Institution: University of Hull

Unit of Assessment: B11: Computer Science and informatics

a. Context

The Department's research impacts "the economy", "health, public policy and services" and "quality of life" both nationally and internationally. The Department's three research groups – Dependable Systems, Intelligent Systems, and Simulation and Visualization – map onto four strategic University/Faculty research themes, namely: *Telehealth*; *Transport*; *Environment*; and *Medical Systems*. Beneficiaries of the *Environment* theme include: industry, policy makers and the general public; and of the *Medical Systems* and *Telehealth* themes: patients, the NHS (as an organisation, and nursing and medical communities), medical device companies and the general public. For Dependable Systems, in addition to the advanced tools being developed, the research affects industry and standards for the design of Transport and other Safety Critical systems. These themes are multidisciplinary and involve extensive external collaboration.

For all research groups there are strong, established relationships that are actively promoting transformation of research into tangible benefits at both operational and strategic levels, *i.e.* research projects (FP7, KTP, and Technology Strategy Board) that include academics with industry and/or health service staff working collaboratively. The Department's innovative research into new products, processes and devices generates opportunities for commercialisation, with concomitant job and wealth creation, as well as improved delivery and cost-effectiveness for industry, the NHS and other health services.

Computer Science is a growing priority of the institution as witnessed by the recent investment in staff and facilities, with ambitions for significant further expansion. The University has *Health and Wellbeing* and *Energy and the Environment* as two strategic priorities, which also reflects the region's priorities. For example, in recent years the city has invested £250M in major new hospital facilities and £36M in offshore wind and the wider renewable sectors on the North and South banks of the Humber. The activities within Computer Science directly support both these regional and institutional priorities, as well as contributing to similar national priorities, as demonstrated below.

b. Approach to impact

Pathways and approaches to impact

In addition to commercialisation of research (e.g. HiP-HOPS and VERT) through project partners, the Department actively promotes engagement with local, national and international communities/organisations. The Department's two centres – the *Hull Immersive Visualization Environment* (HIVE) and the commercial software unit SEED – play a key role in both engagement and exploitation of research. The Department's Director of Enterprise, provides a conduit to the University's Enterprise Centre, and ensures that opportunities for engagement in commercial applications are widely publicised and supported.

Institutional support

Established using £1.87M funding from the **Higher Education Innovation Fund** (HEIF), the **Centre for Adaptive Science and Sustainability** (CASS) promotes research and collaboration with industry in the renewable energy and low carbon sectors. Expertise from SimVis and HIVE is applied (in HEIF5 inter-disciplinary projects) via CASS, in partnership with businesses, that deliver University expertise to the rapidly expanding renewables sector moving to the Humber Enterprise Zone – the largest in the country and specific to Renewable Energy. It will support development of the three largest proposed offshore wind farms at Dogger Bank, Hornsea and Norfolk.

The University's **Centre for Telehealth** (CfT), established in 2011, brings together telehealth expertise from across the University, primary and acute care, local authorities, industry and third sector partners to develop new service concepts that will form the future basis for telehealth service delivery in the NHS and elsewhere. The multi-disciplinary Centre provides a range of services to health-care providers and industry, supported by research and educational expertise.

Computer Science is a key contributor to the CfT, in particular, adaptable telehealth monitoring systems, and is developing collaborations across the University and in HYMS.

The **Enterprise Centre**, opened by HRH the Duke of Edinburgh in 2008, places the University of Hull at the heart of enterprise activity in the region and nationally. It hosts the University's Knowledge Exchange (KE) and Research Funding Office (RFO). The RFO provides advice and support for securing research funding, while the KE offers proactive support to secure more development-focussed funding, with an eye to exploitation of that research. The KE provides expert advice to staff and students in terms of exploitation and commercialisation, including patent protection, licensing and company spin-outs. The KE has staff dedicated to identifying potential collaborative projects and working with all parties to draft proposals, and has a dedicated officer to both promote and administer **Knowledge Transfer Partnership** (KTP) programmes.

The University of Hull achieved a substantial increase in its allocation under the latest round of the **Higher Education Innovation Fund** (**HEIF**); (47% increase in HEIF5 funding (2011-2015) compared to HEIF4). This is due to its consistent performance against the income-based funding criteria of the Higher Education Business and Community Interaction (HE-BCI) returns. A large part of this has been used to support the work of Computer Science directly through CASS and CfT.

Departmental support and promotion of impact activities

The Department of Computer Science actively supports staff in achieving impact from their research in a number of ways. An explicit allocation of time within its workload model recognises enterprise activities. There are numerous examples of on-going successful partnerships with industry including car manufacturers and medical companies. These are funded directly by the company or through KTPs and other grants, demonstrating that staff are actively pursuing funding to take products to an appropriate end-user. The Department has employed KTPs as a means of exploiting its research expertise and has been awarded a total of 6 KTP partnerships since 2008.

HIVE provides researchers and industrial clients with an array of advanced visualisation, motion capture, and computer graphics technology, and supports a wide range of research and commercial projects. HIVE is also one of the main focuses of the Department's engagement with local schools and colleges, providing educational events, work experience, and training courses for teachers and students alike.

Simulation and visualization are key technologies for realising effective training and therapy applications that deliver improved outcomes, throughput and cost-benefit ratios compared with traditional modalities. Research targets the medical domain (e.g. VERT, a case study and outlined in section d) and environmental domain (via CASS, described above) and is facilitated by HIVE. Also targeting the medical domain is orthopaedic surgery training, which builds on the work on CAOSS (computer-assisted orthopaedic surgery system), recipient of the 1995 BCS UK IT award. The currently developed system, funded by Smith and Nephew, is progressing to validation trials in 2013.

Telehealth draws together researchers across the three research groups, with collaborative projects across the Faculty, University, nationally and internationally. The city of Hull has ambitions to become a centre of excellence for telehealth. The research in the Department, in collaboration with Philips Research and iMonS, impacts heavily on these aspirations.

SEED, the Department's commercial software development unit, seeks to provide commercial experience for students, whilst developing state-of-the-art applications built upon the Department's research expertise, for example on Dependable Systems. Its main product line is the BRIGID suite of mission critical software, designed with and for fire and rescue services. The BRIGID suite provides an end-to-end data communications capability, integrated with live vehicle tracking, mapping and risk data management, with a full command, control and dispatch suite for use in service control rooms. BRIGID is used in 15 of England's 45 UK fire and rescue services (holding 820+ active licences), providing them with the most up-to-date information possible for management of resources and control of incidents. In a number of services, the efficiency gained through improved visibility of live information has resulted in considerable changes to working practices, with substantial savings.

Another key role of SEED is research exploitation. For example, in the field of medical therapy, by

combining SimVis expertise in computer games and stereoscopic vision with SEED, a new video display technology was developed to treat amblyopia in children. Funded by the Wellcome Trust, this collaboration with the University of Nottingham and Queen's Medical Centre, Nottingham, aims to improve on traditional occlusion therapies for this widespread and potentially debilitating condition.

c. Strategy and plans

The exploitation and commercialisation of research is a key component of the Department's research strategy. SEED is an embodiment of this strategy, by providing a focus for the transformation of both pure and applied computer science research into commercial reality. Researchers are actively encouraged to engage with SEED early in the project life cycle, to explore opportunities to maximise the impact of their research. A significant cohort of MEng students (currently 45) in their final year undertake group projects within SEED. These teams of software developers provide an invaluable yet readily available resource to assist in this commercialisation process.

The Department has organised its research groups so that staff interact to apply their expertise to the major research themes within the Faculty of Science and Engineering, namely tele-medicine, telehealth and medical systems; transport; energy and the environment. Staff develop their specific areas of expertise through collaborative focus projects. This maximises the effectiveness of research in the Department, in terms of both dissemination and exploitation. In the recruitment of new academic staff, the Department looks to strengthen and enhance existing research. PhD scholarships and development funding (e.g. HEIF-5) are used to build such collaborations. For example, one new professorship and proposed Faculty investment will lead to the Department's robotics work being developed for Integrated Healthcare Technology, with great potential benefits to society.

In preparing for further industrial and societal impact, the DS research group is actively engaged in the specification of the new automotive safety standard ISO-262626. The research associated with the HiP-HOPS case study is now being applied, in collaboration with the IS group, to telehealth systems. This will lead to safer telehealth systems of benefit to clinicians, health carers and the general public, and has the potential to impact future safety standards in telehealth.

In collaboration with CASS, SimVis and HIVE will play a key role in developing the £200M Green Port Hull project, which received planning permission in April 2012. Expertise and knowledge in SimVis, developed in projects such as VERT, will contribute significantly to the implementation of the UK's green agenda through the development of innovative surround-visual virtual training environments for the Wind Turbine industry enabling situational awareness and training, notably for operative aptitude testing, ship-to-structure and structure-to-helicopter transfers.

d. Relationship to case studies

Dependable Systems has been pioneering a novel method and tool for dependability analysis and optimisation of complex systems (HiP-HOPS). With the growth of the DS research team within the REF period, HiP-HOPS has achieved global reach, economic impact, and positively affected the state-of-the-art in industrial practice. The HiP-HOPS tool is the culmination of work to transform dependable systems research into the enterprise space. Not only does it have an immediate role within the automotive and aerospace industrials, but it also provides an outlet for the dissemination and exploitation of future dependable systems research.

Research within SimVis has led to the development of Virtual Environment Radiotherapy Training system (VERT) and an associated spin-out company (Vertual Ltd). VERT is a highly innovative training and education tool for radiotherapists with 92 systems deployed in 16 countries worldwide. The knowledge and expertise underpinning VERT has been further developed in SimVis within projects such as ImaGiNe-S and CRaIVE. Going forward this knowledge will be used in Medical Systems research and the wind turbine training simulators with CASS, ensuring further opportunities for dissemination and enterprise.