Institution: University of Lincoln

Unit of Assessment: UoA 11: Computer Science and Informatics

a. Context

Our research is set in the wider context of our strategic aim of undertaking transformative research to promote benefits in society, nationally and internationally, through discoveries and insights, which not only have practical application, but also can change the way that people see the world. Research is based within three strong research centres (discussed below), each with a differing emphasis on non-academic beneficiaries and audiences.

The *Laboratory of Vision Engineering* (**LoVE**) specialises in the capture, transmission, processing and understanding of image, video and other high-dimensional data, extending and exploiting important facets of the image acquisition chain from the development of new imaging devices/systems, through image/video transmission, to image understanding. **LoVE** focuses on application areas including: healthcare, scientific, security and environmental monitoring; as well as designing/supplying new imagers and systems. The latter is a joint activity with our School of Engineering. The main non-academic user groups, of the research conducted by **LoVE** are:-

- The development and promotion of new medical imaging and data-mining capabilities requires lasting and committed interaction with healthcare professionals (clinicians, medical physicists, managers, etc.) as well as appropriate healthcare companies and professional/trade organisations/regulatory bodies to ensure successful translation in practice. For example, our Wellcome Translation grant has 5 NHS Trusts and Foundation Trusts as partners. The local NHS Trust, *United Lincolnshire Hospitals*, have signed a comprehensive agreement relating to research with the University, and we have several on-going projects.
- Developments in the general fields of security involve close working with numerous bodies from central government to local Police Forces. In providing improvements to the treatment of forensic evidence – from crime scene to bureau – we have been involved with the *Home Office*, *Association of Chief Police Officers* (ACPO), NPIA (now incorporated into the *Home Office*), *Police Scientific Development Branch* (now *The Centre for Applied* Science *and Technology, CAST*), *The Fingerprint Society*, over 15 individual UK Forces, police and security organisations in USA, UAE, South Africa, etc.

The *Lincoln Centre for Autonomous Systems Research* (**L-CAS**) specialises in the integration of perception, learning, decision-making and control capabilities in autonomous systems such as mobile robots and smart devices, together with the application of research in various fields including personal robotics, food and agriculture, security and surveillance, environmental monitoring, and intelligent transportation. The main non-academic user groups, of the research conducted by **L-CAS** are:-

- Development of assistive systems for the older people and other disadvantaged groups demanding very close working relationships with individuals, carers, care homes, charities and other support group. In particular, **L-CAS** works closely with *LACE Housing* (the leading social housing provider in Lincolnshire specialising in a wide range of housing, care and support services) as a partner before, during and after funded research projects.
- Work on improving food security and introducing advanced technology into agriculture means that **L-CAS** works with the food processing industry (*National Centre for Food Manufacturing* - NCFM, Defra and other government and industry agencies, e.g., *AHDB Potato Council*, production companies, e.g., *Branston Ltd* – one of the UK largest potato handlers, equipment manufacturers, e.g., *Ishida Europe Ltd*, amongst others).

The *Lincoln Social Computing Research Centre* (**LiSC**) conducts research that deliberately addresses broad societal issues including public health and wellbeing, sustainability and the environment, crime and surveillance, arts and entertainment and the role that contemporary interactive digital technology – and especially social media – has to play in addressing these issues. The main non-academic user groups, of the research conducted by **LiSC** are:-

- Broad user groups within society such as individuals wishing to engage with issues such as improving their health and lifestyle, measuring their impact on the environment, and those wishing to better understand their exposure to crime and surveillance (e.g. through online applications such as *Fearsquare.com* and *Blowtooth.com*). The types of impact addressed in this context include perception of risk, enhancement of quality of life, health and wellbeing,

social welfare and contributing towards environmental sustainability.

- Niche, but yet significant, populations within society with a need to address specific personal health and wellbeing issues such as mental health, ageing and obesity, as well as local authorities, health services, charities and commercial partners (such as *Ultrasis plc*) with a role to play in supporting these groups. The types of impact addressed in this context are enhancement of quality of life, health and wellbeing (e.g. see *Sleepful.me*) and shaping and enhancing the effectiveness of public services.
- Those segments of business and industry who wish to understand how utilisation and deeper analysis of social media can assist them in their own strategic aims, growth and development. The types of impact addressed in this context include enhancing the efficiency, performance and sustainability of businesses/organisations as well as the commercialisation and exploitation of scientific knowledge, leading to new processes, products and services.
- The arts and creative industries who wish to utilise digital technology in expressive ways in their work and activities. The types of impact addressed in this context include enhancing cultural enrichment and contributing to increasing public awareness and understanding of science, economic and societal issues. This is perhaps best evidenced through our social media garden *Digital Capabilities* at RHS Chelsea Flower Show 2013 (see below).

b. Approach to impact

Our approach to impact includes creating a culture of impact, engaging effectively with all stakeholders, encouraging public participation in research and using interdisciplinary collaboration to solve key problems, improve commercial practice and deliver positive economic and societal benefits, at the same time widely disseminating our research findings to professional and public non-academic audiences. Topics such as health, crime, social media and security hold a strong, and understandable, interest with the general public, together with special interest and pressure groups. We take every opportunity to introduce our work and its wider context to diverse audiences from presentations in the House of Lords to local public meetings. Announcements and opinion pieces are provided for traditional media outlets (including the trade press), as well as public-facing websites and other digital media.

Creating a culture of impact

Impact is a fundamental tenet to why, what and how we research. Our culture of impact is developed through: (a) workshops for researchers guiding them through the processes and examples of successfully generating impact supported by an 'impact champion'; (b) access to University-wide external support to promote recognition and development of impact; (c) detailed dissemination of good practice guidelines through blogs, web pages, and other media; and (d) more general university-wide approaches, e.g. research networking events.

Such a culture allows us to react quickly and positively to unexpected opportunities; for example, to a request in 2011 from *RAF Waddington*, who host the RAF's largest airshow, to provide a display of the School's activities – aimed both at professionals (RAF personnel, aerospace representatives) and the general public. At 3 weeks notice, we assembled a 100 m^2 display stand that captured many aspects of the School's research (and teaching) activities. After just two years, we are now a "permanent" feature of this airshow (which attracted some 145,000 visitors in 2013). As a School, we now run graduate courses for the RAF and have several research projects in various stages of development, including application of our novel image sensors within embedded system for surveillance, all directly as a result of this event.

Engaging with stakeholders

As outlined above we have developed close working relationships with the many players and interested parties who in some manner have an interest in our research. We are conscious of remaining open to unexpected potential stakeholders – maybe those unaware that our research or just more generally the technological developments that are occurring will impact on their lives. **LiSC**, together with our Schools of Psychology and Architecture, worked with a garden design practice to create a 'digital show garden' which was exhibited at the Royal Horticultural Society (RHS) Flower Show 2013. The primary purpose, and therefore intended impact, of the garden, named *Digital Capabilities*, was to reveal, in a thought provoking manner, hidden conversations on social media to people who might not normally engage with such technology, in a setting where the capabilities and potential of digital technologies are usually completely absent It achieved national

(prime-time BBC) and international media coverage and was given two highly commended awards by the World Architecture News and winning an RHS Gold Medal at Chelsea itself.

Translating research

The University Research and Enterprise office provide support and facilities for the two-way flow of knowledge and support between the School and industry. It has dedicated staff who can advise and prepare contracts, manage IP transfer, arrange the submission of patents and licenses. We also have an advantage in that Prof. Allinson is a member of the School. He has been recognised by *The Times Higher* as one the UK's top academic entrepreneurs, having co-founded 5 spinout companies from his research. Two companies were formed during the REF census period – *ISDI Ltd* (commercialisation of large-area CMOS imager technology; founded 2011, company no. 07314677. See Impact Case Study) and *Immersive Forensics Ltd* (UK company no. 06596798: founded 2008). Immersive Forensics was formed to provide fully digital workflows for the entire Police forensic process. It built upon the development of systems to enable the transmission of fingerprint and other forensic data directly from crime scene to bureau. These systems are in use by over 70% of the 43 UK Forces. It reduced the average time-to-ident from 8 days to 2 hours – the record being under 15 mins. Prof. Allinson advises all staff with the School on potential and mechanisms for translating research into product.

c. Strategy and plans

Impact is considered a primary gauge of the value of research undertaken within the School, and is actively pursued in its broadest sense, in both the non-academic and academic arenas.

Impact through academic support: A goal of the School is to provide a greater degree of support for staff and guidance on how best to promote, disseminate and exploit the impact of their research. Representatives from the University's Press Office, as well as colleagues in Marketing and Enterprise, regularly attend School staff meetings. The aim is to promote research-dissemination opportunities beyond normal academic output, i.e. social media, press releases, professional society meetings and open-access events for the public.

Impact through postgraduate engagement: We recognise that we must involve all researchers in understanding the benefits in seeking and promoting impact, so we will involve our postgraduates (RSs, RAs and fellows) more. This philosophy also applies to our undergraduate population. Based on some initial successes, the School will pursue focused engagement with University Marketing, Events and Enterprise teams to further such activities for researcher engagement. We firmly believe that impact should be prominent throughout the School's activities.

Impact through expansion of academic-industry knowledge transfer: The School considers knowledge transfer to the commercial sector as a key mechanism for generating impact. We will expand our involvement in KTPs, both at local and national levels. There will be a strategic focus on substantially expanding the School's portfolio of TSB funded projects

Impact expansion through growth: Finally, as the School continues its expansion, it plans to substantially widen the scope of its multi-disciplinary research and its reporting. We already have joint research with Engineering, but with the University's intention to invest further in STEM subjects and the formation of the £14m Science and Innovation Centre for the co-location of academics and commerce, these joint activities with increase substantially.

d. Relationship to case studies

The two Case Studies focus on our ability to transfer relevant research into the commercial sphere.

- "*Giving Medicine a Better Image with Wafer-scale CMOS Imagers*" shows how the sizeable investment required to develop and fabricate new silicon devices (funded by the Research Councils), together with working across disciplines with sizeable teams of experts, can meet an *EPSRC Grand Challenge*, and generate a new company that puts the UK at the lead for this expanding market.
- "*User-trainable visual anomaly detection for quality inspection tasks in the food industry*" is at an earlier stage of exploitation, but illustrates how working with local industry (food production is a leading industry for Lincolnshire) and relevant government and industry bodies we have set the foundations for a expanding new technology that will assist in the maintaining the supply, quality, and cost-effectiveness of British Agriculture.