's (figure 1), and where appropriate, we have arranged direct clinician involvement leading to invaluable tri-lateral ventures. ERI has established a close working relationship with a range of seed and venture capital sources, as well as InvestNI, and has developed expertise in the preparation of robust business plans for advanced technology projects that clearly set out the commercial potential of spin-out enterprises or licensing opportunities. Research ideas have been taken through **Proof of Principle / Proof of Concept** stages, funded by a mixture of IUL seed funding, University Challenge funding or INI/Halo and onto early stage seed funding from local VC/Angel, InvestNI or Wellcome funding. From there, well-funded company formation has resulted with CEO & International Marketing structures.

d. Relationship to case studies: The first case study deals with the highly acclaimed impact of NIBEC research in the field of sensors and medical devices through to global Connected Health via the formation of a number of NIBEC spin-out companies and a range of stakeholder collaborations. Collaborations with industry (GE and Intel) and user groups such as CACR (McEneaney) and International Hospitals (Mass. General) are highlighted. ECRE and AMFoR research impact is represented in the second case study where industrial collaborations with Bombardier, BAE Systems, RR and Caterpillar, and award winning spin-out companies have led to robust, cost effective and environmental solutions for new composite and metal forming processes which have seen commercial uptake. The final case study describes the impact of our nanomaterials research on cost and quality in volume manufacturing processes, through long-term collaboration with companies such as Seagate Ltd and AVX Ltd as well as integration into new product technologies with spin-out and spin-in companies such as SiSaf. The ERI Timeline of Innovation can be viewed at www.eri.ulster.ac.uk/home/impact and this website along with a public exhibition space (ERI Impact Hall of Innovation) at NIBEC demonstrates a proud history of achievements and impact since 1990.

Table 1 – Examples of Formal Links with Industry/Representative Bodies (in bold spin outs)

CHIC: Intel, Bosch, GE, EMC, CIGA Healthcare, HP, S3, I-Innovations, Randox, BT, Accenture, 3fivetwo, Kainos, Task, Isoft, 3M, Exploristics. Also All NI Trusts, Biobusiness, Health Technologies KTN. **NIACE:** ADS, Bombardier, Thales, BASE, Axis Composites, Caterpillar, WIS, BA Aerospace, Rolls Royce, **Axis Composites**, Wrightbus, Salamander, Datum, Composites Hub; Composites Leadership Forum; National Composites Network; UK Composites; Materials KTN, CIMComp. **NIBEC:** Boston Scientific, Medtronic's, Seagate, AVX, Veeco, GE, **Intelesens, Heartsine, SiSaf.**