Institution: University of Derby

Unit of Assessment: 11

a. Context

Computing expertise evolves because of cooperation between academia, industry, and the public. This means that the School of Computing and Mathematics works in an area where local, national, and international organisations are predisposed to collaboration. Such organisations' interest is sharpened by the core of our research being future architectures and services, with a particular emphasis on interoperability and interconnected infrastructure. Companies and international higher education institutions represent a category of beneficiaries that have rich experience of impact from academic research and the benefits and rewards it can bring.

Alongside this, organisations responsible for public engagement, outreach, tourism, and heritage preservation is a category of users that value contributions from academic research while not being focussed on commercial exploitation. Derby's history of engineering, enquiry, and innovation dating back to the 18th century means that this category includes organisations such as media, Derby Museums (DM), and the local branch of the Royal Society for the encouragement of Arts, Manufactures, and Commerce (the RSA). Together, these categories contain ready outlets for the School's research programme.

The impact that we seek is of two types, aligned with the qualities and needs of the two categories of beneficiaries introduced above. For those used to working with academia, we provide benefit through cooperative research funding bids and alignment of our research strategy with stakeholder goals. The attached case studies illustrate this.

Simultaneously, we bring benefit to organisations such as local media, DM, and the RSA by showing that our research can change peoples' lives. We do this through bespoke, targeted interactions with the media (Mr. Kim Smith, Dr. Olga Angelopoulou, and Dr. David Evans have been sought as experts on security and forensics) and have been invited repeatedly by DM and the RSA to lead seminars that provide instruction and inspiration.

b. Approach to impact

The approach to impact taken by the School of Computing and Mathematics during 2008-2013 has had two main components, following the needs of the two categories of users within our environment. We have nurtured research that aligns staff expertise with non-academic beneficiaries' goals. Simultaneously, we have increased our profile by becoming known as a source for expert knowledge and a purveyor of education to those outside the HE sector; critically, this has led to being consulted repeatedly.

As part of the first impact component, the School has focussed on funding sources that involve partners who take part with the expectation of commercially viable, relevant

research. Attached is a case study that illustrates such work with national (XAD Communications, an SME) and international (Roche) partners, with financial arrangements that include the Technology Strategy Board (TSB) and Knowledge Transfer Partnerships (KTPs). Research that has commercial and social impact is supported by other sources as well, and the second case study that is attached describes work involving stakeholders that include international higher education institutions.

The second component of our approach emphasises involvement with the media and local organisations in order to create social impact. We have become known for employing experts adept at giving focussed advice and explaining technical topics. Mr. Kim Smith has appeared on BBC East Television's Midlands Today (December 19th 2012) to explain the links between computers and identity theft, Dr. Olga Angelopoulou has been interviewed by Science Omega Review UK (issue 2, June 10th 2013), and Dr. David Evans has been interviewed by BBC Radio Derby (March 1st 2013) in connection with hacking scams spread by telephone.

Furthermore, Dr. Evans has used his research knowledge of computer communication networks and security in an informal collaboration with Derby Museums and the Royal Society for the encouragement of Arts, Manufactures and Commerce to spread interest in, and enthusiasm for, computing throughout the local community whilst maintaining an environment that does not feel like traditional education. Staff members' annual performance reviews include significant appraisal based on the interests of the staff members. This means that activities that engender impact, fitting into the strategy described above, lead to institutional recognition and reward as described in the document covering our research environment. As examples of this, since 2008 Drs. Richard Hill and Peter Larcombe have been appointed first Readers and then Professors and Drs. Ashiq Anjun and Lu Liu have been appointed Senior Lecturers and then Readers.

c. Strategy and plans

Our research on future architectures and services, emphasising interoperability and interconnected infrastructure, encompasses a set of problems that are of interest and relevance to industry. Consequently, our strategy for continuing to achieve impact begins with attracting academic staff who are research-active and are committed to work that is relevant to external beneficiaries, both national and international. Critically, we shall extend and solidify the collaborative and multidisciplinary aspects of our environment; as of 2013, all of our research projects involve multiple members of academic staff and external partners from disparate disciplines who find the work relevant to their goals. An explicit part of this strategy is gaining funding through TSB, KTPs, and direct industrial investment. This continues the component of our approach to impact where we cooperate on research funding bids and align our research strategy with stakeholder goals. Furthermore, a key quality we look for in new staff is the ability to seek out beneficiaries that may become known only once a research project begins. This leads to work that has impact on users that are not anticipated.

In parallel with ensuring that research maintains industrial involvement, we aim to maintain

alignment between our research work and teaching, especially to beneficiaries external to HE. We do this not only to improve the distinction of our programmes to attract the best students but because the second category of beneficiaries within our environment is helped by demonstrating that our research can change peoples' lives. While we continue our involvement with DM, the RSA, and as consulted experts, we incorporate students into this process by exposing them to the academic research we do via its explicit inclusion throughout the curriculum. We assess efficacy by continuing to monitor students' performance–academically, while on work placements, in the job market after graduation, and in interactions with our beneficiaries–through personal interaction, review of academic profiles, and discussions one to three years after graduation.

d. Relationship to case studies

The accompanying case studies illustrate our approach to realising impact though channelling research interests and activity into work that maintains relevance to beneficiaries; in these instances these beneficiaries are commercial organisations and international higher education institutions. The studies demonstrate specifically the alignment of research staff interests with those of industry and other stakeholders who are not academic research colleagues.

Both case studies focus on cloud computing. Dr. Ashiq Anjum's expertise includes scheduling and resource allocation, discovery, and management. His work has been of interest to XAD Communications, an SME, for the analysis of images from cameras used for applications such as security and traffic monitoring. Processing these images is computationally demanding and Dr. Anjum's work on making computing facilities usable and discoverable in cloud-based environments led to a TSB-funded collaboration. Similarly, Roche, a global pharmaceutical corporation, found Dr. Anjum's research of use for constructing the infrastructure needed to manage clinical trials for the drug discovery process. In both of these cases, in keeping with our impact strategy, Dr. Anjum's interests and knowledge have been tied directly to industry needs, leading to an impact on how XAD Communications and Roche do business.

Dr. Lu Liu has led work on the sustainability and energy consumption of cloud computing infrastructure, including security and isolation of virtualised cloud applications and the delivery of these applications to end-user desktops. He has concentrated on the use of such infrastructure to increase international participation in higher education; this has been done through collaboration with Tongji University, Beihang University, and Jiangsu University, all in the People's Republic of China. Their interest is in using Dr. Liu's techniques for providing enhanced educational capabilities to student populations spread over a wide area, ensuring that energy use is kept to a minimum.

Not only does this work demonstrate alignment between Dr. Liu's expertise and external beneficiaries, but these beneficiaries were not all known at the commencement of the research. Their later inclusion shows evidence of agility and our goal of identifying users of our work whenever they become apparent.