Institution: University of Edinburgh

Unit of Assessment: B11 — Computer Science and Informatics

a. Context

The research output from the School of Informatics brings benefits to industry and society both nationally and globally in areas such as compiler and microprocessor technology, machine translation of natural language, static analysis and verification of software, document validation, and provision of broadband communication. The School has fostered entrepreneurship in its academic staff and research students to create start-up companies based on our research such as *Actual Analytics*, *Contemplate,* and *SpeechGraphics*. The School interacts with the world beyond academia through consulting, sponsored research, collaborative research projects, knowledge transfer partnerships, and a variety of initiatives to move mature research into the marketplace. Examples of successes here include the *MilePost GCC* compiler research adopted by IBM and the *EnCore* processor and *ArcSim* simulator now being developed by Synopsys Inc. The School has made positive contributions to further the application of its research worldwide: several significant software suites created in its research projects have been made available under open-source licences to encourage others to build upon concepts first proven here. Examples include *Moses*, the current benchmark system for machine translation of natural language text, and *Festival*, which forms the basis for many text-to-speech products. Many of the School's impact successes have arisen from direct interaction between the School's research groups and industrial or social beneficiaries. This direct interaction is nurtured and strongly supported through the School's investment in concerted activities for impact, as we describe below.

The outward-facing part of our impact activity is *Informatics Ventures*, which brings together entrepreneurs, investors and innovators from across Scotland. Informatics Ventures was awarded a best practice award by the European Structural Funds in November 2010 and is used as a case study by the Scottish Government. An independent study commissioned by Scottish Enterprise predicted that *ProspeKT*, one of the funded activities driving our initiative in this area, could deliver a cumulative "Gross Value Add" to the Scottish Economy of £109.1M ("Impact Evaluation of ProspeKT/Informatics Ventures", report by EKOS Ltd, April 2011). The approach taken by the School in establishing itself as a hub for entrepreneurship and interaction has been used in Ghent and Trento as a model for leveraging research excellence for economic development. (Contacts: Koen De Bosschere, University of Ghent and Lino Guisti, University of Trento.) The School of Informatics has a current translational award portfolio that includes £24.1M of external funding.

b. Approach to impact

Our approach to impact actively encourages entrepreneurial activity and knowledge transfer. This requires strong commitment from the School in five dimensions: *funding* specifically for impact-related activity; *staff* to act as a bridge between researchers and those who stand to benefit; *space* to act as a physical focus for the activity; entrepreneurial *education and training* for staff and students; and *community-building* events for the research and technology transfer community. We explain below our approach on each of these dimensions.

Funding: In 2005, the School of Informatics created a knowledge transfer partnership named ProspeKT together with our economic and innovation investment agency Scottish Enterprise (SE) and the European Regional Development Fund (ERDF). ProspeKT was approved by the SE board in 2005 and ran from July 2006 to June 2011, its award value of £4.9M paired with an investment from the University of £3.5M. Initial funding from SE was leveraged in 2008 to attract additional matching funding of £3.7M from ERDF to create Informatics Ventures. Both ProspeKT and Informatics Ventures targeted new ways of achieving economic impact from academic excellence. In July 2011, these projects led to the Scotland-wide *AspeKT* initiative (award value £1.17M) to extend our knowledge transfer and entrepreneurship approaches nationally across the entire Scottish Informatics and Computer Science Alliance (SICSA) research pool. AspeKT is funded by Scottish Enterprise and promotes entrepreneurial training, industrial innovation and the fostering of

entrepreneurship in Scotland targeting tourism, cyber-security, and "big data". Our portfolio-funding model for knowledge transfer is unified by delivery under the single brand of Informatics Ventures. The School has thus established itself as the hub for a thriving start-up community in southern Scotland, encouraging academics, researchers and students to develop their ideas commercially.

Staff: The School has a dedicated Director of Commercialisation and a Business Development team comprising three administrative staff, an events manager, a communications and marketing manager, and seven Senior Business Development Executives. We operate the largest commercialisation team within the College of Science and Engineering of our university. The Director of Commercialisation is a member of the strategic management committee for the School. The team is responsible for fostering relations with potential industrial partners, both global and local, and maintaining relations with current ones. They work closely with Scottish Development International (SDI) and UK Trade & Investment (UKTI), hosting at least twenty inward investment presentations per year since 2006. Our team have played a significant role in bringing a number of major companies to the Edinburgh area, including Amazon, Avaloq, Enstratus, EADS, Microsoft, Virgin Bank, and Disney Research. These companies have been attracted by the recognised excellence of the research output from the School and by the talent and reputation of its staff. The School has close relations with a number of global ICT companies and has two joint professorial posts with Microsoft Research Cambridge (C. Bishop and A. Gordon).

Space: The School has 1200m^2 of space dedicated to commercialisation activities over three floors of Appleton Tower. Emerging companies use this as launch space for start-ups, spin-outs, and spin-ins. There are usually around twenty enterprises within this area including both incorporated companies and entrepreneurs on fellowships (RSE Enterprise Fellowships, Edinburgh Pre-Incubator Scheme, and others) who have the intention of starting a company. The dedicated space in Appleton Tower provides interaction space for collaborating companies and Innovation Labs from a number of global companies, with Disney Research and EADS as current occupants. Appleton Tower has been home to Actual Analytics, Contemplate and SpeechGraphics since their formation. Over the 2005–2011 period of ProspeKT, the School was responsible for 51 start-ups and spin-outs, despite this being a period of economic recession. Data from *spinoutsuk.co.uk* shows that no other UK university department or school created more start-ups and spin-out companies during this period. Since January 2008 there have been 44 start-ups and spin-outs, which have raised in excess of £16M in seed funding. The School played a major role in arranging entrepreneur participation in a number of schemes set up to encourage enterprise creation, such as Scottish Enterprise Proof of Concept (two awards), UKRC Follow-on funds (three awards), Edinburgh Pre-Incubation Scheme (fifteen awards) and the Royal Society of Edinburgh Enterprise Fellowships (six fellowships). Some 27 licenses have been established with commercial ventures since 2008 and three collaborations through our Knowledge Transfer Partnership programme.

Education and training: Our alliance with Stanford University, the *Edinburgh-Stanford Link,* led to the creation of an MSc-level technology entrepreneurship course. The University of Edinburgh Business School now delivers this course and has established a Chair in Innovation and Social Informatics. One of the first successes of the Informatics Ventures programme was in delivering entrepreneurial education to both the university population and local potential entrepreneurs and those running early-stage companies. Some 5500 individuals have attended our entrepreneurship events – more than sixteen times the original target metric for the programme – with over 600 organisations actively engaged. An independent evaluation study by EKOS Ltd concluded that this was real evidence of significant industry engagement with our research and our approach to impact.

The Informatics Ventures programme delivers a series of CEO master-classes each semester. These are half-day seminars led by serial entrepreneurs from Scotland or Silicon Valley. The audience for these seminars is made up of CEOs of local early-stage technology companies and students and researchers who aspire to form and lead a company. Informatics Ventures has established links with the Stanford Technology Ventures group in California and the Sloan School at MIT. These links have brought Prof. Ken Morse and Prof. Bill Aulet from the MIT Sloan School over to give regular seminars on various facets of entrepreneurship, roughly once per quarter over

the first three years of the programme. Through Informatics Ventures, we were able to host the Stanford Roundtable on Entrepreneurship Education in Edinburgh in the autumn of 2010.
A bursary scheme has been created to fund a minimum of six high-potential start-ups each year to attend the annual Entrepreneurship Development Programme (EDP) course at MIT, a one-week extensive workshop to build entrepreneurial skills (information and reviews available at *http://executive.mit.edu/openenrollment/program/entrepreneurship_development_program/15*) and Cambridge University's Ignite programme (*http://www.cfel.jbs.cam.ac.uk/programmes/ignite/*).

Community building: Through Informatics Ventures the School organises and hosts an annual research/industry interaction event called *DemoFest*, held each November. This attracts some 50+ exhibiting research groups and 240+ attendees. An annual investor conference is held each May, called *Engage, Invest, Exploit (EIE)*. This attracts around 35 exhibiting start-ups and an audience of 500 with more than 130 investors. In the six months prior to the conference EIE delivers a preparatory programme of business proposition articulation and investment pitching with local serial entrepreneurs as mentors. The event also enables participant companies to headhunt management teams, often a problem for academic start-ups. EIE is now the largest investor conference in Scotland and one of the pre-eminent European events of this kind. EIE has quadrupled in size since its inception in 2008, being held in London for the first time in November 2013. EIE in London increases opportunities for Scottish entrepreneurs as delegates pitch to the London investor community and broaden their funding and development networks.

Informatics Ventures has also set up a series of monthly *TechMeetUps* (*http://techmeetup.co.uk*). These bring students and academics together with informatics practitioners from a variety of areas of industry, including government, the NHS, financial services, software houses, and start-ups. They are informal "un-conferences" with three or four short presentations per evening organized by the community themselves on technical or business subjects of mutual interest to stimulate on-going dialogue with the local community of technology enthusiasts. Through SICSA involvement this model has inspired similar activities in Aberdeen, Dundee, Glasgow and Inverness that provide lively fora for the exchange of ideas and for professional networking.

To further encourage inclusion, Informatics Ventures sponsors the *Girl Geek Scotland* initiative (*http://www.girlgeekscotland.co.uk*), promoting the position and visibility of women in computer science and technology entrepreneurship.

An *Entrepreneurs-in-Residence* panel provides mentoring for emerging start-ups. The panel consists of Colin Adams, Ian Ritchie, Martin Ritchie, David Milne, David Simpson, Derek Gray, Crawford Beveridge, Bill Dobbie and Gerry Docherty. They have been involved with more than twenty-three of the start-ups.

In addition to the specific impact agenda described above, we generate research impact via our research groups and institutes. In Section (e) of our Environment document we demonstrate how all the School's research institutes are involved in significant collaboration with industry. This collaboration, together with the interdisciplinary research cutting across these areas, encourages research impact that we then amplify. The general culture of entrepreneurship awareness that is created by the cycle of EIE investor conferences, TechMeetUps and DemoFests that take place in the Informatics Forum has significantly lowered the barrier to academics achieving real impact from their research. Appleton Tower and the Informatics Forum are co-located, facilitating easy interaction between our academic researchers and our integrated expert commercialisation team.

c. Strategy and plans

The School already has a successful dedicated system for technology transfer and impact so our priority is to grow and further develop it in the long term. We explain below our approach on each of the five dimensions from Section (b) above.

Funding: The School will continue to pump-prime activity with the support of Scottish Enterprise and the Scottish Funding Council. A major new award is the *Digital Health Institute* (DHI), a £10m

Scottish Funding Council initiative funded under their programme to establish an initial set of three Innovation Centres in Scotland. The University of Edinburgh leads the DHI in close collaboration with the Glasgow School of Art. Also involved are four further Scottish Universities, Scottish Enterprise, a number of large and small companies, and NHS24. The project will deliver a range of innovation opportunities to large and small business in the Digital Health and Care arena with a focus on design-driven innovative solutions using the latest Informatics research. Fundamental to the DHI's mission is the challenge of demographic change and the need for an agile, modern health and care sector to meet that changing landscape. We are just concluding negotiations with the SFC for an additional £10M award of a second Innovation Centre 'Datalab' led by Edinburgh to facilitate data-intensive research from across SICSA. In the longer term, we will achieve sustainability of funding through a (small) share of income generated from the technology transfer activity and through expansion of the activity in Scotland, the UK and Europe. In Scotland we already act as a hub for knowledge transfer via Informatics Ventures and the SICSA network of Scottish universities. In the UK and Europe we are engaged in knowledge transfer with other universities. With UCL and Imperial College we are the UK arm of the EIT Knowledge Innovation Community (KIC) in ICT. This is a Europe-wide network funded by the European Institute of Innovation and Technology consisting of major universities engaged in technology transfer.

Staff: As our technology transfer success continues, the School will depend on its dedicated Director of Commercialisation and associated Business Development staff. Already the DHI funding has brought to Informatics a new Director-level role, with an external senior industry leader recruited to fill this post. The DHI funding will support five new business development roles spanning innovation, engagement and relationship managers and three new administrative support staff. DHI funding has also resulted in the co-location of a Network Integrator from Scottish Enterprise within our commercialisation hub in Appleton Tower.

Space: Our current dedicated commercialisation space in Appleton Tower operates at full capacity with a waiting list. A major refurbishment of Appleton Tower itself will follow in a two- to five-year timeframe (estimated £22M outline budget funded by the University). This investment will renew the commercialisation space and protect our future exploitation capacity. The School is also actively shaping local capacity, positioning us at the heart of a geographical critical mass.
A start-up incubator funded by the private sector, TechCube (*http://www.techcu.be*), has opened close by. Technology tenants are attracted by proximity to the School and the additional incubator space provides valuable overspill capacity as companies grow and move out from their first incubation space in the Appleton Tower. Also close by is Quartermile (*http://www.qmile.com/*) which provides modern office accommodation for more mature industry ventures. Recent high profile technology tenants include Skyscanner (*http://www.skyscanner.net/*), which has since arriving grown to be Europe's top flight-search engine; and a 60-strong IBM developer group which moved into Quartermile in order to be closer to the research activity in the School of Informatics.

Education and training: Our initial effort in entrepreneurial education began by bringing in educators from other institutions (notably MIT). These educators had been successful in starting the sort of environment that we wished to have. Now we have established a body of educators and practitioners within the School (engaging with our Business School and the SICSA network) and can sustain the activity ourselves, although we maintain the resulting network of links to key educators internationally.

Community building: We will continue to grow our community-building efforts through established activities such as: DemoFest; Engage, Invest, Exploit; TechMeetUps; and GirlGeeks. In addition to these activities we have also created a centre for *Design Informatics* with £1M initial funding from SFC. This is primarily to develop design aspects of our research discipline but it also has a specific remit to promote technology transfer alongside our Informatics Ventures entrepreneurial activities. Design Informatics will continue with a valuable Resident Entrepreneur programme that brings in young design practitioners to work alongside research teams and early-stage companies. Our aim is to develop researchers with a culture of deep knowledge in a research specialism combined with expertise in design and business. This reduces barriers to impact such as underdeveloped design skills or lack of entrepreneurial drive.

d. Relationship to case studies

The nurturing and supportive nature of our commercialisation activities led to significant tangible benefits for the work that is reflected in our REF impact case studies.

The commercialisation team helped *Actual Analytics* to manage the competitively-awarded Proof of Concept programme with Scottish Enterprise. James Heward received funding to attend the MIT EDP programme and subsequently became CEO of the company. We made an introduction to Ken Morse, funded his consultancy on the company's direction and provided assistance on fund-raising. This included contacts with several groups of "business angels" and introductions to angel investors and management talent. Actual Analytics exhibited at the EIE conference in 2008, 2009 and 2010. They presented a pitch in 2009 that Informatics Ventures host as a video on their web site. Exhibiting at EIE'08 brought them into contact with David Craig, ex-COO of Maclaren Software, who advised on the more detailed elements of running a software business and on raising capital. He recommended the Software-as-a-Service business model and the Amazon hosting platform: the company adopted both of these recommendations. Actual Analytics were given access to the Entrepreneurs-in-Residence panel in November 2009. This led to the award of £15K to assist in developing a sales strategy, which funded a Saltire Fellow to work with them. Actual Analytics attended various CEO master-classes and MIT workshops within the Informatics Ventures programme. They have been highlighted to various industrial visitors to the School.

The commercialisation team helped Professor Don Sannella of the School through the initial contact and negotiations with ITI to set up the SIE programme and subsequent negotiations with ITI on consulting contracts. The researchers involved were housed in Appleton Tower for the initial ITI contract and have remained there as *Contemplate* since they formed. Contemplate exhibited at EIE'10, EIE'11 and EIE'12, and were given pitch training for a pitch at EIE'11. They attended a full set of the MIT Entrepreneurship workshops run by Informatics Ventures and also various CEO Master classes. Professor Sannella was given a bursary to attend the MIT EDP programme. Contemplate were given access to the Entrepreneurs-in-Residence Panel in March 2010 and awarded £20K to help with commercial planning for its product launch. This funded Ian Stevenson, a Saltire Fellow, who assisted on the business plan and initial product pitch to customers, and who subsequently joined the company as a consultant and non-executive director, and led to the subsequent hiring of Derick James as CEO.

A similar pattern of introductions, consultancies, EIE presentations, training and mentoring has helped in several other cases. The *Moses* machine translation work received support for its research impact from the Informatics commercialisation team in arranging consultancies for Professor Philipp Koehn with Asia Online and Canadian SAS. In connection with his work on the *Milepost GCC* compiler, Professor Michael O'Boyle of the School received assistance from the School commercialisation team in his negotiations with Samsung, ARM and NVIDIA. Professor Nigel Topham of the School received support from the commercialisation team in his negotiations on the *EnCore processor* with consultancy work for ARC and Synopsys and his IP licenses. Professor Topham met with the Entrepreneurs-in-Residence Panel in November 2009. The *SpeechGraphics* company exhibited and pitched at both EIE'11 and EIE'12. They received pitch training and mentoring for both events. The commercialisation team advised on patenting and the SpeechGraphics SMART grant application. SpeechGraphics have been operating out of Appleton Tower since their formation, recently expanding to open a second office in San Jose, California. A consulting agreement was set up between SpeechGraphics and the School, which allowed sub-contacting of some work to the company as part of the uDialogue JST CREST project.

The School of Informatics supported the *Tegola* project both financially and in-kind by providing a small grant of £5K to purchase wireless equipment to build a rural community wireless network and technician time and expertise to construct this equipment. The School hosted an EU broadband meeting that was pivotal in the development of community broadband. The University of Edinburgh and the School contributed to "*Over the Seas From Skye*", a large community broadband meeting held at Sabhal Mòr Ostaig on Skye in October 2012 (*http://www.tegola.org.uk/CBBS/*). The examples given above provide some insight into the School's commitment to research impact.