Environment template (REF5)

Institution: University of Salford

Unit of assessment: B11 Computer Science and Informatics

a. Overview

This submission is made on behalf of the School of Computing, Science and Engineering at the University of Salford. The School was founded in 2003 in recognition for the need to foster an environment that transcends traditional academic boundaries and with a mission to develop multi-disciplinary applied research that helps to address real world challenges faced by society. Research in the School is organised in Centres that focus on developing research excellence in topics of computer science that help address challenges in domains such as Energy, Digital Libraries, and Engineering. The Research Centres with staff contributing to UoA B11 include:

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

In RAE2008, the University's strategy included a strong focus on research in soft systems methodologies and social aspects of information technology, and staff in the School were submitted as part of the Library and Information Management Submission (LIM, UoA37). Following RAE2008, the University revised its research strategy, as outlined in section b, leading to this first submission to a Computer Science and Informatics panel.

b. Research strategy

Since RAE 2008, the School's vision and research strategy has been to develop our strengths in computing and informatics, and apply them in projects that aim to address the major challenges faced by society. The specific challenges we focus on are based on the University's four strategic themes of: Energy, Built and Human Environment, Health and Wellbeing, and Media, Digital Technology and the Creative Economy that are outlined in the University of Salford Strategic Plan (2009/10 - 2017/18).Our specific areas of expertise in informatics include Virtual Environments (**Roberts**, **Aspin**), which has been carrying out innovative research since it was founded in partnership with EPSRC in 1994;Robotics, Control and Autonomous Systems (**Nefti-Meziani**, **Mei**, **Theodoridis**, **Davies**) which has a strong tradition at Salford that dates back to 1990s, when we hosted the UK's National Advanced Robotics Research Centre; and expertise in data mining and digital libraries (**Vadera**, **Meziane**, **Saraee**, **Tumula**, **Antonacopoulos**) which we have developed in the last decade.

Examples of projects reflecting the success of this strategy include the FP7 funded DEHEMS and SEEDS projects aimed at reducing energy consumption and CO2 emissions; the IMPACT project aimed at increasing access to historical documents; an EPSRC funded project on communicating eye gaze in virtual environments; research on advanced control, condition monitoring and vehicle dynamics funded by EPSRC; and an ERDF funded GAMMA programme, the first initiative of its kind in the UK that is focused on Autonomous Systems, and which is exploiting our relationships with BAE Systems, NNL, NWAA and Airbus. Our strategy is operationalized in School Plans, which define the Key Performance Indicators (KPIs), such as research grant income, number of quality publications, and number of PhD completions. These KPIs are agreed with the College annually and progress towards achieving them is monitored by the School Executive, the College Research and Innovation Committee and the University Research Committee (which reports to Senate).

The progress made with this strategy, which has included significant increases in research grants, publications in major outlets, PhD completions, and organisation of conferences, is the

basis of this submission to the Computer Science and Informatics Panel. In 2012-13, the School was awarded £2.9Mfrom research grants (£5.7M including partner payments), exceeding its target by 26%, and representing 47% of the awards to the University. In particular, evidence of achievements includes:

- A strategy of focussing on larger bids that has led to an increase in the value of awards from the start of the period, when in 2008-09, we had 21 'live' projects with a spend of £533k and overall value of £2.7 million to now, in 2012-13, where we have 11 projects with a total overall value of £4.9 million and spend of £745K.
- Our programme for supporting post-graduate students (section c) has led to a significant increase in the number of PhD completions per member of staff, from 1.5 in the LIM submission in 2008, to 3.5 per submitted member of staff in this period.
- Our researcher development opportunities played a significant role in retaining the European Commission's HR Excellence in Research Award in October 2012.

In the future, we plan to capitalise on our strategic developments, which include investment of over £1M in the creation of the Salford Energy Hub, which offers unique facilities such as the ability to reproduce different climates around a house in a controlled chamber, investment of over £1M at MediaCityUK to provide state of the art visualisation technologies, the School's Audio Research Partnership with the BBC, a specialist Robotics laboratory, a new Control and Vehicle Dynamics laboratory and our unique OCTAVE virtual environment, all of which provide specialist capabilities that will help attract new research collaborations and lead to innovative multi-disciplinary bids.

The recent award of the EU funded CROSS-DRIVE project that will enable Europe's space scientists to "teleport" themselves to a virtual Mars, the establishment of the FP7 funded European Centre for Competence in Digital Libraries, and the start of the GAMMA programme, a cross government-industry-academia £9.1M programme to engage the North West in developing autonomous systems technologies, together with our policy of making strategic appointments, such as the recent appointment of two early career staff with expertise in robotics and embedded systems (**Theodoridis** and **Davies**) puts us in a good position to build upon our successes in the future.

c. People, including:

i. Staffing strategy and staff development

Building capacity and capability is an integral part of our research strategy. Our approach to staffing policy centres on the development of existing and new researchers through the mechanisms described below.

The term-time research workload for staff members is set by the Schools. All staff undergo a regular Performance Development Review with their line manager which includes research activity as part of an overall academic workload. Line managers consult with Research Centre Heads beforehand to ensure senior research manager input is included properly within the review. Each review includes a formal annual meeting and a mid-year progress review. Objectives for these reviews are set within the University's Academic Career Path descriptors, which provide expectations for academic staff by career progression. All staff in the School are given the opportunity annually for review against the Academic Career Path criteria, either for HERA re-grading to Senior Lecturer (in the case of Lecturers), or for promotion to Reader/ Professor by the University Professorial Promotions Committee. This research environment has facilitated career progression for **Nefti-Meziani** and **Meziane** who were promoted to Professors in 2011 and 2012 respectively, and **Aspin**, **Tumula** and **Saraee** becoming Senior Lecturers since 2008.

Newly appointed staff are all placed on a one-year probationary period, and are allocated a

formal mentor from amongst senior staff in their discipline to support them through their first year of employment at the University. In discussion with their line manager, new members of staff who are early career researchers are normally given partial teaching loads in their first year, to ensure that their research activity is not hampered by a large teaching burden. New appointments since 2008 include **Mei**, **Tumula**, **Davies** and most recently **Theodoridis**.

Research training and development is included within the induction programme. There are University-wide staff support schemes, such as the Vice-Chancellor's Research Scholarship Scheme for early career researchers and a College strategic investment fund, together with a rigorous programme for staff development at Research Centre, School, College and University level to ensure that staff are able to extend their skills and competencies in a number of areas, whilst ensuring that high-standard infrastructure and services are provided to our students and contract researchers. Early research career staff are encouraged to apply to the University Vice-Chancellor's Early Career Researcher scholarship, which provides financial support for research activities. **Davies**, for example, has benefited from this scholarship during the REF assessment period. Early Career Researchers and new members of staff are encouraged from a very early stage to fully participate and present their work in training programmes. Pump-priming research funds are provided to support their research. The College also awards an annual Dean's prize of £2000 for early career researchers, which was awarded to **Tumula** in 2011. The University operates a policy where 25% of overhead income from research awards is provided in staff discretionary accounts, which has been utilised by most staff to attend conferences, organise workshops and purchase equipment and software.

A supervisor training programme that was initiated and led by staff in this submission, piloted by the School and then rolled out across the University, is provided to all PhD supervisors. The programme offers an opportunity to share good practice, ensure that staff are familiar with the regulations associated with PhD provision, and includes training on ethical approval, equality and diversity and widening participation. All members of staff are positioned within one of the Research Centres in the School, and can also become associate members of other centres. This allows members visibility and active participation in the development of thematic research strategies, making explicit research synergies across centres, and ensuring research cohesion.

External researchers are linked to activity within the School through the University's Visiting Research Fellow and Visiting Professor schemes. This allows Research Centres to link high-profile staff to the work, and promote the Centres' research. Representative examples include Professor Roe, Chair of the Royal Aeronautical Society, who has helped develop our links with organisations such as British Aerospace, Professor Sugumaran from Oakland University, who collaborates in the area of decision support systems, Professor Rizzo, from University of Southern California, who is working with our virtual environments researchers on Virtual Reality Exposure Therapy for war veterans with post-traumatic stress disorder, and Dr Doermann, from the University of Maryland, who was appointed Royal Academy of Engineering Distinguished Visiting Fellow during 2010-2013 and is collaborating on joint work on document classification and quality assessment in digitisation.

In 2010, the University was one of only 10 institutions recognised by the European Commission for its work in supporting the professional development of its researchers, and meeting a Concordat to support Career development of research staff. In addition, the researcher development opportunities offered at Salford played a significant role in retaining the European Commission HR Excellence in Research Award in October 2012.

ii. Research students

Our research student community is an integral part of the research we do. Postgraduate research studies and activities are managed by a Director of Postgraduate Research within each School. We implement a formal Learning Agreement between the Postgraduate

Research Student and the University, allowing the optimisation of student experiences and expectations. We also have close working links with the North West hub of Vitae, which is committed to working with universities, supervisors and other national organisations to support doctoral researchers.

Postgraduate research supervision is supported by a supervisory team (two supervisors for each candidate) and a Personal Tutor for each candidate. Postgraduate Research Representatives are elected from the student body, who work closely with academic staff, and sit on school committees to make sure that the voice and expectations of students are heard and acted upon. We have diverse PhD modes/pathways which also enables us to maximise the number of students we recruit. These include full-time, part-time, split site and PhD by submitted works. We also have a successful online PhD programme, and the Professional Doctoral Programme, which began in 2008.

We strongly believe that a supportive research-focused environment is critical to research students in terms of the quality of their research, and the general satisfaction of their research experience and so we take active steps to ensure that we provide an environment which is supportive of postgraduate activity in order to foster and nurture young talent. The University-wide Graduate Teaching Assistant (GTA) policy, started in 2003, funds PhD studies and provides training for teaching for the candidates, and has been very successful. The GTA scheme was highlighted as good practice by the QAA Institutional Audit and to date, this has funded 8 GTAs in Informatics as well as 3 EPSRC funded CASE/DTA studentships.

All PGR students in the Research Centres complete their doctoral studies under the University regulatory framework for progression. Students are required to meet three formal points in their studies in order to proceed – the Learning Agreement, completed with their supervisors within three months of registration, to identify their broad research plan, training and development needs and doctoral timeline; b) the Interim Assessment, after the first year; c) the Internal Evaluation, after the second year. These are accompanied by annual progress reports by supervisors and self-evaluation documents by the students, which are scrutinised by the School's PGR tutor, with any issues arising brought to the attention of the Associate Head Research in the School and to the College Research and Innovation Committee. The success of this targeted progression framework can be seen in the rise in PGR awards over the REF period, an increase from 5 awards at the start of the period to at least 10 awards annually since 2011-12.

The University, College and School all provide appropriate development in generic and subject-specific skills for PGRs. The University Research and Innovation unit provides generic training through its Salford Postgraduate Research Training programme (SPoRT) workshops, which are aligned with the national Researcher Development Framework. These cover aspects of doctoral study, such as expectations in the Progression Points and "surviving the viva", as well as introductions to core research skills, such as getting published, making a presentation, writing conference papers. It also provides introductions to key methodological approaches and software – interviewing techniques, focus group research, NVivo and SPSS. This programme has grown significantly since 2008, with the number of annual sessions offered rising from 51 in 2008-9 to 76 in 2012-13; participant numbers have increased similarly, from 441 participants in 2008-09 to 844 in 2012-13.

The College and School provide a vibrant environment for research. The College organises an annual showcase event, where students present posters, and prizes are awarded for best poster and best journal publications by students. The School organises an annual postgraduate research conference and encourages students to submit papers, receive feedback from referees, and enhance their presentation skills. On average, about 25 students have taken advantage of this opportunity annually, with the proceedings published with an

ISBN and available at the British Library since 2009.The School has an active multi-disciplinary seminar series. Examples of seminars in recent years include: The future of virtual environments by Prof Ralph Schroeder from the University of Oxford, Light in Unusual Media by Prof Martin McCall from Imperial College, Companions: Turning Interactions into Relationships by Prof David Benyon, Health Effects of Transportation Noise in Hong Kong by Prof Kin-che Lam from the Chinese University of Hong Kong, Hydrogen Trapping at Dislocations in Deformed Pd at Low Temperature by Prof Brent Heuser from the University of Illinois at Urbana-Champaign, 3D displays: Past, Present and Future by Prof Nick Avis from Cardiff University, Big Data: Challenges and Opportunities by Prof M-Tahar Kechadi, from University College Dublin, Indexing and Retrieval in Heterogeneous Document Image Collections, by Dr David Doermann from the University of Maryland, and a seminar on Lessons for the Future of Document Analysis by Prof Rolf Ingold of the University of Fribourg (Switzerland).
The University also runs the Salford Postgraduate Annual Research Conference (SPARC) where students and early career researchers across the disciplines can present their research and gain feedback. SPARC has run for over 12 years and attracts students from many other institutions including the Universities of Reading, Bristol, Exeter, and the Open University. The aim of the programme is to assist researchers in developing effective research skills as well as transferable skills to enhance employability. The programme maps fully onto the national Researcher Development Framework (RDF). In the last internal Postgraduate Research Satisfaction Survey, carried out in 2012-13 by the University of Salford, our students in the School of Computing, Science and Engineering recorded a satisfaction score of over 85% for academic and pastoral support and 87% in terms of the overall experience, which is well above the upper 95% confidence limit for Computer Science and Informatics reported in the Higher Education Academy's Postgraduate Research Experience Survey for 2013 (Figure 5.1 of PRES 2013).

d. Income, infrastructure and facilities

Investments in specialist infrastructure and facilities:

We have made significant investments to provide the best possible facilities to support our research strategy. Our pioneering research in virtual environment continues, with an investment of over £700K in the OCTAVE, an eight sided projected reconfigurable environment that is one of the largest and advanced facilities of its kind in the world and which opens up new avenues for research on fully immersive environments. The latest upgrade incorporates a wave field synthesis sound system, allowing positioning of both visual and auditory cues in 3D, providing a unique facility in the UK. This facility is complemented by an investment of over £1 million since 2010 in a state-of-the art visualisation technology at MediaCityUK.

Our multi-disciplinary research in applying informatics to minimise energy consumption is supported by an investment of £1 million as part of the Salford Energy Hub to establish facilities for testing new systems and processes including sensor technology within a domestic environment. The Robotics Laboratory has had investment of over £48,000, and includes a Husky all terrain Robot, and NAO humanoid robots, incorporating the latest new technology for mapping and navigation by the use of GPS, Lidar, and vision systems. The School has also established a new Control and Vehicle Dynamics Research Laboratory (£200,000 investment), with state-of-art hardware-in-the-loop, instrumentation and noise and vibration test facilities.

The School has 18 technical staff, which includes two specialist staff to support the OCTAVE and Virtual environments, and two specialist technicians to support Robotics and Automation. Our Energy Hub is supported by a manager, and a technical manager, both funded by HEIF.

Research funding portfolio and future strategy:

Our research grant awards profile reflects our research strategy. In Energy, awards include the FP7 funded DEHEMS project (£295K, Digital Environment Home Energy Management System), the FP7 funded SEEDS project (£299K, Self Learning Energy Efficient builDings and open Spaces), and a British Gas Funded Project (£79K) which used data mining methods on SMART meter data to identify energy consumption profiles with respect to lifestyle and building types. The research on digital libraries is funded by FP7 grants for the IMPACT project (£1 Million), a project providing a Gateway to European Newspapers Online (£326K), the SUCCEED project supporting activities within the Centre of Competence in Digitisation (£156K) and an Andrew Mellon Foundation grant for research on OCRing early modern texts (£52K). Research on Robotics and Control includes an EPSRC funded project that challenges established rules for train control (£345K), an EPSRC funded project that aims to enhance train safety (£50K), and a Technology Strategy Board funded project that aims to develop embedded intelligence in a steer-by-wire system (£175K), a Regional Growth Fund for the Autonomous System Mission Management Applications (£156K) and a Marie Curie ITN aimed at producing the next generation of robotics experts (£3Million). The CROSS-DRIVE project that has recently been funded by FP7 will utilise our OCTAVE to allow space scientists to "teleport" themselves to a virtual Mars.

These awards, together with our investments in specialist facilities and staff put us in a good position to increase our future bidding and awards, both from the EC Horizon programme, industry and EPSRC.

e. Collaboration and contribution to the discipline or research base

Our research is carried out jointly with industry, public authorities, user communities and academic institutions, all working as part of a team to address significant real world challenges. So, for example:

(a) Research in informatics for energy is in partnership with companies that are major providers of energy and building energy management systems such as British Gas, Ferovial, Fraunhoffer, CEMOSA; SMEs that provide specialist technology such as SOFTCRITS, NSC; councils that can play a major role in meeting energy reduction targets, including Manchester City Council, Birmingham City Council, Bristol City Council; and academic partners from the University of Stavanger, University of Malaga, and the Institute e-Austria Timisoara that provide complementary research expertise.

(b) Research on Digital Libraries and Historical documents is in partnership with over 25 partners including many of the world's leading libraries such as: British Library, Koninklijke Bibliotheek, the Bibliothèque nationale de France, the Deutsche Nationalbibliothek;academic partners include Universität Innsbruck, University of Munich, University of Bath, Bulgarian Academy of Sciences, Jožef Stefan Institute, Poznan Supercomputing and Networking Center, and University of Austin. Industrial partners include GOOGLE, IBM Israel and IBM TJ Watson Research Centre in the USA.

(c) Research in Virtual Environments has been in collaboration with industrial partners such as OMG Vicon, BBC, Visual Acuity, Avinti Screen Media, SGI and academic partners including UCL, University of Reading, and University of Roehampton.

(d) Research in Autonomous Systems, Control and Robotics is with the National Centre for Robotics in Switzerland, Carnegie-Mellon University, with whom we have a formal cooperation agreement in research in robotics, ESTIA and LIP6, Paris VII (France), Composite Adour (France), and IIT (Istituto Italiano di Technolgia, Italy). Key industrial partners include the North West Aerospace Alliance, BAE Systems and the National Nuclear Laboratory. In control and

vehicle dynamics, there are established collaborations with Southwest Jiaotong University (China), Tongji University (China), Loughborough University, University of Leeds, Cambridge University and industrial partners include RSSB, Bombardier, SET and InMoCo.

Contribution to the discipline or research base

Staff in the UoA have organised or chaired many conferences including: (a)The 18th International Conference on Applications of Natural Language to Information Systems (NLDB 2013), Media City, Salford, 2013, (b) The IEEE International Conference on Data Mining Workshop on Cost-Sensitive Data Mining, Brussels, 2012, (c) The 15th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DSRT), Salford, in 2011, (d) The Shangh'AI Lecture Series, Salford ThinkLab, 2011, (e) The 22nd International Symposium on Dynamics of Vehicles on Roads and Tracks (Manchester, UK), 2011, (f) The 10th ACM Symposium on Document Engineering, Manchester,2010, (g) The 5th IFIP International Conference on Intelligent Information Processing (IIP), Salford, 2010, (h) The 5th OR Society's European Conference on Intelligent Management Systems in Operations, Salford University, 2009, 2013, (i) The 5th BCS Symposium on Knowledge Discovery and Data Mining, Salford Lowry, 2009.

Staff have also presented invited seminars and are editors of journals. For example, **Mei** has presented invited seminars on his research on vehicle control at Cambridge University (2013), Southwest Jiaotong University (2011,2013), Chinese Academy of Railway Sciences (2013), Nihon University, Japan (2009) and National Taiwan University (2009). **Vadera** has presented invited seminars on cost-sensitive learning at the Chinese Academy of Science in Beijing(2008) and at Kyoto University (2009). **Meziane** is on the Editorial Board of the *International Journal of Information Technology and Web Engineering* and Guest Editor of a special issue of the *Data and Knowledge Engineering Journal on Natural Language Processing* (2013)

Antonacopoulos is Vice-President of the International Association for Pattern Recognition (IAPR), and was Chair of the IAPR Education Committee (2010-2012). **Vadera** served as Chair and Vice of the BCS Accreditations Committee (2008-2010) and led the BCS contribution to establish the international Seoul Accord for IT. He also serves on the IFIP WG 12.2 on Machine Learning and Data Mining. Nefti-Meziani is Vice Chair of the IEEE Robotics and Automation in the UK, Associate Editor of ICRA, IROS, IEEE transaction on Fuzzy Systems, Advisory board member of the EPSRC Centre in Innovative Manufacturing on intelligent systems and North West Academic representative for the North West Aerospace alliances.