Institution: Swansea University

Unit of Assessment: 11 - Computer Science and Informatics

a. Context

Innovation and problem solving are an integral part of computer science culture and each of the Department's three research groups – Theoretical Computer Science, Visual Computing and Human-Computer Interaction – delivers **industrial and social benefit**, **nationally and internationally**, with non-academic beneficiaries drawn from four types of user groups:

- **Large Companies:** Engineers in international companies and organisations such as *Invensys Rail*, *Nokia*, *Hewlett-Packard*, *Grid Tools* and *BBC R&D.*
- **SMEs and Microbusinesses:** Owners and staff of some **3455** companies have engaged with the Department's industrial support unit **ITWales**.
- **Public sector:** Practitioners, policy advisors, civil servants, and politicians in several areas, including *health* (safe medical HCI; integrated social services for substance abuse); *education* (CS curricula, professional development of teachers, engaging 5-19 year olds); *regeneration and heritage* (spatially-aware computing for regeneration and heritage); *civil society and public debate* (digital divide, rural and edge computing in India and Southern Africa; local history of ICT and its impact).
- **General public:** Users of the instruments and devices that benefit from our work on safer HCI, mobile and social technologies; and the public though various engagement activities.

Thus our research has led to **economic**, **health**, **educational** and **societal impacts**.

Our Welsh context is important and needs comment. The domestic life of Wales – economic development, education, health – is devolved to the Welsh Government (WG). The economy is dominated by microbusinesses (0-9 staff) and small businesses (10-49 staff): roughly 95% are micro-businesses and 3% are small, leaving only 2% medium or large. The WG's policies and incentives, including HEFCW funding, have encouraged Swansea Computer Science to create and lead several **innovative pan-Wales** projects to shape and build national computing capability and support the Welsh Knowledge Economy, with the help of both WG and EU funds

b. Approach to impact

Swansea computer scientists are curiosity driven. Our approach to impact is to ensure all academics, their RAs and research students have **opportunities and support** to engage with companies, their clients and supply chains, and with public bodies. Swansea computer scientists recognise that this leads to:

- serendipitous new problems, ideas and topics;
- a wider vision and deeper understanding of computing; and
- valuable new applications and improvements to products or processes.

The Department encourages research impact through **six complementary mechanisms** that encourage and support the early engagement of researchers with end-users and beneficiaries, foster close relationships, and maximise impact in term of its reach and significance:

1. Strategic collaborations with partners. These harness our academic knowledge and creativity to a **shared research vision driven by user needs**. The Department mentors and supports researchers in building relationships with international companies and public services, providing advice, time and funds. Examples include: Moller's work on specifying and verifying digital signalling software with Invensys Rail (a Siemens Company, HQ in Chippenham); Moller and Toft's (Hewlett Packard, Visiting Professor at Swansea) two-year project, applying service science to the design of client-focussed systems for integrating independent private and public providers of care for substance abuse in South Wales (to the benefit of WG, local authorities, NHS, police, charities, companies); and Roggenbach's development of specification and testing technologies for data management with Grid Tools (Oxford). Collaborations with the public sector include **a four-year strategic partnership with BBC R&D** (with five other institutions) announced in July 2013 with the aim of transforming the user-experience of broadcasting, led by M Jones.

2. Commercialisation of research through consultancy. Staff have worked extensively with industry through special consultancy mechanisms such as our Centre of Excellence for Technology and Industrial Collaboration (CETIC) in ***Computing and Software Technologies*** (one of 18 CETICs competitively funded by WG, £400k, 2002-2009), and the ***Welsh National Research Institute on Visual Interactive Computing*** **(**RIVIC) (funded by WG, £5m with £1.1m to Swansea, 2009-2013). Companies also engage with individuals, e.g., M Jones' three-month consultancy (and

subsequent visits) to facilitate integrated working methods across a wide range of groups in Nokia's Helsinki and Tampere Labs. The University's Department of Research and Innovation (DRI) also manages programmes that bring together businesses and academics, supports IP protection, launches spinout companies and facilitates consultancy services through a subsidiary company, *Swansea Innovations Ltd.*

3. Programmes directed at supporting the Welsh economy. The cumulative impact of Swansea researchers on the Welsh economy is significant. Our research underpins the activities of our industrial liaison unit, **ITWales**. Launched twenty years ago, it creates opportunities for, and offers support to, Swansea researchers' commercial collaborations. Researchers work with SMEs to address medium-term software problems relevant to products, services or operations. From experience, intervention has high impact on an SME because (i) software is fundamental to small companies existence; (ii) awareness of and access to research expertise in computer science is negligible; and (iii) researchers can engage deeply with business through ready access to owners and CEOs. However, such work does not normally require publications.

ITWales most recent awards of EU funding of £19.5 million (Jan 2009-Dec 2014) enables us to deliver this activity **across Wales**, thereby securing interventions and **economic impact on a large scale and reaching all industry sectors in Wales**. Since 2006, the **Swansea HQ** of ITWales has funded staff at **four** other Welsh universities. Through ITWales, we have access to an industrial user-base of more than **3455** companies. Currently, the ITWales portfolio includes **Software Alliance Wales** (£13.5m from EU/WG), which delivers projects, training and certification, and **Technocamps** (£6m from EU/WG), which offers workshops to young people and teachers of computing and ICT. Some **5500** pupils have attended Technocamps computing workshops on the Swansea campus alone. We deliver measurable impact in raising **public and political awareness** of computer science in Wales.

ITWales's EU projects require significant commitment from Swansea academics. Their time is costed as matched funding and is determined to be the actual costs of their time, measured by detailed time sheets and overheads. All ITWales funding receives rigorous accounting and auditing. The formal evidence of these accounts confirms that the work done by Swansea academics is considerable. To take a completed project as an example, consider the ITWales EU project *Promoting High Level Skills*. Staff delivered this industrial programme involving projects, workshops, consultancy, and graduate student supervision. The researchers' time accounted was **6084 hours**, and the total match funding provided by the Department for this single project was valued at **£413k.** The project worked with **1319 companies** and attracted **4471 participants**.

ITWales was mentioned approvingly in the *EPSRC International Review of ICT* in 2006 and is cited in the acknowledgements of research papers. Its achievements are best known in the business community: its founding Director, Beti Williams, won *Best Woman in Academia and Public Sector* category in the *Blackberry Woman of the Year Awards 2006*, and was awarded an MBE in the 2012 Honours List for pioneering work on small businesses.

In 2008, Swansea initiated the creation of **HPC Wales Ltd**, a national High Performance Computing facility and programme for economic development (£40m funded by EU (ERDF, ESF) BIS, HEFCW). Tucker was appointed Deputy PVC in 2011 to develop a University-wide strategy to enhance the impact of computing on the economy. Tucker also founded BCS in Wales to give a devolved political voice to practitioners.

4. An integrated multidisciplinary approach to research. This enables us to widen our delivery of impact. Examples include collaborations with economic historians on spatially-aware computing for regeneration of Swansea's 18th Century Copper Quarter; supporting bioscientists by using HPC and our own software designed to deal with animal movement tag data to display multi-dimensional information in innovative configurations; and collaborating with the College of Medicine through the Techealth initiative. The University holds an **EPSRC Impact Acceleration Account**. A portion of this (£180k) funds a ***Techealth Impact Facilitator*** in Computer Science, to develop opportunities for research collaboration and commercialisation activities.

5. Support for staff to achieve impact. Participation in knowledge transfer and industrial projects is valued and recognised in staff workloads; and staff have been promoted on the basis of outstanding impact activities (technology transfer, exploitation, public engagement). (The University's academic career pathways scheme **recognises and rewards staff** who demonstrate their impact through knowledge transfer.) The Department granted **periods of paid leave** to two

researchers to enable them to concentrate on enhancing the impact of their research. Academic appointments consider candidates' potential to interact with research users.

6. The Big Picture. The above five approaches are complemented by our efforts to keep in view contemporary computer science, by gathering and sharing experiences, news and opinions formally though external advisory boards, research away days, and our monthly discussion forum, and informally though daily conversations with our business liaison staff. Several of the actions above have their origins in such forms of intelligence gathering and horizon scanning.

c. Strategy and plans

Swansea will continue to develop its wide-spectrum approach to impact, recognising the importance of **industrial and multidisciplinary research collaborations** and **public engagement activities** that are firmly based upon the interests of individual researchers. Our impact strategy will also be influenced by the Welsh Government's strategy for economic renewal. ICT became a formally recognised sector of WG economic planning only in 2010. We see the Welsh economy as an important beneficiary through large-scale injections of computer science research expertise, and the Welsh base as a launch pad for new UK and international ventures.

Supporting staff in seeking and creating opportunities continues to be the key idea. The unit will undergo radical change in structure and operation to **transform our delivery of impact** through the construction of Swansea University's new, £250m **Science and Innovation Campus**, which will provide purpose-built facilities supporting enhanced interaction with industrial partners and end-users. The 31,000 m2 facility will open in 2015 and is predicated on an open innovation model, co-locating industrial R&D activity with academic research. The University aims to establish **a £15m ICT Precinct** on the new campus that by 2020 will enable (i) Computer Science to **double in size** and (ii) the **integration** of our academic staff, students and business support teams with managers and developers in private and public enterprises. These will transform opportunities for problem solving, knowledge transfer and commercial exploitation. A 5,000m^2 facility will house the Department, commercial and public service tenants, and our industrial and business support projects. The aim is to facilitate impact through:

- Acting as a *beacon* for research collaborations with private and public partners;
- Encouraging and enabling academics to locate their research in the commercial world and address *computational problems in situ*;
- Creating and managing *grass-roots projects* that transform and defend the Welsh economy;
- Developing a strong *entrepreneurial culture* around research and development;
- Engaging in/creating global and regional *networks* of technologists, users and policy makers.

In addition to strengthening our three research groups, we expect to form new groups on **data science and high performance computing;** and a multidisciplinary centre on **invention, innovation and change**. The expansion and ICT Precinct will enable the Department at Swansea to expand and deliver its research, teaching, outreach and impact strategies, and to enhance its contributions to public debate, policy development, and lobbying for Computer Science through partnerships with professional and trade bodies, think tanks and charities (e.g., *BCS*, *Computing at Schools*, *Foundation for Science and Technology*, *Learned Society of Wales*, *Institute for Welsh Affairs, Wales Quality Centre*).

d. Relationship to case studies

The case studies provide strong evidence of our commitment to collaborative work with non-academic users, but only partially showcase our current wide-spectrum approach and future strategy. The case studies are **motivated by ambitious long-term societal aims**; they are on-going and exemplify how groups of computer scientists, driven by their own passions to change the world, and with strong encouragement and financial support from the Department, can translate long-term research into outcomes.

- *Case Study 1: Safer HCI* demonstrates how the creation of a new research agenda, and a comprehensive research programme on safe HCI design for **healthcare**, **impacts** on patients, practitioners, manufacturers and regulators.
- *Case Study 2: UK Railways* demonstrates our **industrial impact**, through Invensys' adoption of formal methods that have led to cost and time reductions in the testing cycle, and is impacting on the future of signalling, motivated by the national need to increase rail traffic.
- *Case Study 3: Digital Divide* shows how our research has **international reach**, impacting rural communities in India, Southern Africa and the UK.