Institution: Keele University

Unit of Assessment: B15 General Engineering

a. Context:

The Institute of Science and Technology in Medicine (ISTM) evolved from a merger between the Clinical Engineering Directorate and the School of Postgraduate Medicine (formed in 1978) at the North Staffordshire Hospital. The research activity was deeply embedded within the hospital environment with clear links to end-user needs and ultimately the health of patients. The environment was multi-disciplinary linking engineers, physicists and biologists with practicing clinicians. Keele has had a long tradition of multidisciplinary research continuing to the present day through our successful EPSRC and MRC Bridging the Gap Programmes. The award of a new Medical School in 2007 saw the Institute forming the basis of the evolution of the School's research activity and an expansion in posts within the School of Medicine and Institute combined. The key aspects were the combination of postgraduate training in Medical engineering disciplines interwoven with patient care and clinical networks which led to successful development and significant impact.

The Institute for Environment, Physical Science and Applied Mathematics (EPSAM) is at the centre of Keele's overarching sustainability theme and has a strong record of promoting interdisciplinary and multidisciplinary research. The impact arising from the research carried out by the Environmental Engineering subgroup has had significant impact on the sustainable technology, advanced materials and chemical industries, local authorities and councils, and the general public through an increased awareness of sustainability issues. This has been achieved through projects directly relating to environmental sustainability (including national outreach and public engagement activities), chemical feedstock production, nuclear fuels and energy production. Much of this work has involved direct contact with international researchers and industrialists.

b. Approach to impact:

Keele's Research Institutes (RIs) provide dedicated, distributed support, an administrative infrastructure and resource for developing, promoting and enabling the impact agenda. Researchers are encouraged to raise the profile of their field and its impact across traditional boundaries. Incentives to researchers to promote their interests include explicit recognition of impact in promotion, direct financial incentives (to support speculative research, including through HEIF 'innovation Keele' funding), and dedicated research time allocation, with increased research-time given to individuals who achieve enhanced research impact as evidenced during annual appraisal (SPRE and PPRE). The first point for impact dissemination is generally Keele's internal communications, identification in reports to the University's Research Committee, Senate and Council, and subsequently a well-defined path of progression to press release, regional, national and international news coverage, all handled by a dedicated press officer, within the Directorate of Marketing and Communications (MAC), which was established in 2011. Examples cover a wide range of activities, from local awareness-building through Keele's website, Week at Keele and Keele Times newsletters, Discovering Excellence brochure, Video Wall, publications database and open-access repository, and individual staff web pages, through to Keele press releases and engagement of individual researchers with a variety of media outlets. ISTM/EPSAM's work has been the focus of numerous television, radio (e.g. BBC Radio 4's *Material World*) and print news reports around the world e.g. *Science, Scientific American, The Washington Post*, *New Scientist, Nature News, BBC Radio News, The Times, The Telegraph, The Daily Mail, US National Public Radio, Reuters, UPI*. Keele work was featured in the exhibition "Nanotechnology: Small Science, Big Deal" at the Science Museum in London. News reports on commercial activities have been featured in *The Economist, The Dow Jones Investment Wire Newsletter,* and others.

At an institutional level, Keele's research impact is managed and promoted by dedicated staff within Research and Enterprise Services (RES), including Enterprise Business Managers, Technology Transfer (IPR) and European funding experts and extends to the Commercial and Business Engagement Directorate via the Keele Science & Business Park. This approach is supported by RI Managers and seeks to engage with enterprise, business and academia, for example through the Senior Management Committee, annual 'Away Day' and active seminar programmes that host high-profile visiting speakers. The counterpart to this is the coherent 'research passion' shown by ISTM and EPSAM researchers and their willingness to engage in dissemination activities, including promotion of their own work through discussion visits and invited

research talks. This engagement is intentionally broad, ranging from major public engagement activities reaching over 25,000 people (including Bestival in 2011, 2012, 2013, British Science Festival invited session 2012), school outreach visits, to presentations and seminars at universities, hospitals, companies, research institutes and public and third sector organisations throughout the UK and overseas. Evidence of the interaction with external UK/international Institute engagement include Trevor **Forsyth** (now on secondment to ILL/EMBL and leading a team of ILL and Keele staff as head of the ILL/EMBL Deuteration Laboratory), and Josep **Sule-Suso** (SR FTIR spectroscopy; Chairman 2007-2013 of B22 MIRIAM infrared beamline working group at Diamond UK, and member of Peer Review Committee 5 "Biology-Health" of the Soleil synchrotron, France).

Researchers submitted to this UoA enjoy a long-standing relationship with several companies in the Innovation Centres on the Keele Science & Business Park, e.g. **Biocomposites**, **nanoTherics** and **Cobra Biologics**, including the sponsorship of PhD students and contract research. To develop new links the **Nova Centre** was established in 2012; an on-campus business growth programme and incubation unit for start-ups, with dedicated on-site support and peppercorn rents (evidence: **nanoTherics**, **MICA Biosystems** winners of the ***Lord Stafford award for Innovation***). Evidence of our successful efforts to translate innovation is shown by the recent award of a ***Royal Academy of Engineering Enterprise Fellowship*** to an ISTM PhD student to develop IP within our spin out MICA Biosystems. A major avenue for commercial engagement is through our ***EPSRC Centre in Innovative Manufacturing in Regenerative Medicine*** with Loughborough (lead) and Nottingham Universities. The Centre is industry-facing with projects linked to UK- and US-based companies such as CERAM, Baker, Smith and Nephew, and Tissue Growth Technologies. Regular forums include an annual Industry Day to establish the challenges for the Centre, significant industrial presence on Senior Management Boards and regular key stakeholder groups.

Keele hosts a successful ***EPSRC Centre for Doctoral Training in Regenerative Medicine***, which has set the model for bioengineering PhD structure through integrated training and experience with industrial partners. In addition, Keele has built a good track-record of PhD CASE students supported across the three relevant research councils (BBSRC, EPSRC and MRC) through constructive collaboration with the industrial CASE partners. All postgraduate research is showcased at the annual Postgraduate Symposium bringing together industrial partners, and practitioners, to showcase new research and set the agenda for future relationships. As a consequence of these interactions a number of General Engineering academics provide long-term consultancy within the SME sector and beyond. More general regional engagement includes the Stoke-on-Trent and Staffordshire LEP, on which Keele has Board representation, the North Staffs Chamber of Commerce and Local Authorities. PhD students and early career research staff benefit from well-developed training, ranging from RI, University-wide and external courses, including RCUK and Vitae. A new research training programme was developed and launched in 2013/14, including a Student Researcher Development Fund managed at RI level for all PhD students. Examples of postgraduate impact is the sustained and seminal contributions to the development and use of national central facilities (Synchrotron radiation, Neutron scattering). Keele postgraduate students are now holding key positions e.g. Director, Neutron Scattering Sciences Division at Oak Ridge National Laboratory USA (D. Myles), Team Leader of the Proteomics and Neutron Protein Crystallography team at Los Alamos Neutron Scattering Centre (P. Langan), leader of the Functional Biosystems Imaging group at Diamond UK (M. Martin-Fernandez), Senior Scientist at Stanford SRLS (A Gonzales-Alvarez).

Centrally, RES and Library and Information Services support and enhance impact, not only through accessibility e.g. detailed expertise and public-facing research webpages and open-access repositories, but also through dedicated support to academics on engagement in **European and international research activities**, e.g. European networks and partnerships to raise our profile. Researchers submitted to this UoA have been involved and leading in European partnership funding for two decades, primarily through Frameworks FP4 to 7, which by their nature include collaborations with users of research results and potential commercial exploiters of inventions. Members of the Institute have been involved in setting the agenda for European Framework funding and specifically new calls in stem cell research. Links have flourished to include successful Marie Curie Initial Training Networks and IRSES partnerships co-ordinated from Keele, and fellows who came to Keele on these schemes continue to build the University's wider network of research when they move on to work in industry or other research institutions worldwide. Key evidence of our outreach includes HYANJI which is a partnership with Tsinghua and Sichuan Universities in

China involving exchange of 15-20 PhD/Postdoctoral researchers between UK and China for 6 month periods over the past 4 years leading to further Faculty appointments in China and significant network building through to Asia.

c. Strategy and plans:

Within Keele's Strategic Plan, the third strategic aim is to **'deliver international excellence and impact in focused areas of research'**. In line with this, the Research Strategy (2011-15) sets out plans for research to have a significant social, cultural, environmental and economic impact, and to work with external partners and collaborators to benefit society. Keele's impact strategy is thus embedded in the annual planning process of all RIs and highlights impact at the highest level, including resource needs, in a nested-hierarchy to the Faculty Deans and the Senior Leadership Group. At the unit level, strategies for deciding which areas of impact to focus on and support are discussed regularly at Faculty Executive level and by the RI Senior Management Committees (SMC). This includes regular strategy meetings for individual research themes which are reported back to SMC and debated more broadly at the annual 'Away Day'. Impact activities are embedded in the appraisal and promotion processes and analysed as part of annual review of research activity and research planning process. In recognition of the growing importance of cross-disciplinary research within European and the international community, Keele has continued to increase its European and International grant portfolio and provide support to academics on engagement in European and international research activities that raise profile and impact of research. Keele's strategic commitment to European engagement is evidenced by the recent investment in Brussels-based support. Securing representation in events, the organisation of bespoke meetings and opportunities for informing future policy on the basis of research will result in new partnerships and ensure that the impact of research is maximised. At the level of the individual researcher, Keele adopts managed strategies to release staff time to support impact activities, including through additional research buyout, employment of temporary teaching replacement staff and flexible working to assist colleagues. Central to this strategy are robust mechanisms for mentoring of new appointments and early career researchers. In addition, there are embedded policies to provide financial incentives to help maximise research impact. For example, individual staff can share in the financial benefits arising from enterprise activity and licensing. More broadly, ISTM releases 90% of all overhead income directly back to the individual researchers responsible for the external funding awards. These funds can be used to enhance and promote activity and impact of individual research groups and help to 'pump-prime' further activity.

Plans to further enhance ISTM impact include establishing far-reaching clinical links through our Health Services Research Unit (HSRU) via existing and new networks and organisations such as NIHR WM Stroke Research Network, Medicines for Children Network (both led by Keele) and the proposed, Keele-led, clinical orthopaedics research network, and in EPSAM with business, external organisations and the public through the new £3.5M Sustainability Hub, an exemplar 'sustainable' building that supports external engagement activities. Commercial engagement opportunities will be expanded upon with strengthened relationship to partners such as Athersys, Reneuron, EMImaging LLC, The Baker Company, and Instron. ISTM/EPSAM also plan to maximise outreach and opinion leader status via key stakeholder positions of staff members including **El Haj** (EPSRC SAN), **Ormerod** (Keele PVC Research), **Smith** (Fellow of the Royal Society), and **Dobson** (Royal Society's Member of Parliament-Scientist Pairing Scheme).

d. Relationship to case studies: Keele's approaches have translated through to far-reaching impact to others. We have selected four case studies as exemplars of this impact:

Impact Case Study 1: "Biological and Cell Therapies in Orthopaedics - Autologous Chondrocyte and Mesenchymal Stem Cell Implantation" - demonstrating direct impact into patient benefit.

Impact Case Study 2: "Technological solutions to facilitate independence in the community for people with long term conditions affecting their mobility" - 40 years of impact in rehabilitation treatment and industry by the Orthotic Research/Locomotor Assessment Unit (ORLAU).

Impact Case Study 3: "SIFT-MS: instruments for breath analysis and trace gas analysis in medicine and industry" - development and adoption of novel diagnostics for direct patient benefit.

Impact Case Study 4: "Microseismic Monitoring for Environmental and Geotechnical Engineering Applications" – a case study describing 20 years of research informing industry and government regulations. **Styles** was submitted to this unit in 2008, but is being returned to UoA7 in the REF as part of a major institutional strategic investment in Earth and Environmental Sciences.