Institution: University of Bedfordshire

Unit of Assessment: 11- Computer Science and Informatics

a. Context

At the University of Bedfordshire (UoB), the Institute for Research in Applicable Computing (IRAC) brings together four research Centres, each led by a senior researcher, typically professorial level.

- Centre for Computer Graphics and Visualisation (CCGV)
- Centre for Research in Distributed Technologies (CREDIT)
- Centre for Wireless Research.(CWR)
- National Centre for Cyberstalking Research (NCCR)

The last of these was formed in 2011, and IRAC has expanded since 2008 from 25 to 66 staff. All of the UoA11 work at UoB is either within, or led by, IRAC.

From an impact perspective, the research programmes of each Centre can be described in terms of their benefits to different parts of civil society. Thus, the research in medical visualisation helps improve the lives of patients and supports healthcare professionals. The research into distributed computing and robotics technologies improves the quality of life for the elderly. Research carried out in wireless techniques impacts the connected society, from advanced network enablers to ways of harvesting energy from the radio environment, of particular relevance when energy efficiency and reduction are of increasing international importance. Research into information security benefits victims of cyberstalking, both directly and indirectly, through the support given to law makers and enforcers.

From a technical perspective, these benefits are realised from the unifying theme of information management, specifically its acquisition (data mining, sensing, imaging), distribution (wireless and computer networks), processing (sorting, aggregating, analysing, visualising) and control (robotics and actuators).

Key developments in UoA11 have been made possible through close interactions with (among others) physicians, psychologists, engineers and technologists, and the outcomes are the design and development of novel tools (both hardware and software) which impact organisations and individuals in society and help to bring about technical and policy changes.

b. Approach to impact

IRAC has followed a multi-pronged strategy to create impact from research carried out within UoA11, and to support the strategic aim of creating knowledge and tools that will have tangible benefits to society. The following facilities, expertise, resources and processes have been used.

(i) **University of Bedfordshire Knowledge Hub.** The knowledge hub acts as a gateway for the University to reach out to organisations and for them to access expertise within the University; over 400 experts and leading researchers, of whom many are in IRAC, work with businesses to facilitate knowledge transfer. Types of support include undertaking the design, testing or evaluation of a product or system, acting as an expert witness and the provision of bespoke training or management development programmes. IRAC engaged with the Knowledge Hub in organising events to engage high-profile clients which led to productive and strategic collaborations with end users. Examples of IRAC clients are Hayward Tyler, Clearhead Media, EADS and Luton Council, and support has ranged from student projects to paid consultancy with research input into clients' five-year plans.

(ii) **Business Interaction Manager (BIM).** The BIM actively exports IRAC ideas and innovations to potential beneficiaries outside academia and provides a portal for industry to access the expertise within IRAC. The dynamic environment of internal and external seminars, visiting staff and cross-institute collaborations led to IRAC being involved in a pioneering future healthcare project with Luton Clinical Care Group (CCG), and our ground-breaking technologies are being distributed through local and national businesses such as Silent Sentinel to make them successful. The BIM's function is to translate our specialised knowledge of technology to a wider audience, making it more relevant and accessible to end users.

(iii) **Pro-Vice Chancellor's Office for Research and Enterprise.** The Pro Vice Chancellor (PVC), Prof Carsten Maple, is spearheading the drive for research and enterprise at the University, and he works extensively with local, regional, national and international communities and businesses, building new links and actively seeking new potential partnerships. IRAC has worked with the PVC to put in place structures for effective engagement with end users, such

as seminars to which users are invited, a biannual regional employers' panel to focus our research directions and an e-zine to promote IRAC's advances in knowledge and its ability to provide expert advice and support to external organisations.

(iv) **IRAC Management Board.** Quarterly reports by each Centre to the IRAC Board include an assessment of opportunities for impact across the Centre; project reports identify actual and potential impact, with indications of actions to be put in place to pursue and realise the latter.

Industry and Public Focussed Engagements with Key Users, Beneficiaries and Audiences

IRAC staff members (supported with time and expenses) are part of steering and advisory committees at the national and international level which impact the end user. Such committees include UKCMG (UK Computer Measurement Group), of which an IRAC academic is President, $(ISC)^2$ (International Information Systems Security Certification Consortium), CAS (Computing at School) and TIGA (The Independent Games Developers' Association). The users of our outputs have included industry, medics, academics, businesses and Government.

An example of how we introduce a user community to future possibilities was the University's Knowledge Network event, held in 2010 at the UoB conference centre near Luton on 'Advances in Medical Healthcare Using Computer Visualisation for professionals'. This public seminar provided an overview of the Virtual Physiological Human initiative spearheaded by CCGV, and showed how 'blue sky' research could impact various aspects of healthcare in the coming years. The keynote speaker, Prof. Gordon Clapworthy, head of CCGV, focused on specific tools being developed within IRAC which help identify and treat many serious medical conditions such as brain and lung cancers, heart failure and osteoporosis, and which support surgical procedures such as stent placement to treat vascular diseases. Attendees included the Head of Luton Clinical Care Group, CEOs of charities and special interest groups. As a result of this event, IRAC now has a member on Luton Clinical Care Group's IT management board to continue the collaboration.

IRAC staff led a 'Future Healthcare' event at the House of Lords, London, in November 2012. Prof. Carsten Maple outlined the roadmap for Future Healthcare Technology *Supported Living at Home*. The event was attended by 70 senior researchers, developers and end users from the UK and EU, including Philips, Autotech and Shadow Robots. IRAC have developed and delivered an online cyber-safety awareness course with major societal impact, informed by research and distributed at cost for maximum reach through charities such as *Enough Abuse UK.*

We work with SMEs, typically 20 to 60 per year and often on a short-term basis, to enhance their commercial offering (facilitated by the BIM, with networking events, e-zine, social media and mailshots). An example is the 4-week software re-write we undertook in 2012 for Silent Sentinel, which overcame inherent structural problems and which enabled them to expand their work for government, defence and transportation. Another is our data mining work in 2013 with Herts Constabulary analysing GPS data of tagged offenders to determine re-offending risk.

IRAC Support for Staff in Creating Impact

Pilot programs are supported (typically 2 or 3 at any one time – currently Clearhead, Jaguar Landrover and Luton Culture) where staff members can enrol end users or organisations to participate and steer their research. IRAC proactively rewards staff members who are involved in knowledge transfer and consultancy through a 'finder's fee' and 70% of the net profit.

c. Strategy and plans

As is reflected in its name, IRAC is committed to carrying out research which can be applied. Since its formation in 2002, it has expanded its links with sponsors who wish to make use of its skill and knowledge base, while the facilities noted above help such links to be identified and grown.

IRAC has encapsulated its emphasis on enhancing the impact of its work through a set of strategic objectives, which are fully in line with the wider strategy of the University. The principal ones are:

- Increase and demonstrate the applicability, exploitability and impact of the research.
- Grow and develop technology and knowledge which will underpin and extend IRAC's reputation for achieving impact, sustainability and collaboration.
- Generate new areas of inter-disciplinary research expertise responsive to the global challenges of social and demographic change, economic competition and the sustainable development of organisations, communities and societies.
- To be recognised by industrial organisations, both large and small, and other stakeholders within our regions and communities, as a provider of client-led enterprise and innovation.

- Model creative partnership working as the core characteristic of our delivery of excellent service quality to internal and external customers and partners.
- Emphasise team-working and cross-team collaboration in the contribution of staff to the continued success of the University and its community.

To achieve these objectives, actions are in place, under continual review, which emphasise early engagement and cooperation with funders and sponsors to provide a good understanding of the user needs and aspirations – an essential element if a high level of impact is to be achieved. This cooperation with the sponsor continues after the research stage into implementation and beyond, thereby maximising the impact.

We believe that flexibility to identify impact opportunities is essential, and so the BIM holds an informal quarterly review with researchers to meld ideas, define working methods with clients, identify potential major industrial partners and devise 'seed-corn' schemes which investigate technical and impact possibilities.

Our good record of participation in EU-funded programmes and the credibility this brings to IRAC's capabilities also facilitates access to organisations in a position to exploit the Institute's research, with appropriate independent follow-up actions as necessary. The BIM is building a network of technology-related companies and offering a focussed working group around skills, training and future tech. An event is held quarterly in Luton to share knowledge.

The expansion of IRAC's work to support Smart City developments (since 2012) provides significant impact opportunities. The annual communications conference, co-led by IRAC and with international attendance, is to have 'Smart Communications for Smart Cities' as its 2014 theme. The recent (October 2013) award by HEFCE of a £16M contract to an Open University led consortium, with IRAC funded at £1.6M, presents scope for impacting the citizen with the benefits of the use and management of Big Data through the five industrial partners.

Cross-disciplinary working is seen as an enabler for expanding IRAC's impact. The benefits of this have already been seen in IRAC's contribution at national and government level to understanding and combating cyber-stalking, while the results of the Virtual Physiological Human work has enabled the BIM to create links with biomedical and media departments, and IRAC outputs are now used to replace animal tissue experiments. The IRAC work on cyberstalking and online risk has led to nationally-delivered CPD courses for teachers, social care professionals and the public.

d. Relationship to case studies

The four Case Studies presented in REF3b exemplify a range of impact types, and of approaches to impact described above. They have in common a proactive approach which uses a strong research knowledge base to address real-world technical or social needs.

Cyber-stalking countermeasures – A cross-disciplinary combination of information management, electronics and psychology, coupled with a perception of a social need, led to an engagement with, and funding from, a national charity to investigate and codify the nature of the cyberstalking problem in the UK. Technical and political impacts have resulted, including a change in UK law.

High Performance Computing – The close and effective collaboration between a multi-national supplier of industrial electrical generation equipment and a research team led by a Professor who joined UoB in 2010 has resulted in a set of software design tools that has been incorporated into that company's standard tool-box to provide additional economic impact. Being highly responsive to the client's needs has resulted in a long-term partnership which the client is keen to take further.

Femtocell enablement – A group with expertise in wireless networks recognised the embryonic interest in international expert groups for very small communication cells. Links were developed with a major UK telecoms operator, and with its additional funding a toolset was designed and developed to aid the planning and implementation of such femtocells, which are now in commercial use worldwide. A book was published by the team to aid both researchers and implementers.

Energy harvesting from radio signals – An awareness of UK Government priorities for nationally-relevant research resulted in research into an efficient way of harvesting energy from ambient radio transmissions. The resulting low-cost technology has been patented and, when applied appropriately, can act as a source of power for remote locations and can simplify the associated maintenance logistics. The development has gripped the imagination of the general public and of investors alike through an effective dissemination programme by the research team.