Institution: University of Brighton

Unit of Assessment: B11 Computer Science and Informatics

a. Context

The main non-academic beneficiaries of our research in computer science are software engineers, ontology engineers, commercial publishers, public institutions, marketing companies, and public health practitioners. End users include: Nokia, The Victoria and Albert Museum, the Royal Society for the Blind, Macmillan Publishers and the Oxford University Press. The range of impacts from which they have benefitted include enhanced delivery of professional services, improved commercial markets for existing businesses, new working practices for cultural institutions, reduced risk of future commercial losses and improved consumer data protection. Research impact is delivered by staff across the B11 UoA, but in particular by our diagrammatic reasoning, visualisation and natural language generation researchers (REF5).

b. Approach to impact

Our approach to impact is based on the identification of industry and societal needs for bespoke and complex computing systems that demand innovative research solutions. We pursue this through collaborative partnerships between academic researchers and key end user groups. This is enabled by providing a framework for impact delivery that: facilitates staff and end-user interactions; empowers staff to seek and maximise the benefits of their research, and; provides dedicated, professional support for identifying opportunities for impact-led research with industry and managing client relations. REF3b [1,2] exemplify our impact-driven research agenda, further demonstrated by the examples given below.

The framework for engaging with key users: A variety of formal and informal routes allow staff to develop and maximise interactions with key users and audiences, including the following:

Collaborating with end users: Mechanisms for facilitating collaboration include end-user involvement on research projects, industry-funded PhD studentships, and internal investment schemes (REF5) to support impact-driven research. Some exemplars resulting from these mechanisms include:

ECR RODRIGUEZ ECHAVARRIA's EPSRC First Grant award involves the Regency Town House (RTH) as a project partner. The RTH holds prestigious collections of letters, drawings and architectural ornaments. They will make use of the technologies delivered by the project to support the organisation and discoverability of digital 3D content. ECR RODRIGUEZ ECHAVARRIA has also worked closely with many other heritage professionals on the organisation and annotation of high-level semantics, enriching the information about cultural heritage artefacts.

PhD student Clark, supervised by ECR FISH and HOWSE, is funded by Energy Technology Control Ltd. Clark's funder is now using new methodologies for analysing failure modes in safety critical systems, resulting in safer products (such as boilers) that conform to ISO standards.

BELZ, following her V&L Net project (REF5), has secured follow-on funding from the European Cooperation in Science and Technology for networking activities. This network involves Yahoo and Google, with an emphasis on combining computer vision and language processing to yield impact through advanced search, retrieval and annotation of visual data. BELZ's research on natural language technologies has also been applied to develop seeing aids for the blind with the Royal London Society for the Blind, Nomensa, and AbilityNet.

ECR ZHOU's visualisation research has direct application in the medical domain, with ultimate beneficiaries being the public at large through improved healthcare. As a result of her research, there are now new methods for better visualising and interpreting data captured using advanced 7 Tesla MRI scanners. Thus, it is now possible to visualise anatomy previously unseen, via microscopic spatial resolution. ECR ZHOU's impact-driven research has benefitted partners at the Sir Peter Mansfield Magnetic Resonance Centre and Queen's Medical Centre at Nottingham. These partners are able to apply ECR ZHOU's results in practice, for investigating stroke in the human brain and neurodegeneration, including multiple sclerosis and Parkinson's disease.

Commissioned projects, KTPs, and contract research: These projects stimulate two-way discussion of research breakthroughs and realignment of company funding priorities. For example, funded collaborations with CRIMTAN (a leading online marketing company) and Torux (a leading financial investment software company) have leveraged value from big data and analytics technologies developed by PETRIDIS. CRIMTAN can increase the efficiency of market targeting by up to 70% and Torrux are including research findings into their methodology.

An Industrial Advisory Board (IAB): IAB members (formed 2012) include representatives from BT, Cogapp, Mason IT, Teradata and SAS. These companies bring expertise in commercial digital visualisation, management of big data sets, data analytics and digital communications systems development. The IAB advises on the strategic direction of academic, research, and enterprise activities as well as providing opportunities for the creation of strong links with industry.

Co-working with the public sector and charities: ECR RODRIGUEZ ECHAVARRIA, on the 3D-COFORM project, collaborated with an extensive network of end users, including the Louvre, the V&A, British Museum (Portable Antiquities Scheme), the Galleria dell'Accademia, the Osaka Castle Museum and the Public Monuments and Sculpture Association. Impact from the 3D-COFORM project includes the recording of cultural artefacts with semantically enriched 3D content and the visualisation of designs for the 1760s architectural competition to extend the Louvre. Heritage organisations and individuals, including the general public, have engaged with the research through testing, training, seminars and hands-on exercises using 3D technologies. These 3D technologies have provided end users with access to technologies for the documentation of artefacts in a more effective way.

Public engagement: Exhibitions, coupled with media coverage, have stimulated public engagement. For example, our research has been covered by the BBC's *Radio 4 Today* programme, ITV's *Meridian News*, *BBC South East News*, *The Sunday Telegraph, The Times,* and the Discovery Channel Canada. This media exposure led to take-up of cultural heritage results by Brighton Museum, the Portable Antiquities Scheme, Sussex Cricket Museum and others.

Supporting and rewarding staff to deliver impact: Staff are encouraged to maximise the impact associated with their research through a suite of internal investment schemes. There is now formal recognition of impact through the staff promotion process and workload allocation. Impact engagement and delivery is, for the first time, included in the new professorial promotion criteria from July 2013, where entry-level professors must demonstrate their original research has 'substantial impact beyond the university' and 'Distinguished Professors' are researchers 'whose work manifests knowledge exchange having lasting impact on the economy, society, culture or the environment'. Details of internal investment schemes that support impact-driven research are given in REF5. As examples, ECRs BURTON and ZHOU both gained Rising-Star Awards (£10k each) to support their impact-driven research agendas.

Institutional support is also geared towards supporting the framework for engaging with key users. The School's Business Development Manager (BDM) identifies opportunities for collaborating with industry, develops networks and partnerships to exploit Intellectual Property and economic benefit, and identifies impact opportunities. The BDM co-ordinates the IAB and organises industry oriented networking events at which the School's research is showcased; for example, one such event was held in conjunction with PETRIDIS's inaugural lecture. The BDM's activities are complemented by an external consultant who is contracted to identify impact opportunities for research on the OntoED project (REF5). The consultant has already identified several companies who wish to model ontologies using concept diagrams (an area of impact central to OntoED), so far resulting in a non-disclosure agreement being signed with Cognicor.

c. Strategy and plans

The university has recognised the increasing need to engage with the wider impact agenda. This is reflected by investment in: strengthening the support infrastructure; incorporating impact monitoring and target setting into research planning, and; providing additional training of researchers to recognise and pursue impact opportunities. These priorities are designed to realise SA2 in the REF5: '[to] *manage and deliver impact from our research and communicate this to scientific, business and public audiences*'.

Strengthening the infrastructure: Impact activities, and benefits accrued, are captured and monitored by the university's Economic and Social Engagement (EASE) Office. In 2013, the EASE Office joined with the Research Office to become a single department aiming to maximise impact from future research. The university will be appointing an Impact Policy Officer in 2014 to support the collection of evidence of impact and to feed into policy decisions on impact initiatives. Within computing, the BDM initiates and supports engagement with end users.

A new Intellectual Property Policy was introduced in 2013 to support enterprise creation and growth by staff, students and recent graduates of the university. Implemented through EASE and the BDMs across the university, this policy will stimulate the commercialisation of ideas and facilitate the licensing of work to other parties as a route to gaining both income and impact. An Enterprise Panel will encourage, support and fund staff to take forward their innovative ideas that can form the basis for commercial exploitation.

Embedding impact into institutional planning: From 2014, the School's annual research monitoring process will include: an explicit impact-related component that includes the identification of potential and current end-user groups; an analysis of the impact achieved to date; plans to deliver future impact, and; an analysis of resource requirements. These monitoring reports are received by the School's Research Strategy Committee which makes recommendations to the School's Management Group regarding allocation of resources to impact-related activities. EASE financial targets, including collaborative R&D programmes and intellectual property income, are now included alongside research income targets and monitored by the Faculty Dean. EASE impact activities and metrics are reported bi-monthly to the university's Business and Community Committee (BUCC), which includes representatives from the Board of Governors.

Training of researchers: From 2013, the university has ensured that research students receive formal training on recognising and embedding impact, types of knowledge exchange and methods of dissemination. This is complemented by training sessions at The Future's Bright annual conference for ECRs and RAs (REF5). Staff are asked to provide an impact plan for internal investment schemes such as Rising-Stars and Innovation funds.

Future ambitions: Over the next three years we will direct resources and effort to:

- Disseminate and publicise the impact of our research through: offering training courses to all staff, by the new Impact Policy Officer, on how to stimulate, document and publicise impact, and; the launch of an entirely new university research website in 2014 that will provide examples of impact, including end-user testimonials for our research.
- A closer integration of the IAB into research and EASE planning, setting targets and evaluation of research and EASE activities.
- Develop a Proof-of-Concept Programme, designed to kick-start impact-related activities (REF5). The Proof-of-Concept Programme is being test-driven on the OntoED project, by the funding of an RA to deliver open-source, freely available software to deliver wide-scale impact through take-up of the research results.

During 2014, the School's Research Strategy Committee will be developing key performance indicators to monitor the realisation of impact within computer science.

d. Relationship to case studies

The two case studies illustrate our approach to impact and exemplify key impacts of our research. REF3b [1] details a longstanding, mutually beneficial partnership with a major international company. This partnership, supported by RCUK grants and internal investment, led to research that contributed significantly to ongoing innovation resulting in new technologies. The results include economic benefits to Nokia, affecting their millions of customers.

REF3b [2] shows how a long-standing programme of RCUK-supported research, inspired by a dramatic increase in the availability of text in digital form in the 1990s, transformed dictionary production. This case study exemplifies how our research can engage end users, to define, frame and solve a problem in a way not previously imagined. The exploitation of this lexicography research, resulting in the Sketch Engine software, inspired the new Proof-of-Concept Programme, which is designed to accelerate the transformation of research into practice.