Institution: University of Hertfordshire

Unit of Assessment: Panel B (11): Computer Science and Informatics

a. Context

Computer Science research at the University of Hertfordshire (UH) has a long history of collaboration with business, industry, and governmental organisations, with its origins in the early mission of UH (then the Hatfield Technical College) to provide the De Havilland Aircraft Company (later British Aerospace) with highly qualified personnel. Although its target beneficiaries have changed, much of the Centre for Computer Science and Informatics Research (CCSIR) activities originate, one way or another, in Professor Laurence Dixon's renowned Hatfield Numerical Optimisation Centre, which supplied state-of-the-art algorithms for numerical calculus and optimisation to many industrial partners as well as to the aerospace industry.

Recent non-academic beneficiaries

- The German Waterways Board has improved the efficiency of its modelling, and the software houses SAP and SCCH have improved the efficiency of their software.
- Local SMEs as well as large multinational companies such as Thales, Philips Healthcare and the German enterprise software company SAC AG have profited from a novel solution to problems in concurrency and synchronisation.
- The Wellcome Trust Sanger Institute; Patients Know Best®; the topical drug delivery specialist MedPharm; and Tesco Plc (UK), the Mahasarakam Provincial Government Office (Thailand), and the demographic data provider GeoStrategies (Romania) have all optimised their data acquisition, analysis and management efficiency.
- R&D departments in the biomedical industry and in charities are able to more efficiently mine and exploit knowledge about target pathways for cancer drugs, owing to SBML and the BioModels database, whose specifications originate at the CCSIR.
- The lives of autistic children and their families, and of people needing assistance in daily living, are being improved through novel robot assistive technology, and also because media attention attracted by our research has raised awareness among governmental institutions and demonstrably changed public policy.
- Visually impaired people worldwide have been enabled to work more productively as the Web Accessibility Standards and guidance for non-visual information systems, developed in the Sensory Disabilities Unit, have changed public perception and policy.
- The general public benefits from the cultural impact of the work of the Artists in Residence, who collaborate with researchers at the CCSIR to artistically explore our relationship with digital technology in a way that goes well beyond entertainment.

b. Approach to impact

The CCSIR strategy is to let the challenges of real-world problems guide our choice of research topics, allowing us to provide solutions valued by our non-academic collaborators and at the same time contribute to knowledge. This strategy requires us to evolve collaborations with a variety of enterprises, identify ways to improve processes on companies' critical paths, formulate high-tech solutions, and use this to extend our research in new directions. We distribute our resources across a selective range of topics, believing that high-quality solutions can only be delivered when founded on a solid theoretical base.

If a solution has impact, as manifested by its uptake, its development is followed by knowledge transfer to other products and organisations, which may ultimately lead to a wider transformation of practice and policy. Knowledge Transfer Partnerships (KTPs) are an excellent means for pushing research into practice, and they generate income and impact in the short term. The CCSIR avails

itself as much as possible of the UH-wide service offered by the university's Enterprise and Business Development Team, which brings businesses into contact with experts, maintains a database of our expertise, knowledge and skills, and entices SMEs to actively look for partners at UH. As a leading business-facing university, UH has a mission to facilitate services to businesses, and the CCSIR benefits from the university's investment to support these activities.

Potential opportunities for collaboration with local enterprises are often first identified through the undergraduate student placement system, our collaboration with Tesco Plc being a case in point. The students and their managers act as a reference point for further relationships.

A key part of our strategy is obtaining UK and EU grants involving industrial partners in our priority areas, and encouraging staff and collaborators to increase the visibility of their research, and their understanding of critical-path industrial issues, through secondments, visiting fellowships and conference organisation. Goal setting and monitoring, as described in the Environment Statement, is an integral part of this strategy. We maintain a network of collaborators outside academia, built over many years and still including partnerships originating in the Hatfield Numerical Optimisation Centre over forty years ago. As evidenced by our impact case studies, our research focus is informed by critical-path real-world problems from partners such as BAE Systems, the Met Office, QinetiQ, Thales, Philips Healthcare and many others, and has close ties with NAG, the numerical software provider. We also liaise with end users through representative bodies such as the National Autistic Society and the Royal National Institute of Blind People (RNIB).

Outreach and media exposure increase the visibility of our research, and motivate potential partners to seek contact. As well as our robotics research, which continues to provoke media interest and public discussion and has demonstrably influenced government policy, public engagement has also been stimulated by our participation in RoboCup, the robot soccer competition where, since 2002, software developed by a team of students and staff has produced many winners. Our Artist in Residence programme has led to productions that attracted over 9,000 visitors at the V&A Digital Design weekend, and go well beyond straightforward entertainment. The art installation 'My New Robot Companion' won the 2011 Award for Public Understanding of Artificial Intelligence from the Society of Artificial Intelligence and Simulation of Behaviour, and has provoked substantial public discussion.

The university has provided substantive financial and institutional support for the unit's impact strategy. It received over £23,000 from the university's internal grants competitions in 2010, 2011 and 2012 to support, for example, the KASPAR project and public engagement activities. The Business Development Team provides assistance in developing external collaborations across the commercial, educational and charitable sectors, including help with bid-writing, costing and tendering. A dedicated team also supports Knowledge Transfer Partnership activities. The Marketing and Communications divisions help organise publicity and PR for public events, while the UH media team actively seeks out opportunities to publicise and disseminate research. A university research blog has been established, to which **Dautenhahn**, **Polani** and **Amirabdollahian** have contributed.

c. Strategy and plans

Seeking and addressing real-world problems to inform our research will remain at the heart of our strategy. This secures a path to impact. We will target UK and EU priority areas, in particular advanced technology, health and ageing, and cultural enrichment. While nurturing existing collaborations to extend impact of completed projects and positioning ongoing ones for anticipated and serendipitous impact, we also aim to extend our network via EU projects, conference organisation and staff exchanges. Each of the research groups is developing plans for impact generation alongside the required research delivery plans for the post-REF period.

Economic targets. The EU projects CRAFTERS and ADVANCE will lead to substantially increased efficiency of synchronous computation, and are expected to have a major impact on the software industry. Partners Thales, Philips Healthcare and SAC AG are eager to reap the benefits.

The EU ACCORDANCE project (with partners Alcatel-Lucent, Deutsche Telecom and Telefonica, Spain) will deliver a novel access network architecture, resulting in improved broadband delivery to the home. CompAD is aimed at optimising algorithms for Automatic Differentiation, and will be further exploited to generate specialist top-of-the-range compiler designs for NAG. Ongoing KTPs will exploit databases and digital marketing in collaboration with SMEs Acoustic Control Engineers and Symble, respectively.

Health and Policy. The EU projects ACCOMPANY and CORBYS will enhance rehabilitation for stroke and degenerative diseases. Several EU-funded projects will bring ideas around robot companions (A-LIZE; LIREC) and robot-assisted therapy (KASPAR) closer to reality. A collaboration with the Erasmus Medical Center Rotterdam will improve understanding of neuronal spiking in epilepsy, and advance its treatment. Simulation of the interactions of cancer drugs with biological nanostructures will address cancer therapy, whereas the EU BIOMICS project aims at a comprehensive mathematical understanding of the dysfunction in intracellular pathways that lead to cancer. We will expand our portfolio with projects that target these and related areas, particularly in alignment with upcoming priority area initiatives at RCUK, the EU and appropriate charities such as the RNIB.

Media and Culture. We will build and extend upon the excellent media relationship that has been achieved and maintained by our Robotics team to engage the public and stimulate the debate about ethics. Our Artists in Residence will continue to support cultural impact, and debate.

Staff Support. Through our Enterprise Unit, we have recently placed the coordination of KTP acquisition and management in the hands of our Student Placement Coordinator so that these activities can synergistically lead to more effective knowledge exchange, secondments and commercial development of research outcomes. Effective staffing policies, such as reducing the teaching load of staff who dedicate time to the success of a KTP, will continue. All research groups will have specific impact targets, monitored informally by peers and collaborators through mentoring and team formation, and, more formally, bi-annually by the CCSIR and the Science and Technology Research Institute.

d. Relationship to case studies

Our four impact case studies exemplify the CCSIR strategic approach to impact.

'**Industrial Applications of Automatic Differentiation and Advanced Methods in Compilation Technology**' demonstrates a successful strategy of building on long-standing, well-established collaborations, including some going back to the 1970s.

'**SBML, the Systems Biology Markup Language**' represents the approach of building collaboration through the pursuit of a common goal, and raising awareness as a consequence of high-profile international events that cut across academia and industry around the globe.

The impact of one of the many EU-funded robotics projects, '**Robot-assisted Play for Therapy in Children with Autism**' shows the payoff and benefits of a strategy of combining support from collaborative EU projects with judicious use of the media.

'**Digital and Accessible Information: Accessibility for All**' exemplifies collaboration with a high-profile user group, and demonstrates how the establishment of a national centre can deliver products that change policies and lives.