Institution: Loughborough University

Unit of Assessment: B11 Computer Science and Informatics

a. Context

The Unit's research mainly contributes economic impacts to two groups of non-academic users. The primary beneficiaries are the Technology Vendors and Service Providers who take the research outcomes and commercialise them. The secondary beneficiaries are the consumers and professionals who use the commercialised products and services.

Primary beneficiaries

Technology vendors and service providers that have capitalised on the research from the unit include: process engineering system developers, railway traffic management companies, designers and manufacturers of automobiles, manufacturers of energy efficient control systems, designers and manufacturers of defence transport systems, automated manufacturing system developers, network service providers, TV broadcast and on-demand service providers, visual special effect and video analytic software developers and manufacturers of consumer electronic devices. Socio-economic impact and benefit is generated through the commercialisation carried out by these entities in Europe, America and Asia-Pacific.

For this group, economic impact is generated through direct take up of our research that has led to new or improved commercial products and services. In addition to the companies noted in the three case studies, there are other industrial involvements in commercialising the Unit's research. For example, a CCTV forensic analysis tool, FiND, developed in collaboration with Visimetrics ltd, was launched at the IFSEC 2012 and is at present entering the video analytics/forensics market.

Secondary beneficiaries

The consumers and professional end-users are: process engineers and plant operators in the pharmaceutical, petrochemical and nuclear industries; railway commuters; automobile users; household and industrial energy consumers; the Ministry of Defence; automobile manufacturers; network service users; emergency and rescue services; consumer electronic device users.

This group has also benefitted from the Unit's research. For example Safety Engineers can carry out hazard identification more efficiently supported by new software tools. Research into network congestion control has led to BAE Systems Ltd changing their internal processes in handling communications between networks of military vehicles.

b. Approach to impact

The Unit's approach has five components. First, to create impact in the industry there is a need to understand their strategic issues and problems. Over 90% of the research grants and contracts of the Unit involve collaborations with industry and government organisations. The Unit has been awarded Industrial Research Fellowships, industry funded research studentships, industry sponsored grants and EPSRC/TSB/ERDF grants in collaboration with industry. For example, a Royal Society Industrial Fellowship and a Royal Academy of Engineering Industrial Fellowship were awarded to Dr Guan and Prof Yang, respectively. This enabled them to work with BAE Systems in the areas of Internet Quality of Service (QoS), network congestion control, wireless communication and network security. Five PhD studentships have been provided within the REF period by BAE Systems, Apical Ltd., CISCO and DFKI. Another eight EPSRC EngD studentships have been sponsored by Hazid Technologies, BAE Systems, Apical Ltd, Apricot Training Brokerage and JCK joinery, through the Doctoral Training Centres at Loughborough University. The Unit is part of two EPSRC grants involving industrial collaborators each of which is over £1M in value [EP/J011525/1, EP/I000267/1] and completed EPSRC/TSB grants totalling £1.2M within the REF period.

Second, the Unit seeks follow-on collaborative R&D funds after the successful completion of research projects from government funding bodies (e.g. TSB), University (via its EPSRC Knowledge Transfer Account) and industry to create impact from its research. Projects contributing

to the development of existing industrial practices and commercial software packages for BAE Systems, SURE Technology and The Foundry were funded by this route. A total of five Knowledge Transfer Partnership (KTP) grants to the value of over £600K have been awarded in the REF period for collaborative projects with RWA Rail, Apical ltd., Visimetrics and BAST. Two of the above projects (RWA Rail and Apical ltd.) were shortlisted for 2012 and 2013 Loughborough University Enterprise Awards for knowledge transfer. The 2013 award was won by the Apical KTP project. The ASTRAEA project with BAE Systems was a finalist for an IET Innovation Award 2009.

Third, the Unit seeks to spinout companies to commercialise its research results. For example, Hazid Technologies was formed to commercialise Prof Chung's research in safety-related systems with investment from the University and other funders. This company now has a portfolio of international clients, e.g. Clough, Australia; Chiyoda, Japan; Hyundai Engineering, Korea; Bechtel, USA. The Unit has been and continues in negotiations to spin out other companies.

Fourth, impact of research has further enabled interactions through consultancy undertaken by staff (e.g. Energy Technology Institute, English Institute of Sports, JS consultancy). Loughborough University Enterprises Ltd manages the initial introductions, contract negotiations, costing and project management on behalf of the academics. Research students and staff employed by industrial collaborators after successful completion of projects is another path to knowledge transfer leading to commercial exploitation of the Unit's research. The Unit has also provided training to its industrial partners (Rolls Royce, Apical) via specialised MSc level modules.

Finally, staff are engaged in dissemination and public engagement activities such as invited talks, keynote presentations, public seminars and exhibitions, enabling fundamental research ideas to be disseminated to a wider audience both nationally and internationally. For example, Prof Chung was awarded an Invitation Fellowship by JSPS to visit Japan in 2012. Prof Yang gave the keynote speech at the Wireless Sensor Networks and Energy Harvesting Conference, Germany, 2011.

The Unit has a Strategic Research & Enterprise Account of £20K per annum to pump prime research, establish new partnerships/consortia and facilitate dissemination activities. The Unit has an Enterprise Champion who works closely with the Associate Dean (Enterprise), School of Science, to manage enterprise related activities. Enterprise activities are recognised in the performance assessment of academic staff. The Unit has an agile approach to creating impact by seeking and responding to opportunities to be engaged in any of the components mentioned above. For example the Unit actively seeks involvement in TSB and KTP programmes and has been successful in securing over 10 awards in the REF period. The Loughborough University Research and Enterprises Offices that are led by the PVCs for Research and Enterprise provide valuable support to the Units staff in consortia building, forming new industrial links, project costing, project management, contract negotiations, IP issues, patent applications etc. The Enterprise Performance Group (EPG) manages innovation funds that are allocated in a competitive manner to staff wishing to exploit research. The Unit has received £ 204K funding since 2008 via this route to pump prime commercialising research ideas.

c. Strategy and plans

The strategy to support and enable impact from the Unit's research in the future is first focused on bringing together the right mix of staff to carry out research and create impact effectively. Staff are encouraged to follow appropriate training courses delivered by the University's Staff Development Programme so that they are familiar with the pathways to impact.

The second part of the strategy is to involve industry in the Unit's research. Industry has been invited to collaborate at all levels of R&D, including joint supervision and funding of PhD/EngD students and postdoctoral researchers. The Unit has an Industrial Advisory Group which meets twice a year. The membership is drawn from the Unit's industrial collaborators whose role includes providing advice on the direction of current and future areas of close-to-market research. The aim is to establish long term partnerships with these companies.

The third part of the Unit's strategy is to work closely with the Enterprise Office to make use of the

support and opportunities they provide. For example negotiations are underway to invite one of the key industrial collaborators, Apical Ltd. to relocate in the planned Loughborough University Enterprise Park in 2015. This will enable a closer working relationship with this company.

The fourth part of the strategy is to make state-of-the-art research facilities and services available to external users (NHS, Apical Ltd., The Foundry, Visimetrics, BAE Systems, BSkyB). Dedicated laboratory facilities to the value of £300K in networking, imaging, graphics, robotics and autonomous systems have been set up for this purpose.

The plan is to further develop projects that have potential for commercialisation. For example the research on energy efficient control systems has led to the design and prototype of an energy efficient domestic radiator control valve which was patented in the UK. Suitable industrial partners are being sought to improve the product design and for commercialisation. The work in modelling material reflectance has resulted in the movie special effects industry and automotive design industry re-designing their present software for better performance. The Unit is working with The Foundry and BMW to bring the software into the marketplace.

d. Relationship to case studies

The impact described in all the case studies link closely with the approach described above. They all use various components as explained below.

The case study *"The commercialisation of novel knowledge-based computer tools for process plant design check and hazard identification"* went through the following steps: British Gas - Royal Academy of Engineering Senior Research Fellowship (Chung 91-99) and research grants to generate results; Gatsby Fellowship (Chung 2002) with support from the University to start a spinout company – Hazid Technologies. Funding from the company for two EngD studentships (2004 and 2005) to support further research. By starting Hazid and transferring the technologies to the company, impact is generated in the process industry through CAD vendors and sales.

The underpinning research of the case study *"Enhanced products and services through low-cost wireless solutions"* started in 2000 funded by EPSRC. Further subsequent funding from the TSB, Carbon Connection and the European Regional Development Fund enabled the technologies to be developed and evaluated as wireless solutions in collaboration with industry. A six-month Industrial Fellowship from the Royal Academy of Engineering allowed Prof Yang to work within BAE Systems to develop the technology further and to successfully obtain four TSB-funded R&D grants to support the development of the case study.

The underpinning research of the case study "*Loughborough University Research into Image Enhancement Allows Digital Images to be Viewed as Seeing-by-Eyes"* originated via an EPSRC grant funded in 2005 in collaboration with Apical Ltd. The first grant covering the applied research was funded as a Collaborative R&D grant between the Unit, Apical and BSkyB (2009-2012). Follow on funding was generated to take products into the market via two KTP projects (2010, 2012) funded by the TSB, Apical Ltd., and the University Knowledge Transfer Account. Funding for three PhD/EngD were provided by Apical Ltd and the company has also employed four further postgraduates from the Unit to support their technology development.

The case studies have helped the formulation of the impact strategy and plans described in Section C. The experience gathered from the case studies has informed:

- The importance of awareness of potential commercial value of research outcomes and opportunities to work directly with industry.
- The role played by the Loughborough University Enterprise Office in providing advice in IPR issues, contract agreements and other legal and financial matters.
- The benefits of developing and maintaining a long term partnership with industry partners through commitment, trust and delivering timely results.