Institution: UNIVERSITY OF DUNDEE

Unit of Assessment: UOA 11 – COMPUTER SCIENCE & INFORMATICS

a. Context

The UoA, based in the School of Computing, has a sustained track record of practical application of its research, achieving since 2008 impact on a broad set of beneficiary groups, including:
(i) Patients and their carers including healthcare professionals, covering (a) health impacts including quality of life improvements for those with dementia and those with speaking difficulties; and (b) impact on public policy with respect to personal care plans;
(ii) Judiciary and government, national and local, both in the West and in the Developing World, covering (a) impact on public policy through co-organisation of a series of Digital Scotland workshops for Scottish Parliament, helping direct government policy through 'Scotland's Digital Future'; (b) impact on society of local communities in the Americas through technology results delivered by the Human Centred Computing (HCC) group which support online engagement with economic and environmental policies; (c) impact on professional services for lawyers, magistrates and educators who use software from the Intelligent Systems (IS) group for analysing argument;
(iii) World space agencies and aerospace industry, covering economic impacts on users and builders of spacecraft in aerospace companies and space agencies around the world, who use the software, hardware, standards and techniques developed in the IS group for defining, engineering and testing spacecraft on-board communications, and for building and testing vision-based navigation for planetary landers.

b. Approach to impact

The School's approach to delivering impact is tailored to different types of impact and beneficiary:
(i) Delivering quality of life impact
In order to translate research results into applications that impact people's lives, a complex network of stakeholders needs to be engaged. The School has over thirty years of working in this space and understands the challenges that this network presents. Its approach is to coordinate relationships with healthcare bodies (not only NHS trusts, but also care home providers such as Balhousie, and private providers such as BUPA), education departments (such as Dundee City and Perth & Kinross Councils), professional bodies (such as the GMC and RNIB), funders and charities (such as Capability Scotland, the Alzheimers Society and Maggie's Centres) and commercial organisations (such as DynaVox and Toby Churchill). A good example of this coordinated approach is **Hanson**'s new £1.3m EPSRC project (EP/K037293) which brings together care home staff, patients and family groups in order to understand how the built environment affects digital inclusion, and then connects with architects to disseminate the results as policy documents, professional body guidelines and best practice working papers.
(a) through working directly with end users: In much of the work across the School, particularly (though not exclusively) in the HCC group, there is a commitment to strong user focus. In 2005, the School opened a *User Centre* – a well-equipped laboratory reserved for working with older adults from the community in technology classes that occur four times per week. The User Centre is equipped to accommodate a variety of user-centred research and is also used by the StraightTalking User Group, convened by **Waller**, a unique group of adults with severe speech and physical impairments who provide consultancy to industry, researchers and academics who wish to design systems for people with severe disabilities. The group has provided consultancy for Toby Churchill Ltd, Tobii, NHS and Sheffield University and others. Building on this success, **Hanson** has coordinated the creation of the SiDE User Pool (established through the £12m RCUK Social Inclusion in the Digital Economy, SiDE, Research Hub) a group of nearly 900 individuals, mostly older adults in the greater Dundee area, who engage with the SiDE researchers in Dundee and Newcastle to advise on technology design, use, and priorities. The pool is coordinated by a dedicated member of staff. This direct access to end users plays a central role not only in both the Unit's fundamental research, but also in cycles of evaluation and feedback crucial to delivering long term impact.
(b) through working with healthcare professionals and services suppliers: Healthcare professionals are a key group with whom the School builds close relationships. Throughout four EPSRC grants worth over £700k (most recently, GR/T09279), the HCC group worked with carers in developing and testing reminiscence aids for those with dementia. The software can offer substantial improvement of quality in life (for a dramatic demonstration, see http://www.tinyurl.com/CIRCA-in-use). With advice from those in the School with spin-out experience, and support from the

University's Research & Innovation Services, a new company was formed to exploit this technology. Over 1600 patients and 900 carers in 59 centres across the UK are now regularly using CIRCA Connect's product, representing turnover to date of £177k.
Healthcare service suppliers also represent an important target. The £473k EPSRC grant EP/H052046 on analysis of retinal images provided a foundation upon which **Trucco** developed a strategic relation with market leader Optos. This relationship was supported through a further £750k of funding from EPSRC, DTI and others, and was nurtured by the School, through, for example, the award of a NRP PhD studentship to the relationship. Clinicians in the UK, Europe, USA, Brazil and Singapore now use the software and have developed international guidelines based upon it. The result has been to improve the reliability and efficiency of computer-assisted diagnosis of high-incidence diseases (e.g., diabetes and cancer), with a consequential improvement in patient management and care. The group's results have also improved patient safety through real-time monitoring in a surgical high-dependency unit.
(ii) Delivering economic impact to industry
To ensure coordination and to manage relationships, the School maintains a register of industrial contacts to ensure existing links are used as a springboard and multiple links are developed coherently (a good example is **Reed**'s contacts with the programme making side of the BBC which have been brought together with **Hanson**'s contacts with BBC R&D leading to new applied research, including £150k RCUK Hub Partnership Resource funding targeting high impact outcomes). Building relationships with industry through schemes such as KTP is supported by the School with recent successes including **Reed** and **Moncur**'s KTP awards together worth £290k, which have been facilitated by experience provided by the College's Business Development Managers who provide both horizon scanning to help identify opportunities and also mentoring and support through specific application processes.
(a) to the Aerospace industry: The number of major players in the aerospace industry is relatively small, and managed single-point-of-contact relationships and rapid turnaround are crucial. Dundee streamlines the management of these relationships, providing tailored support to the Space Technology Centre. The Spacewire Impact Case Study describes how research on spacecraft on-board networking has led to a standard adopted by all major space agencies and aerospace industry, which is already in-orbit or being designed into commercial, Earth Observation and scientific spacecraft worth in excess of $15bn. The Space Technology Centre has supplied ESA, JAXA, NASA, RosCosmos, CAST, SAST and other space agencies and aerospace companies across the world.
(b) to Informatics industries: In contrast to aerospace, informatics is a broad and complex industry with many players. Our approach is to provide all staff with an environment in which engagement with industry is supported, encouraged and expected. To that end, the School convenes an Industrial Advisory Board with members currently drawn from Amazon, North Face Ventures, CISCO, Chevron, NCR and BrightSolid. Examples of the success of this approach are **Moncur**'s collaboration with Microsoft (formerly represented on the board) which led to a £240k EPSRC fellowship EP/I026304 and impact with Maggie's Centres for digital inheritance planning; and **Komendantskaya**'s Industrial Proof of Concept grant (funded by the Scottish Funding Council and the Scottish Informatics and Computer Science Alliance pool) for delivering proof discovery tools to the software/hardware verification including Centaur and Rockwell Collins (who subsequently supported **Komendantskaya's** £281k EPSRC grant EP/K028243).
(iii) Delivering policy-oriented impact for government
The reputation of the Unit's staff leads to their engagement in policy advice activity which is facilitated and encouraged by the School. Two recent examples are **Hanson** who was invited to address the Scottish Parliament on Scotland's Digital Future, leading to contributions to the government's Scotland's Digital Future roadmap, and **Waller**, who contributed to the 2010-11 and 2011-12 annual reports to UK government on *Research and development work relating to assistive technology* for the UK government. Arnott and Hine also had impact on healthcare technology policy by contributing to the European Telecommunications Standards Institute (ETSI) standard ES202642 on Personalisation of eHealth systems, and Hine is advisor to the mayor of Bogota on ICT use in the city's schools. The School and University are increasingly providing training and mentoring for academics in such a role, and the School Research Committee also provides informal guidance and support for individuals engaging in policy advice.
(iv) Delivering impact to practitioners
The School also works to deliver impact to practitioners through training and consultancy. The

School uses the University's *Innovation Portal* to advertise competencies, but also relies upon individuals' reputations and networks to deliver, for example, Whitehorn's regular column on business intelligence for *The Register*, **Trucco**'s medical imaging training in Kuala Lumpur and TEKBAC (Australia) and **Reed**'s consultancy as interim CTO for a Dundee-based SME and analysis training in Canada, the latter of which led to deployment of the 'Araucaria' software from the group across 400 magistrates offices in Ontario. For them, the impact is economic efficiency, as the software allows them to process cases more effectively. For law firms from Hollywood to Hong Kong, the impact of the software is in performance improvements in being able to summarise complex cases efficiently. For educators that use it in more than 200 universities, colleges and schools in over 50 countries comprising more than 10,000 distinct users, the software provides substantial improvements in both the quality and efficiency of the learning environment.

c. Strategy and plans

The School's Impact Strategy for maximising impact is in three parts: **coordinating** opportunities for impact across the Unit**; facilitating** individuals in taking advantage of those opportunities and capitalising upon them; and **collaborating** across institutions to gain critical mass.

Coordination: To drive an impact agenda, the School will create a Head of Entrepreneurship. The aim is to develop proactive guidance for all staff to explore new potential beneficiary groups for successful research projects. Both this person and the Head of Research will sit *ex officio* on the School's Industrial Advisory Board to ensure that opportunities for industrial impact are identified early and staff are given appropriate support to capitalise upon them. The Chair of that Board, Farquhar, is a serial entrepreneur and in 2011 was appointed Honorary Lecturer to teach entrepreneurship to both staff and students. The Head of Entrepreneurship will be tasked with expanding provision of training and mentoring for both staff and students. In 2013, the School has established a new Research Impact Investment Fund, to support strategic seed-corn investment in potentially high impact activities. Bids are submitted to the School Research Committee and awarded competitively. The School will track the success of the fund through a set of KPIs.

Facilitation: To facilitate researchers in maximising the potential impact of their research, the School and University will coordinate to enhance: (i) commercialisation support through advice, practical training and 1-to-1 coaching (this has led to successes such as STAR-Dundee, formed in 2002 and growing, profitably year-on-year since, and, more recently, CIRCA Connect, which is already profitable after less than 12 months); (ii) strategic investment for impact related activities (which has seen the results of the £1.4m TSB-funded FABRIC project (**McKenna**, PI) delivering impact for museum goers, with visualisations of V&A and Liberty Art Fabric collections exhibited, and an interactive exhibit forming the centrepiece of the Compass lounge at the National Maritime Museum, London); (iii) media training (with **Waller**, **Hanson**, **Moncur**, **Petrie** and **Reed** all appearing during the period on programmes such as *STV ("Straight Talk", "STV news")*, *BBC1*, *BBC Radio 4 ("You and Yours", "Word of Mouth")*, *CBBC ("Young inventors competition")*, *CBC ("As it Happens"), BBC World Service ("The World Today"),* and local radio) which is a key part of broadening impact (a good example is **Reed**'s 2012 appearance on the BBC's "*Click*", audience 22 million, which led to enquiries from potential beneficiaries including Jaguar Land Rover).

Collaboration: The School is building on its involvement in SICSA, particularly in its engagement with the industry-led £30m Data Lab innovation centre, and pan-Scotland TechMeetups.

d. Relationship to case studies

(i) Augmentative and Alternative Communication: The development of the underpinning research was focused and driven by engagement with users – engagement which continued as the prototypes sought a route to market. By carefully managing relationships with industrial partners including DynaVox and Toby Churchill, healthcare providers including the NHS and local specialist schools, and NGOs such as Capability Scotland, a route to market was established resulting in direct impact on the quality of life of end users.

(ii) SpaceWire: Agile administrative support from School and University has facilitated the IS group being invited into competition-free 'direct-negotiation' for several technology research contracts from the European Space Agency. University support for spin out activity has created a mutually beneficial relationship between STAR-Dundee and the University that allows application of research to be carried out commercially whilst protecting the research intensive component of the group's work.