Institution: Sheffield Hallam University

Unit of Assessment: 13 Electrical and Electronic Engineering, Metallurgy and Materials

a. Context

The main beneficiaries of the Materials and Engineering Research Institute's (MERI's) impact are its many **industrial** and **public-body partners** (listed in full in **REF5e**) especially within Robotics and Automation; Materials Systems, Performance and Reliability; Sustainability and Green Technologies; and Healthcare and Bioscience. Products and processes arising from MERI's research also benefit **end-users** and **investors**. MERI's work impacts on **professionals** and **policy makers** in need of technical research expertise. Further, broad understanding of research findings is promoted through activities aimed at **policy makers** and the **general public**.

Most of MERI's impact is **economic.** All research groups undertake commercially-focussed projects to achieve a broad portfolio of activities. Many projects are designed and implemented in collaboration (and under contract terms) with external partners, but some commercially relevant work is kept in-house so as to retain IP and patents for future exploitation by spin-out or direct licensing. MERI's work also impacts positively on: **professional practice**, through CPD courses and training materials derived from research findings; **policy development**, through commissioned technical reports; **legislative development**/accident investigation procedures, through forensic expertise and practice; and **public understanding of science** (PUS), through outreach activities.

MERI's impact relates to its research via: development of commercially realisable products and processes from research findings; use of research to improve understanding of existing products and processes, so enabling informed future decision making; a range of Knowledge Transfer (KT) mechanisms designed to up-skill the research and commercial capabilities of external organisations; and effective communication of research expertise to inform in a non-academic context either at high level (e.g. CPD, expert witness, policy development) or more generally (outreach).

b. Approach to impact

MERI's financial and staffing structures are organised to promote and nurture **external partnerships.** The most obvious route for engaging with industrial beneficiaries is through collaborative research projects. This has been achieved through: full cost research projects (e.g. Sammon's work with *Bristol Myers Squibb* on controlled drug release); EU-funded collaborations (e.g. the FP6 programme *Innovatial* through which Ehiasarian and Hovsepian worked with companies including *Fiat*, *Hauzer* and *Ionbond* to develop nanoscale multilayer PVD coatings); TSB- and MoD-sponsored partnerships (e.g. Jones' development of ceramic materials for body-armour applications, **REF3b(3)**); EPSRC, BBSRC and STFC CASE studentships (e.g., Breen's collaboration on nano-composite paper coatings with *Chesapeake,* EP/G501726/1 (08002513)); joint funded MERI-Industry studentships (e.g. Wang's work on organic photovoltaic coatings with *Beckers*, Wang 3&4); licensing of patents or specific expertise (e.g., Ehiasarian's HIPIMS coatings for *Mahle*'s automotive components and *Biomet*'s hip replacements, **REF3b(1)**); and launch / development of spin outs to exploit IP and attract investment capital (e.g. *Xeracarb*, **REF3b(3)** / *Liquid Granite*, **REF3b(2)**). Thirty nine patents have been granted to MERI researchers within the REF impact period, with six pending. Groups securing recent patents include Polymers and Nano-Composites, HIPIMS, Sol-Gel and Corrosion Technology. Return on patents and other licence agreements totals **£410k of technology transfer income** in the REF impact period.

Consultancy and Knowledge Transfer (KT) are embedded in the Institute's day-to-day operations. MERI runs a £350k-400k pa full-cost consultancy service through which external partners access characterisation equipment and materials expertise. The ~150 pa troubleshooting investigations undertaken through this service provide a reservoir of external partners from which larger scale projects flow. Where partner requirements escalate from consultancy into specific research activity, MERI maximises these opportunities through a Customer Relations Management system. This tracks projects to completion, gathers customer feedback, maintains an end-user database, and triggers regular follow-up contacts. An example of project escalation is given by work initiated in 2011 by Luo as a feasibility study with *Tinsley Bridge* into heat treatment schemes for high strength steels. This prompted a successful TSB grant application (720113, 2012) by *Tinsley Bridge*, through which Luo achieved materials treatments needed for high performance suspension systems. As a consequence, device-scale torsion bars produced by *Tinsley Bridge*

using Luo's processes are to be trialled by the MoD within Warrior Tank suspension systems in early 2014 https://www.innovateuk.org/-/tinsley-bridge-rises-to-the-occasion.

MERI is **proactive in relation to KT engagement**. A second, and more prolonged, route by which industrial partners access MERI's research facilities and personnel is through coordinated KT programmes in which researcher time is directed to industrial interventions. In 2008, MERI completed Routes to Innovation (R2I), a materials and engineering KT programme for companies in South Yorkshire. R2I achieved £477k of "private sector match" funding, led to a total turnover boost to participating companies of £20m, and saved/created ~100 jobs. Two further ERDF-funded KT programmes were delivered during the REF impact period: Nanofactory (£130k of interventions), a collaborative project between six Yorkshire-region research-intensive Universities, which built partnerships to create commercial opportunities in micro- and nano-technologies (including modelling work reported in **REF3b(4)**); and Innovation Futures (£260k of interventions, 2009-12), a SHU-coordinated programme targeted at the services and processes offered by SMEs in Yorkshire and Humberside. Within Innovation Futures, MERI achieved interventions with 34 different partners, the most significant of which led to a seven figure increase in GVA for *Gripple* through innovations to production line processes. A new coordinated KT programme, Innovation Futures 2 (£250k), commenced in February 2013. MERI also undertook a further £765k of HEIF-funded and £70k of RDA-funded KT activities in the REF impact period. For example, in 2009 MERI performed KT work for *Kostal*, in which microstructure characterisation was undertaken to optimise the PVD coating on a business-critical product. This product enhancement proved crucial to *Kostal* gaining a contract with a major automotive company, protecting jobs and achieving a seven figure increase in GVA.

MERI researchers have also achieved impact through the **operation of KTPs**. Thirty one KTPs were completed in the REF impact period, yielding several exceptional outcomes. For example, a KTP with *Joseph Rhodes* (2009-11) led to: a £10m increase in annual sales turnover; an increased profit margin of £100k; £14m of new orders with *BAE*; and the development of a new autoclave business. Another, with *Penny Hydraulics*, a traditional provider of lifting equipment and cranes, introduced innovations which enabled the company to diversify into the nuclear industry. *Penny Hydraulics* subsequently became a Tier 2 supplier to the industry and gained contracts of over £400k from Sellafield and Magnox, while the KTP associate involved won national awards.

MERI's impact-related partnerships also extend to **professional groups**, through **forensic investigation and training**, **policy makers**, through **reports and consultations**, and **the broader public**, through **PUS**. Jones and Sammon have undertaken expert witness work, through which forensic investigations have been conducted and expert witness statements presented to courts in the UK and the USA. Also, MERI researchers have developed expertise on vehicle light-bulb forensics, from which specialist training has been developed and delivered to all UK Accident Investigation Authorities. In the REF window, 227 accident investigation professionals received this training. Additionally (**REF3b(2)**), 392 bridge management professionals have undertaken CPD based on Mangat's research. Policy interventions include Penders' lead authorship of a 2013 *Foresight Futures* paper on Robotics and Dharmadasa's interactions with government ministries in Bangladesh, Nigeria and Sri Lanka on solar-cell technologies. PUS activities undertaken include Cleaver's participation in science fairs (**REF3b(4)**) and Jones' development of a PUS stand based on his "What's in My Stuff" project within SHU's interdisciplinary 'Engineering for Life' programme (**REF5e**). This stand ran for a month as a Road Show exhibit in the Sheffield Millennium Galleries (2012) with a footfall of thousands per week. Follow through of this activity included: a reprise of the Road Show at the London Goldsmiths Livery Company; invited talks for the British Embassy in Berlin, the French Embassy in London, and the RSC's public "Year of Chemistry" series; web videos produced under the auspices of the joint RSA/TSB outreach project "The Great Recovery" http://www.greatrecovery.org.uk/resources/?res=whats-in-your-mobile-phone-at-shu ; and an appearance on BBC1's "The One Show"

The University's central **Research and Innovation Office** (RIO) coordinates major KT initiatives and allocates HEIF funds to promote such activity. Since 2008, RIO has financed and coordinated the work of KT Champions across SHU to develop KT strategies and priorities and to implement follow-up of interventions. MERI had a 0.5FTE KT Champion throughout the REF period. This initiative supported KT engagement by ensuring active participation in, and communication of activities such as KT Networks, and calls from funders such as the TSB and the MoD. RIO also used HEIF to provide seed-corn KT funding over the REF period. RIO staff provide

significant central expertise to support development of funding proposals, preparing detailed costings and arranging institutional sign-off. Further, dedicated personnel (8.0 FTE) support the exploitation of research and the development of commercial technology transfer relationships with external organisations. Through its IP Commercialisation Committee, the University invests a budget of £80k pa in patents, legal fees and company spin-outs.

MERI's flexible staffing approach (**REF5c(i)**) provides the agility needed effectively to respond to research opportunities arising with external partners. Work-plan allocations and time-sheeting for research, KTP supervision, KT and consultancy are arranged on a project-by-project basis. This enables staff to deliver effectively and provides the flexibility needed to operate in a demand driven environment. Research staff are rewarded through promotion (**REF5c(i)**) and through SHU's generous approach to licence income. Within this, individual staff members receive 70% of the first £25k of each block of net licence income earned and 50% of the second £25k. In practice, this has led to the majority of the £410k of licence income achieved by MERI in the REF period going to the inventors.

c. Strategy and plans

MERI's future strategy for impact reflects the four priorities of the University's impact strategy: partnerships, knowledge exchange; public engagement; and culture, infrastructure and support.

Partnerships MERI will focus on achieving economic impacts via external collaborations, patents and spin-outs. Licence income will increase by ~10% pa to aggregate over £750k over the 2014-19 period, and ~50 patent applications will be made. Partnerships will continue to be initiated through a range of mechanisms (including consultancy and KT), confirmed through contractual agreement, have clear IP protection arranged through RIO and, where judged appropriate, nurtured over time.

Knowledge Exchange MERI will deliver over 40 KTPs between 2014 and 2019. Research-informed CPD materials will be developed to impact on professional practice of appropriate industry sectors. Healthcare-related research will be developed to at least the clinical trial stage.

Public Engagement MERI will post 60+ outputs pa on the institutional research repository (SHURA) and will engage with the SHU research data archive. MERI will also institute an impact budget to embed engagement in activities such as PUS. All interdisciplinary projects undertaken through the Imagine programme will include an outreach component. MERI will disseminate its activities through a regular newsletter, case studies, press releases and social media.

Culture, Infrastructure and Support MERI will systematically record impact and use these data within the rubric for allocating support to Research Centres. This will feed through to individual researchers via annual work planning. Impact will be a standing item within annual appraisal.

d. Relationship to case studies

The four case studies submitted all lead on **economic impact** achieved through partnerships with external bodies and/or exploitation of IP. **REF3b(1)**, **(2)** and **(3)** provide examples of enhancements to products and services, whereas **REF3b(4)** mainly relates to improving the understanding of partners' products. The number and range of engagements raised in these evidence both MERI's agility in identifying collaborative partners and the strong reputation it has earned through years of productive delivery. More broadly, the case studies illustrate MERI's ability to lead industrial uptake of research innovations ranging from high-performance coatings through new building materials to novel computer simulation methodologies. The case studies also provide examples of impacts on **professional practice**, particularly through CPD activities based on MERI's research, and communication of research through **PUS**.

The Partnerships element of MERI's future Impact Strategy has been informed by experience gained within these case studies. Achieving impact through research is often a long-term process, contingent on external factors such as a partner company's broader strategy or patent issues. To remain robust through such challenges, it is essential that contractual details and IP-exploitation strategies are established at the earliest opportunity. Further, to ensure that key partnerships remain strong, regular review and strong management are required. The case studies illustrate the range of IP-exploitation approaches that MERI's researchers have employed to achieve impact. These have been developed alongside RIO's contracts and technology transfer team who have provided confidential legal and commercial expertise. By enabling researchers to focus on technological issues and achieve effective team dynamics with collaborators, the security provided by this in-house facility has aided the development of MERI's impact portfolio.