Institution: University of Stirling

Unit of Assessment: B11 Computer Science and Informatics

a. Context

Our research vision is completely focussed around close stakeholder engagement and inter-disciplinary collaborations to underpin high impact outcomes. The collaborative and interdisciplinary nature of our research necessarily involves close engagement with our stakeholders. Indeed, the stakeholder's role in formulating our research agenda represents a fundamental component of our research strategy. We work with a wide range of non-academic organisations including companies, government and the public sector. Our research enables our stakeholder partners to improve and enhance their operations by engaging with our cutting edge research agenda. Our innovative research into Intelligent decision support systems enables the analysis of historic and current data to provide evidence for formulating strategies to improve efficiency and to enhance organisational policies. A wide range of sectors require the formulation and simulation of computational models to understand and act upon different possible scenarios. For example, our computational modelling research enables a consideration of the impact of the movement of livestock on the spread of disease. Such modelling has significant impact in forming economic and environmental policies at business and governmental levels. Our research into Sentic Computing is enabling significant industrial impact and improved operations across a wide range of high profile international companies. A selection of examples of our close non-academic collaborations and the high level of impact generated is presented in the next section.

b. Approach to impact

The Computational Heuristics Operational Research and Decision-support Systems (CHORDS) group engages directly with a range of industrial and healthcare organisations. The group's £6.8M EPSRC Programme Grant (joint with UCL, Birmingham and York) includes collaboration with a wide variety of industrial organisations including ABB Group, Berner and Mattner, BT Laboratories, Ericsson, GCHQ, Honda, IBM, Microsoft Research, Motorola and Park Air Systems (Northrup Grumman). The group works closely with Westminster and Chelsea hospital to explore decision support methodologies for surgery scheduling. CHORDS engages with Manchester and Zurich airports on an EPSRC funded project on integrated airport operations and the group is also working with Ortec on personnel scheduling. In addition, the group works closely with KLM / Air France on operational issues in the air transport industry. A major successful feature of the CHORDS group's engagement with the impact agenda is the opportunity for research staff to take periods of secondment in stakeholder organisations. A post-doctoral researcher (Banerjea-Brodeur) is currently on a six month secondment to the Westminster and Chelsea hospital to ensure that her research programme in automated decision support for surgery scheduling addresses the complexity and uncertainty of the real problem solving environment in a busy modern hospital. We have written statements from KLM / Air France, Zurich Airport and Park Air Systems (Northrup Grumman) to support further post-doctoral research secondments. The group works closely with its industrial and public sector partners to ensure that stakeholder requirement is built into its transformative research agenda. We currently have a series of scientific research challenges that were formulated jointly with our stakeholder partners following site visits and workshop activity that led to wide-ranging debate and discussion.

The Modelling and Analysis of Complex Systems (MACS) group has generated impact by developing computational models of disease spread that have influenced government policy on containing a disease outbreak (see case study). This has built on close collaboration with Cefas and colleagues from across a broad range of disciplines including aquaculture, environmental science and biology. Norman's research has also resulted in policies on the control of Louping ill (LIV), a tick-borne virus, being disseminated to gamekeepers as part of a Knowledge Scotland Research briefing. The Scottish Funding Council Strategic Research Development Grant entitled, *Mobilising Advanced Technologies for Care in the Home* (Turner) engaged with health service groups from the very beginning. Turner was also a co-investigator on the ESRC-funded *Data Management through e-Social Science* (DAMES) project that has brought web portal data analysis tools to a broad range of social scientists across governmental organisations and academia. The ECO-DELIVERY project (Kleczkowski) was funded by the European Investment Bank. It

represents a collaboration with Stirling Management School and requires engagement with a broad spectrum of policy makers and non-governmental organisations.

In the Cognitive Computation group (CC), EPSRC-funded research (Hussain) on autonomous vehicle control is investigating computational intelligence techniques for control engineering. This project has SciSys and Industrial Control Systems as industrial partners. EPSRC Industrial CASE studentships have been employed to enable innovative basic research to feed into applicable systems. For example Hussain's PhD student (Cambria) has explored Sentic technologies with Sitekit Solutions Ltd. This studentship was brokered through Interface: The Knowledge Connection for Business (http://interfaceonline.org). Cambria worked on-site at Sitekit. The results are deployed in Sitekit's commercial Content Management System. The CC team also engaged closely with Abies Ltd UK, HP Labs India and Microsoft Research Asia, and now all of these companies have released commercial products containing Sentic technology (see case study). A further EPSRC CASE studentship (with Sitekit Ltd.) and Stirling University Impact Studentships (50% funded by industry: Unitech Ltd. and Ucare Ltd.) have been awarded, to develop support systems for health care. The CC group (Smith) has also worked closely with Qinetiq Ltd on an EPSRC funded project into autonomous systems.

Our Impact Champion (Smith) provides leadership on impact strategy and stakeholder engagement across all areas of our activity. The Division established an Industrial Advisory Board in 2007 and we have appointed an Honorary Professor, David Marples, of Technolution (http://www.technolution.eu), to provide input into our impact agenda. The University's Research and Enterprise Office provides an outstanding level of support for our impact agenda which enables a rapid response to emerging opportunities. Knowledge Transfer Partnerships (KTPs) enable an agile approach to impact. For example, Swingler (research fellow and part-time PhD student, CC) has had a KTP during the REF assessment period with "Think Analytics" (Glasgow) enabling the company to incorporate leading edge research into their Enterprise Data Miner product. The Division has also had both a KTP and an SFC Innovation Voucher with Maidsafe, which enabled the company to make a major update of their Novinet product. In addition, the Division has had an Innovation Voucher with OneDrum, enabling a PhD student (Furness; funded by a University studentship) to engage with them.

Stirling is an active member of the Scottish Informatics and Computer Science Alliance (SICSA), which coordinates interaction with industry through its business development executive and programmes. In addition, SICSA's annual DemoFest brings together researchers at an early stage with commerce and business leaders. The Division has also played a leading role in an EPSRC funded public engagement grant entitled, "*Waiter there really is a computer in my soup and it's telephoning me!: Revealing invisible computers*", which developed a show at the Glasgow Science Centre in collaboration with the Royal Conservatoire of Scotland. This show highlights recent research at Stirling in a way that is accessible to the general public and particularly to school children. Local public engagement impact has been achieved through a series of weekly research based public lectures that were held in spring 2012 and 2013. This successful series is scheduled to continue for the foreseeable future.

c. Strategy and plans

Our impact strategy is an integral and critical component of our research strategy. **The goal is to develop embedded partnerships with stakeholders at all stages in the research process: from the initial formulation of research challenges to the realisation of societal and industrial impact.** Our research vision can only be realised by enabling stakeholders to engage closely with our scientific agenda. Our current strategy encourages and facilitates impact through:

- Formally considering potential plans for impact as one criterion for staff appointments.
- Competing for investment to foster research excellence with impact through the University's prestigious Impact Fellowship and Studentship programme. We currently have four University Impact studentships.
- Assessment & monitoring via staff appraisals that identify current and future impact plans and resource, training and support needs.
- Training in grant writing and in-house internal peer review processes providing expertise on maximising impact from funded research.
- An honorary staff system that recognises impact as a key appointment criterion.

- Research Staff and PhD student secondments to foster embedded collaborations with stakeholder organisations.

Research impact is routinely written and costed into our research grant applications to provide a sustainable source of funds to support project engagement nationally and internationally. This approach is proving successful in sustaining the impact agenda as well as expanding the funding for our research still further through the creative synergy that is developed by engaged dialogue between academics, industrialists, policy makers and end-users. We believe that our strategy has helped to focus the impact relevance of our research and has led to our recent increase in grant income success. Impacts are ensured by:

- Collaborating closely with international and national stakeholders, including focused engagement with the Division's Industrial Advisory Board and Honorary staff.
- Working closely with the University's press office at the launch of each project to encourage and stimulate project engagement.
- Ensuring that we have public sector and industrial membership on project advisory panels.
- Organising end-user workshops at critical points of projects to maintain a two way dialogue.
- Generating effective public engagement via innovative use of social media.
- Contributing to local and nationally organised public engagement events.
- Interacting strongly with 4 major new Scottish Government funded Innovation Centres.

We have a strong network of stakeholder engagement and we are committed to extending it to ensure that the impact agenda continues to underpin our research agenda. We have appointed an impact champion for the Division (Prof Smith) to drive forward our impact strategy. This includes sharing our approach with other units in the School of Natural Sciences through impact workshops designed to foster closer collaboration and the dissemination of good practice. We aim to ensure that staff use all available mechanisms including Knowledge Transfer Partnerships, Industrial Vouchers, CASE studentships and University impact studentships. We also specifically support direct contact with potential stakeholders, assisted by the Division's Industrial Advisory Board and our Honorary Professor, David Marples, of Technolution (http://www.technolution.eu).

The Scottish Government has recently announced the launch of 8 major innovation centres which represent an investment of over £80M to enhance the contribution of the research base to the Scottish economy. One of the main aims of these centres is to open up new partnerships between universities and industry to underpin innovative economic development. The University of Stirling has provided the academic lead for the industry led Scottish Aquaculture Innovation Centre. It has a planned initial budget of over £11m from 2014-1019 and will be headquartered on the Stirling campus. It will deliver a coordinated response from across the Scottish research base to the industry's research and training needs and the aquatic food security programme being led by Prof Norman from within the MACS group will have an important role to play in its activities. We are also playing a role in another 3 of these centres: Digital Healthcare (Turner, building on our work on homecare technologies), The Scottish Sensor System centre (Smith, on signal processing work) and The Data Science Lab on big data (Smith). Innovation Centre engagement will be an important feature of our impact strategy. SICSA will continue to provide opportunities for creating impact, through its industrial contacts and engagement programme, including the annual Demofest.

d. Relationship to case studies

The case studies highlight two specific areas which represent clear examples of the success of our impact strategy. Both case studies have emerged as a direct result of our approach to impact.

Sentic Technologies: This has grown out of Hussain's work in the CC group. EPSRC case studentships supported an industrially focussed approach that was centred around stakeholder requirements and commercial need. This enabled successful realisation of research impact and attracted the attention of a number of international companies who have engaged enthusiastically with our research agenda.

Models of the control of Koi Herpes Virus: Norman's work in the MACS group on modelling of disease spread, computationally and mathematically, has been applied by Cefas in the determination of government policy by DEFRA on Koi Herpes Virus, a disease of Koi Carp.