Institution: University of Salford

Unit of assessment: B11 Computer Science and Informatics

A: Context: Research undertaken in the School of Computing, Science and Engineering at the University of Salford is developed by multi-disciplinary teams in partnership with the commercial and industrial sectors, communities, the public and voluntary sectors. The main non-academic user groups, beneficiaries or audiences and main types of impact specifically relevant to research within Computer Science and Informatics at the University of Salford include:

- Energy suppliers and consumers, for example British Gas and its customers through optimising energy production, distribution and consumption patterns, where impact is focused optimising energy production, distribution and consumption patterns.
- Domestic energy users in the European DEHEMS project, which explored how energy monitoring within a home can be used to support people to reduce their household energy consumption, where impact is focused on applying communications technology to reduce energy consumption within buildings.
- Business energy users through the European SEEDS consortium to optimise how buildings consume energy and resources, where impact is focused on optimising energy consumption, maintaining user comfort in new and existing buildings to reduce the estimated 35% of the continent's carbon emissions from the built environment.
- Not-for-profit Industrial and Provident Societies, which provide access to credit, savings and financial advice, where impact is developed in the application of data mining to reduce the number of people turning to unmanageable debt, promoting financial inclusion.
- The automotive industries and their customers, and the economies of the communities in which the industries are based, in particular Jaguar Land Rover, where impact is developed in the area of improving vehicle design using visualisation technology. Multi-site businesses, their staffs and customers, where impact is demonstrated through the development of collaborative virtual environments.
- Libraries, museums and archives and the communities which use them, where impact is generated via the EU Pattern Recognition and Image Analysis (PRImA) Improving Access to Text project, developing technology to increase access to public archives, offering new and existing audiences and users of archives unprecedented access to archival material in digital formats.
- Community Health and Social Care Services, Children's Services, healthcare providers, Environment and Community Safety Agencies, Police and Fire and Rescue Services and Housing Trusts where impact is generated in the area of creating virtual mirror images of real urban spaces populated with rich statistical information, enabling local agencies to work collaboratively to achieve 'better for less' services.
- The food production, aerospace and rail industries, their staff and customers, and the economies of the communities in which the industries are based, where impact is developed through the application of advanced robotics to address automation requirements in industry, and multi-agents systems for improving efficiency, process and competitiveness in those industries.

Impact in the area of energy reduction, improving financial inclusion and improving access to archives originates from research on data mining and pattern recognition (Vadera, Meziane, Cooper, Apostolos), impact related to improving vehicle design, supporting community health and social services is achieved through research in virtual environments (Roberts, Aspin), and impact related to food production, aerospace and the rail industries originates from our research in robotics and autonomous systems (Nefti-Meziani, Mei, Davies, Theodoridis). The research that gives rise to the impact is conducted across the following Research Centres:

- Informatics Research Centre
- Autonomous Systems and Advanced Robotics Research Centre
- Engineering Research Centre

This diversity creates a platform well suited for collaborative research, supporting the capacity to develop impact in the areas of media and digital technology, energy and infrastructure

including transport and environmental systems. Impact is additionally generated through multi-disciplinary research based in:

- The Salford Energy Hub, bringing together multi-disciplinary teams to address the challenge of continued growth in demand for utilities and the need to reduce CO2 emissions. The Hub includes research expertise in built environment, thermo dynamics, materials, social science, behavioural psychology, and housing as well as computer science and informatics, and includes the Salford Energy House, an early 20th Century terraced house reconstructed in a fully environmentally controllable chamber.
- The University is a major partner in the development of MediaCityUk at Salford Quays, which encourages creativity, innovation and collaboration between researchers, professionals, communities and industry. The School has research expertise based at Media City, and is developing links with user groups including an audio research partnership with the BBC, links with large multinational corporations and public, community and voluntary sector organisations, public sector bodies and SMEs.

b. Approach to impact: The Unit's approach to interacting with, engaging with or developing relationships with key users or beneficiaries to develop impact from the research is as follows:

- Optimising energy production, distribution and consumption patterns in partnership with British Gas and its customers, by using Bayesian learning to develop a sensor validation model in collaboration with the Mexican Instituto de Electricas, a British Gas funded project applying data mining to SMART meters data from over 40,000 households to identify user profiles with a view to recommending tips for reducing household energy consumption.
  - **Evidence:** Report available on request
- Supporting pe**o**ple to reduce their household's energy consumption by applying User Driven Innovation (UDI) as a basis for system development where users participate in 'living labs' to improve and refine system design so that it achieves higher coherence and user satisfaction in the European (DEHEMS) project, enabling experimentation and co-creation with real users in real life environments.
  - **Evidence**:Digital Environment Home Energy Management System (DEHEMS) project
- Optimising how buildings consume energy and resources in the European SEEDS project by using wireless sensor technology and data mining methods and collecting data on temperature, humidity, luminance, and occupancy, via wireless sensors. The software then learns to optimise heating and ventilation so that user comfort is satisfied but energy consumption is minimised.
  - **Evidence**:Self learning Energy Efficient builDings and open Spaces (SEEDS) project
- Reducing the number of people turning to unmanageable debt, promoting financial inclusion through KTPs with not-for-profit Industrial and Provident Societies, using data mining of partner systems and developing a means for evaluating the factors that influence a customer's ability to repay loans with a data control system for account processing, resulting from a KTP programme based on data mining theory in micro finance.
  - **Evidence**:Enabling Low Cost Loans
- Improving vehicle design through improving the design process via the JLR CAVE, developing holistic visualisation technology across design stages and teams. Supporting efficiencies in virtual meeting situations through the development of 3D video-based reconstruction and supporting communicational eye-gaze across distance, faithfully communicating appearance and attention in immersive collaborative virtual environments.
  - Impact Case Study
- Offering new and existing audiences and users of archives unprecedented access to archival material in digital formats via the (PRImA) project, through the development of tools and evaluation frameworks to significantly reduce costs of document digitisation, whilst maintaining, or increasing the quality of large-scale digitisation.
  - Impact Case Study
- Enabling local agencies to work collaboratively to better understand how partner resources are being invested in different communities to deliver shared outcomes and achieve 'better for less' services by creating virtual mirror images of real urban spaces populated with rich

statistical information to enable new views and analysis of service provision.
    - **Evidence**: Virtual Salford
- The application of advanced robotics to address automation requirements in Intelligent Tasking and Mission Management, including control systems applications, onboard mission, collaborative planning and task allocation, optimisation, Intelligent Decision Making systems, fault diagnosis systems, and safety management and fault tolerance.
    - **Evidence**: GAMMA Autonomous Systems project

Staff within the Unit, from early career researchers to established research colleagues, are specifically supported and enabled to achieve impact from their research through:

- Workload allocation, allowing dedicated time to pursue impactful research.
- The application of discretionary funding to enable staff to capitalise on opportunities to generate or enhance impact or evaluate research for impact.
- Establishing mechanisms for non-academic partners to engage with the research throughout its development by recruiting a range of professional representatives through ThinkLab and MediaCityUK, with 100+ companies invited to engage with the potential of working with cutting edge researchers and facilities.
- Developing Knowledge Transfer Partnerships offering an outstanding record in driving innovation, enterprise and skills, with a range of commercial and public sector organisations, with 40% of staff submitting leading KTPs between 2008 and 2013.

The unit made use of institutional facilities, expertise or resources in undertaking these activities through:

- Salford Impact Advisory Group with cross – university representation to build momentum and develop excellence in evidencing impact;
- Impact Fund to support researchers in generating impact;
- Vice Chancellor's Research Excellence Award celebrating excellent research impact;
- Embedding impact in funding bids;
- Early Career Researcher training in impact;
- Sabbatical scheme with a key focus on generating impact.

c. Strategy and plans: With a record of generating research in partnership, the University of Salford is well-placed to articulate its impacts. It has developed an institutional approach, Salford Impact, with the aim of evidencing, developing and celebrating the transformational impact of University of Salford research. Computer Science and Informatics research plans to continue to develop Salford Impact in future research practice through the successful realisation of impact through;

- Understanding major societal challenges and focusing research towards addressing them; optimising design processes to derive efficiencies in production; reducing consumption through greater availability in and efficiency of the use of technical processes, design, manufacture and use of resources;
- Increasing innovation in and depth of partnerships with public, commercial and industrial sector organisations, with enhanced focus on understanding and addressing their pressures and supporting their priorities, in particular;
    - Through the Digital Cluster, an interdisciplinary research collective that brings together the expertise of academics and practitioners from across the University of Salford, working in a range of areas and fields relating to the digital economy.

d. Relationship to case studies

Case Study 1: Virtual environments exemplifies and has informed the development of the Unit's approach to impact through its application in supporting improvements in design processes in the UK automotive industry generating significant economic benefit.

Case Study 2: Digital libraries, historical texts exemplifies and has informed the development of the Unit's approach to impact through its proven application in exponentially improving access to archives internationally.