Institution: University of Leicester

Unit of Assessment: 8 Chemistry

a. Context

Overall framework: The UoA's approach to impact sits within a broader university and college context where an enterprising approach is of key importance. The university is seeking to establish itself as a leading institution for enterprise and innovation. The UoA has established 3 key aspects to improve impact delivery; *establishing time for enterprise*, *funds and support for catalysing collaboration* and *bespoke facilities to incubate research* to an appropriate technology readiness level (Demonstrator Units).

Non-academic user groups and beneficiaries: Impact stakeholders engaged during the REF period cover a spectrum including large industry (Rolls Royce, TWI, Arcelor Mittal), Public Sector (police forces, hospitals and councils) and particularly SMEs (Anopol, Foster and Freeman, Sheridan). The impact has been delivered through new techniques (e.g. novel finger print imaging technology for police forces) new diagnostics (e.g. mass spectroscopy tests for hospitals) and new processes (e.g. metal finishing processes for a range of companies).

Main types of impact: Demonstrator Units have been developed as part of a strategic policy to deliver impact to an advanced technology readiness level to drive implementation. Three demonstrator units have been established which have been responsible for delivering the Impact Case Studies by showcasing technology at an appropriate scale. They were all funded using European Regional Development Funds (ERDF) and were designed for business engagement. As such there were stringent and challenging business engagement targets set, all of which were accomplished as evidenced through external audit. The main specialisms which have led to impact from the UoA concern the ability to interpret chemical analysis on a global scale using satellite data, the use of ionic liquids to carry out material processing on an industrial scale and the development of surface imaging technologies for forensic analysis.

How impacts relate to research: (a) Fundamental research using satellite data to study atmospheric chemistry led to the **G-STEP** demonstrator which develops applications for satellite derived data for novel products and services to enhance economic growth. It has impacted a wide range of benefactors, such as mapping environment and land use managers using reflectance data measured in the visible and near infrared region to monitor land use and crop development. Reflectance for these wavebands shows vegetation variables such as Leaf Area Index (LAI), which characterizes canopy development, and chlorophyll content, both of which are indicators of vegetation health. There are 6 staff whose sole role is delivering impact.

(b) The expertise in ionic liquids led to a demonstrator (**ILD**) to commercialise the use of ionic liquids in the metal finishing sector. It contains 6 pilot plants, each using > 50 kg of ionic liquid. This has enabled the implementation of commercial scale processes (> 1 tonne) for printed circuit board manufacture at PW Circuits and Electropolishing in Anopol Ltd. It has led to a new turbine blade etching process for Rolls Royce and a facility for sustainable hard chromium deposition with Arcelor Mittal.

(c) The commercial opportunity arising from longstanding collaboration between the UoA and Northamptonshire Police led to the strategic recruitment of Bond to lead the forensic initiatives on fingerprint development. This has been supported by the University with significant investment (>£300k) for state of the art analytical equipment.

(d) Outstanding mass spectrometry facilities led to the establishment of Real-time Air Fingerprinting Technology (**RAFT)** demonstrator which has helped improve performance in 10 businesses, leveraged >£320k of funding, placed 7 graduates in SMEs and been used in support of crime prevention initiatives. Additionally, a key impact has been development of a non-invasive detection of disease capability leading to bespoke 'Point of Care' devices, with a RAFT demonstrator being located in the A&E Department at Leicester Royal Infirmary next to a resuscitation bay where it has already assisted in the diagnosis of >100 patients. The facility is also used for clinical testing for Industry.

b. Approach to impact

Institutional facilities, structures and expertise: University Enterprise activities are coordinated at university level through the Enterprise and Business Development Office **(EBD).** Links to the Departments are strong and EBD has business partners embedded within each college to give direct assistance to academics. The College of Science and Engineering's Enterprise committee is one of the main mechanisms for dissemination of information and acts as a conduit for enquiries

and funding opportunities. The committee has representatives from each Department and germinates ideas for proposals for cross-college enterprise projects.
The College strategy for impact is reviewed by the Business and Industry Advisory Board (BIAB) which meets to discuss activities such as business engagement methods, analytical services and internships. The board is drawn from a variety of blue chip companies, government agencies and regional companies and provides input into impact strategy.
The UoA's fundamental research impacts significantly on materials, sustainability and environmental issues and therefore is of interest to a wide range of user groups. The regional innovation networks (**i-Nets**) have provided funding and contacts with 7 local companies in the transport, food and drink and healthcare sectors. In one example the food and drink i-Net, linked a local SME, Just Egg, and the Chemistry Department to use eggshell in plastics and the project won a regional innovation award (2012). The partnership is now establishing a commercial plant to process ca. 1 tonne/day and this has received worldwide news coverage.
Staff engagement with users/ beneficiaries: An important aspect of delivering impact in the UoA has been engagement and dissemination of successful new protocols and processes. One successful way to achieve this has been to team up with trade associations to run half- and full-day information events. This has been successfully achieved in the Ionic Liquid Demonstrator using events organised by the Institute of Metal Finishers, the Surface Engineering Association and numerous European trade associations including the European Institute of Printed Circuitboards EIPC. One of these meetings delivered the consortium that produced and tested a new process for printed circuit board production while another led to the collaborative projects with Rolls Royce. The College has annual Innovation Days where it engages interested companies in a variety of technologies. Typically these will attract 150 companies and we showcase new technology through talks, videos and technology stands, and these have been successful in drawing new companies into new research collaborations http://www2.le.ac.uk/business/innovation-leicester. Dissemination to the public has been carried out by Abbott on the bioplastics project at the RS summer exhibition (3k visitors) and the Big Bang event at Manchester (15k visitors) and Radio 4. The work led to the Royal Society Brian Mercer Award and the potential commercialisation of a new MDF substitute with a Local Company Sheridan & Co. Monks has appeared on TV (e.g. BBC World, CNN, Regional BBC), Radio (e.g. Radio 5/local Radio) to discuss medical diagnostics and air pollution. The work on fingerprint development has been showcased worldwide in all forms of media (see case study).
Evidence of Relationships. The G-STEP, ILD and RAFT projects have audited proof of engagement with over 50 companies. Innovation Partnerships and HEIF funded projects have been extensively used in the UoA to facilitate relationships. In addition 8 innovation fellowships (funded through HEIF) 12 consultancies and 11 innovation partnerships were undertaken at a value in excess of £1.8 M over the REF period.
Evidence of follow-through: EBD has regular review meetings with staff to monitor business engagement, supplying links from outreach events and facilitating partnerships from e-mail enquiries. The College has business managers (Wells and Heintz) who manage the interface with industry. EBD has also assigned a business manager (Pratt) to specifically project manage the various projects in the UoA and she has monthly meetings with those engaged in 3rd stream activities. She assists in applications for regional funding and completes the paperwork for consultancy agreements. Another business partner (Cozier) writes, negotiates and implements KTP projects and a group of three deals with EU contracts, costing and agreements. The UoA has been successful at obtaining EU partnerships with industry during the REF period and much of the impact has been delivered through multinational consortia such as IONMET, POLYZION. Monks is a co-director on the UK Space Agency Centre for Earth Observation Instrumentation and works with industry to develop new space instrumentation. In particular, projects with Astrium, SSTL and Bluesky were undertaken.
Enabling Impact. The UoA has identified key staff who deliver impact and has supported their efforts either through light teaching/admininstrative loads or through supporting fellowships. This is evidenced by Monks (HEIF funded fellowship) Ryder (RS Industry fellowship followed by HEIF fellowship), Hillman (University funded sabbatical) and Bond (direct College funded employment to specifically engage end-users).

c. Strategy and plans

The key to delivering impact is the ability to develop technology through the various readiness levels. The UoA has identified the stumbling blocks to technology transfer as business engagement, support through early stage development and the ability to demonstrate technology on a suitable scale.

Business engagement: EBD ensures effective business engagement handling all aspects of contracts, business cases, IP protection and market review. Their literature contains numerous case studies as written, web and video outputs. Under the "Let's Talk" brand they publicise the University's capabilities through various engagement mechanisms including innovation days, breakfast meetings and demonstrator information days (http://www2.le.ac.uk/offices/ebd).

Support through early stage development: Many of the business facing projects run by the UoA were initiated using University schemes funded through ERDF including ***Innovation Partnerships*** and *Partnerships in Knowledge Transfer* ***PiKT****.* These offer practical support from 'idea to implementation' stages to help SMEs in the East Midlands work more efficiently and productively by utilising new knowledge and technologies in the design, engineering and manufacturing processes e.g. conserving energy, raw materials and reducing waste. Using ERDF and Economic Challenge Investment Fund, companies can work with the University through Secondments, Graduate Internships, Productivity and Efficiency Consultancy and biannual Resource Efficiency Themed Workshops.

Ability to demonstrate technology: As explained in (a) the UoA has already developed externally funded demonstrator units for G-STEP, ILD and RAFT which are responsible for much of the impact delivered. It is currently establishing demonstrator units for Bioplastics and Forensic Science in the new Materials Centre.

Enabling impact in the future: Chemistry takes a proactive approach to enterprise and leads many of the Enterprise initiatives across the institution. Abbott is newly appointed Deputy Pro-Vice-Chancellor (Enterprise) for the University, and is responsible for developing policy and delivering engagement. This provides us with new opportunities to grow our activities in the areas of impact. Ryder chairs the College Enterprise Committee which works closely with the EBD to publicise the University's capability to engage with business. Abbott created a University wide web portal to allow business engagement through facile access to **L**eicester **An**alytical **Ser**vices (LAnSer). This has significantly increased the number and types of companies interacting with the University.

Continuing the above approach Monks has developed a new impact project entitled "*Innovation through Research Support Accelerator" (IRSA*) (total value £950k) which looks to aid SMEs developing new products, services, technologies, processes and markets by collaborating with R&D at the University of Leicester. The ERDF funded project delivers 30-50 fully funded stipends available for MSc/PhD type projects that are focussed on East Midlands SMEs. The UoA has also recruited five academics from Cranfield in the field of biosensors: this provides new opportunities in this area to further enhance research impact.

d. Relationship to the case studies.

All of the case studies have been established using the principles described in (c). The technology has been delivered by freeing up time for key staff (Monks, Ryder, Hillman and Bond). Projects such as Innovation Partnerships, IRSA and PiKT have helped to incubate ideas and produce proof of principle data. Externally funded demonstrator units with essential equipment, staff and facilities are at the core of the impact statements and have taken these projects on to the implementation scale. The establishment of critical mass with each of them (ILD, G-STEP and the Sir Alec Jeffreys Forensic Science Institute) have developed the impact.

An example of how this strategy has worked is electropolishing where a range of ionic liquids was developed for stainless steel. EBD facilitated a link with Anopol leading to TSB and EU consortia which produced a commercial plant. A dissemination event by the Institute of Metal Finishers showcased the technology and gained interest for superalloy electropolishing from Rolls Royce. The ILD provided evidence that it could be used for polishing turbine blades. Ryder obtained a Royal Society Industry Fellowship taking the technology to readiness level 5 within the company which led to a strategic partnership between Rolls Royce and the UoA with 3 further projects. This demonstrates that the policy of facilitating research, providing demonstrator units, holding dissemination events and freeing up academic time through fellowships can lead to the delivery of significant impact.