Impact template (REF3a)

Institution: University of Essex

Unit of Assessment: 11 – Computer Science and Informatics

a. Context

The Essex submission to UoA11 draws upon the complementary expertise of staff from the School of Computer Science and Electronic Engineering, and the Department of Mathematical Sciences. Research is conducted under the broad themes of **artificial intelligence** and **communications**, accompanied by a number of research centres. This work addresses key challenges faced by industry, as well as those concerning the wider population, such as ageing and assisted living and environmental protection. In order to realise the potential of the Unit's research, staff actively engage with **a range of users and beneficiaries**, including: i) companies in the computer hardware, software and engineering sectors; ii) computing and telecoms network providers and operators; iii) IT based services; iv) computer games and internet services providers; v) international standardisation bodies for emerging technologies; and vi) utilities companies and public authorities.

The **Artificial Intelligence** theme covers a number of subfields including intelligent and pervasive systems, robotics, games intelligence and multimedia. Research is applied to improve the efficiency and performance of operations and processes across a broad range of sectors. For example, embedded systems, computational intelligence and pervasive engineering are used to improve workforce planning, business performance and resource efficiencies for companies including **BT, British Gas, Rolls Royce and PMC Sierra**. Brain-computer interfaces, robotics and adaptive systems are used to enhance the technical operations of **NASA, ESA** and various SMEs. These include **Felixstowe Port and Rail Company**, where optimisation and evolutionary algorithms are used to improve operations, and **Vacuumatic Ltd**, where machine vision and learning is used to enhance paper counting. Robotic implementations have demonstrated available healthcare and environmental benefits. This is exemplified by the use of an intelligent wheelchair in Southview School, Witham, and in several **hospitals in France** (as part of the SYSIASS project on Autonomous and Intelligent Healthcare), as well as through the deployment of underwater, pollutant-seeking robots in Gijon, Spain. Research into computer game design and dynamics has contributed to the commercial sustainability of developers, such as **BioWare**, and multimedia processes, such as **video transcoding**, have been adopted within industry standards and used to improve the **BBC's public service delivery**.

The **Communications** theme conducts research on optical networking, optoelectronics and high speed communications, with a particular focus on access networks. Theoretical and practical outcomes are used to improve networks, products and service provision, primarily in the **telecoms and broadcasting sectors**. These applications underpin commercial, technical and societal impacts for network providers, manufacturers and users. Novel concepts and **implementations for optical and grid networking** have been developed in collaboration with European National Research and Education Networks (NRENs), adopted in industry standards, and are used to inform telecoms, e-Science and internet applications. This research results in faster, flexible and more efficient network provisioning and has formed the basis of engagement with **BT, Alcatel and Telefónica.** Additionally, UoA staff have used optical routing and switching implementations to inform the product development activities of **ADVA Optical Networking** and **Intune Networks**. Optoelectronics and photonics research, directed towards high speed communications, also underpins engagement with the manufacturers **Fianium and Oclaro**.

b. Approach to impact

Staff in UoA11 typically adopt three distinct approaches to generate impact from research:

Interactive engagement: by forming relationships with key individuals in relevant companies and standardisation bodies, staff develop a continuing dialogue about specific research needs. For instance, **the Unit exploits many strands of interaction with BT's main technical hub.** This has led, amongst other outcomes, to the use of research on intelligent and pervasive systems to guide workforce planning, to provide a mobile search engine, and to optimise protocols for network demand, scheduling and access. Extensive dialogue, supported by contractual agreements and fellowships, has sustained on-going research and ensured that its outcomes are efficiently targeted towards user applications. This approach is complemented by the wide-ranging consultancy and

advisory activities of staff, and by the UoA's industrial advisory board.

Collaboration: most of the Unit's externally-funded research is inherently collaborative, and often involves industry and standardisation bodies. Such collaborative relationships form a natural starting point for impact creation. For example, the **spinout UltraSoC Technologies Ltd** arose from collaborative EPSRC research projects with Delphi and Infineon Technologies. Collaborations are also used to leverage significant in-kind support from industrial partners, for example, McDonald-Maier has secured approximately £2M in this way from organisations including **Thales, Motorola and Rolls Royce.** Knowledge Transfer Partnerships (KTPs) are used extensively in collaborating with industry. To date, seven KTPs (worth approximately £585k in funding) have been successfully completed. The successes of these projects have been widely recognised. For example, the KTP with **Sanctuary Personnel**, which led to the formation of **Logical Glue Ltd**, was awarded the Lord Stafford Award for Achievement in Innovation for the East of England, and was a **finalist in the TSB's 2011 'Best of the Best' awards**.

Dissemination: research findings are actively shared with key user groups to inform them of developments of topical and strategic significance. This typically takes place at industry-facing conferences (which also attract relevant journalists). Social networks are used to disseminate new developments rapidly. The UoA organises an **annual joint workshop with industry**, where staff interact with research users. This event has a strong track record of leading to new collaborations and enables both research and industry to gain an insight into the latest priorities and capabilities within the sector, thereby allowing UoA staff to react to topical challenges. Finally, three members of staff from the Unit have acted as Business Fellows in the **London Technology Network**, promoting the Unit's research and capabilities, and catalysing knowledge exchange opportunities.

To support these approaches to impact, the **UoA provides practical and financial assistance**, as well as career incentives to its staff:

- UoA departmental operating budgets provide financial support to attend impact-related meetings. The Unit has also organised business breakfast events on topical themes, such as big data.
- Practical support includes termly research theme discussions on how to maximise impact from existing and planned research. Senior staff introduce junior colleagues to significant user groups. Staff members also produce annual research plans including specific statements of plans for achieving impact. Contributions to research impact factor very significantly in both staff appointments and promotions at all levels.

The UoA also uses **University support** to maximise research impact in a number of ways:

- 16 UoA projects have been funded through the University's Knowledge Transfer Innovation Fund (KTIF) (2009-13). KTIF uses the University's **Higher Education Innovation Fund** (HEIF) to facilitate knowledge transfer from Essex research. Two projects have also been supported by the University's internal 'Building Partnerships' fund.
- UoA staff use University financial support to produce **vodcasts** to outline and explain their research, as well as its impacts, in a highly accessible way. Unit staff have delivered **outreach events** on topical areas such as big data and cloud computing at key locations including Tech City, which promote Essex's capabilities and encourage collaborative activity.
- Unit staff work closely with the University's Research and Business Partnership Managers (RBPM) to identify and support the development of opportunities for research commercialisation and for the licensing of intellectual property. The University has supported a number of **commercialisation projects**, for example the start-up company UltraSoC which has, since its inception, raised in excess of £5M in start-up funding from venture capital funds as well as £500k in R&D grants from RDAs and the TSB.
- Advice from the PVC (Research), the University's Research Committee and the University's Enterprise Board is used to inform the direction of research and to ensure that its outputs can be efficiently translated towards industrial application.
- UoA staff draw upon the advice and expertise of personnel within the Faculty including: the Communications Officer, who assists in writing press briefings and articles; the **Impact Officer**, who monitors impact engagement; and the RBPM, who supports incorporation of impact into external funding applications.

c. Strategy and plans

UoA11 at Essex aspires to produce high quality research that can be used to address major challenges faced by industry and society. To achieve this, the Unit will use its strengths in the

applied areas of artificial intelligence and communications, coupled with an emergent impact strategy. It is recognised that much of the Unit's impact arises from the application of research to inform industry activities. Hence, the Unit targets a number of means by which its strong track record of industrial collaboration and interaction can be maintained and enhanced. For example, the Unit seeks to maximise the opportunities for user interaction associated with the formation of **EPSRC Centres for Doctoral Training** (CDTs), which will focus on a number of the UoA's research strengths. Essex leads a multidisciplinary CDT bid on *Assistive Living and Rehabilitation Technology* and, with two partners, the Unit also seeks to develop a CDT on *Intelligent Games and Games Intelligence*. This bid has attracted more than £3M in cash and in-kind support from 50 organisations, representing significant potential for future interaction.

The unit will extend its use of **KTPs** as a way to achieve impact. As of the end of the REF2014 impact period, the Unit has five active KTPs with a total award value of £480k. Two further expressions of interest have also been accepted. Unit staff aspire to continue this upward trajectory and now aim to maintain a minimum of ten active KTPs in the next REF impact census period. Staff are also increasingly designing and partaking in research projects which have the explicit aim of realising impact and which include research users from the outset. A recent example is the *Robotic Devices for Independent Living* project, which has a user interface stakeholder group comprising seventeen partners, including service users, the NHS, wheelchair and display system manufacturers, and an occupational therapist.

In addition to these activities, staff are heavily encouraged to join **external networks and advisory boards associated with major funding bodies**. Unit staff have held key posts in groups including EPSRC strategic advisory teams, IEEE Computational Intelligence Society networks, the British Machine Vision Association and the British Computer Society. These memberships strengthen relationships with key policymakers and funders, and enable staff to maintain awareness of topical and collaborative impact opportunities. Additionally, they provide a means by which staff can proactively influence the impact agenda of major funders, generating opportunities to proliferate the use of technology. A number of staff members have also participated in events organised through the Knowledge Transfer Networks (KTNs) over the past five years.

Finally, existing Departmental, Faculty and University-level infrastructural provisions will be maintained and enhanced. The UoA's research-led teaching agenda will be developed and will **include students in projects that have a strong impact component.** Best practices for impact realisation will be shared throughout the UoA, particularly so with early-career researchers. The role of the Faculty Impact Officer will also be enhanced, to support academic staff in forging long term relationships with likely research users.

d. Relationship to case studies

The Unit's four case studies are indicative of its proactivity in applying research in commercial and industrial contexts. Each case draws upon a range of the approaches outlined in section b, above. In the **Virtual Worlds** case study Bartle was highly active in *disseminating* research insight. This was achieved using books, press articles, interviews and invited lectures, as well as a range of consultancy positions, collaborations and advisory board memberships. Bartle's extensive activity in this regard meant that his 2003 player types model could be quickly shared with external parties, thereby experiencing widespread uptake.

The **Optical Switching** case study demonstrates how the UoA's approach towards *collaborative research* can effectively catalyse impact. The High Performance Networks group engaged with users from the outset of projects and impact was intended to be an integral part of research.

The **Fuzzy Logic** case study embodies elements of both the *collaborative* and *dissemination* approaches to impact. Contract research and a KTP, in the cases of BT and Sanctuary Personnel respectively, enabled staff to engage with challenges faced by external users. Hagras was also active in *disseminating* the insight of his research, which led to impact for Discovery Investing Ltd.

The **UltraSoC** case study employed a *collaborative* approach, supported by a broad strategy of *dissemination*. UoA staff established research partnerships with major electronics and semiconductor companies. Having formed the spinout company UltraSoC Technologies Ltd, researchers took an active approach towards *disseminating* research findings in order to attract investment. This involved industry-facing talks, input into standardisation activities and bidding for venture capital investment.