**Institution: University of Derby**

**Unit of Assessment: 11**

**a. Overview**

This submission relates to research conducted in the School of Computing & Maths (SCM) and within the Distributed and Intelligent Systems (DISYS) Research Centre. DISYS represents the critical mass and concentration of expertise available within the SCM. Twelve (12) out of 27 FTE SCM Cat A staff (including 4 early career) have been submitted (44%). DISYS consists of 15 principal members (4 Professors, 2 Readers and 9 Lecturers/Senior Lecturers), 11 members, 3 Visiting Professors and 13 Visiting Researchers (42 in total).

**b. Research strategy**

**Background:**

This is the first submission that the University has made to UoA11. In 2009, SCM established a clear focus upon knowledge creation and dissemination within the Computer Science provision, by assembling an environment where research activity is pervasive and sustainable. This vision was made concrete by the aspiration to move towards a financial income model of: 65% UG teaching, 20% PG teaching, and 15% income from research and commercial activities. The realisation of this aspiration commenced with the following five key actions:

1) **Building research leadership capacity**. All senior staff appointments since 2009 have had research credibility, external esteem, and a PhD as essential criteria.
2) **Formation of a research group**. The Distributed and Intelligent Systems Research Group (DISYS) was formed in 2010, as a vehicle to formalise the processes of knowledge creation, whilst also serving to propagate the research aspirations of the School.
3) **Creation of a research culture**. During 2010, the academic staff appraisal system was revised to include staff development objectives for research and scholarly activity. In conjunction with this, the Academic Work Planning process was used to create space for academic staff to engage in research activity. Academic staff development sessions were held, to promote research-based teaching practices.
4) **Acquisition of the Mathematics subject area**. SCM actively obtained specific expertise in Mathematics, to inform and enrich the quality and depth of Computer Science provision.
5) **Re-engineering the curricula**. The PG curricula was refreshed during 2011, to take account of emerging staff expertise, followed by the entire UG curricula during 2012. This task of re-engineering enabled the processes of research to be directly embedded, and therefore research outputs would be disseminated, through research and teaching activities.

These actions have set the scene for a period of transformation for the SCM, resulting in the development of a broad academic base that rewards engagement with knowledge creation and dissemination. This culture of research supports staff and student excellence, and is an attractive environment for research active academic staff.

**Long-Term Vision:** To progressively develop a sustainable, internationally excellent, research environment, that is highly regarded for societal impact through scholarship, interdisciplinary collaborations, income generation and knowledge contributions in the field of future computing architectures, services and technologies. In particular, the focus will be interoperable, interconnected, distributed, large-scale e-infrastructures such as P2P, Grid, Cloud and Inter-cloud computing, Internet of Things (IoT) and context-aware environments.

**Objectives:**

1) To attract high quality scholars by providing an active and collaborative environment known for its international, high quality, original and interdisciplinary research;
2) To foster and enable leading synergies and, collaboratively with enterprises and other national and international research networks, engage in inter- and cross-disciplinary, high quality scholarly activity, knowledge and income generation;
3) To demonstrate research and technology transfer through its applicable exploitation and enhanced societal impact;
4) To develop students and academics to undertake significant and influential roles in academic communities and enterprise throughout the world.

**Achievements during the REF-2014 period:**

Since its inception, DISYS membership has grown from 4 to 42 academics, and has developed from a research group into a formal University Research Centre during 2013. This status reflects a coherent critical mass of 15 principal members, together with external income generation of at

least £50k per annum. Our efforts have exceeded University targets including a 10% increase in income generation and research outputs year-on-year.

The Director of DISYS is Prof Bessis (joined UoD 2010) and the composition of the Centre is as follows: 15 principal members, who are all academic staff from SCM; 4 researchers, 7 research associates, and 13 visiting researchers. In 2012, the School's external reputation as a hub of expertise for Cloud Computing, was further endorsed with the appointment of Prof Rajkumar Buyya, the most cited author in the world from 2007-12 in the area of Distributed and Parallel Computing, as a Visiting Professor. Similarly, Prof Manish Parashar - a world-renowned expert in distributed computing - and Prof Antonio Liotta, a leading academic in the field of autonomic computing, also both joined DISYS as Visiting Professors in 2012.

Between 2010 and the end of July 2013, DISYS has gained funding worth £0.5m. Successful proposals have attracted funding to improve the quality of life and social wellbeing of Housing Association tenants, through more efficient and relevant service delivery (Voorhis and Dakin); the development of a software/hardware interface that uses digital games to motivate young children's engagement with vital mucus clearance physiotherapy (Oikonomou); a federated Cloud solution for robust and high throughput analysis of video streams in real-time for security, surveillance and object tracking (Anjum); a Cloud-based semantic search engine for knowledge discovery (Hill); energy-efficient Cloud computing architectures (Liu) and a series of optimised intelligent Cloud applications to improve a company's product development workflows (Anjum and Antonopoulos).

The volume of published work is also increasing each year, with over 80 articles for 2013 so far. In keeping with a strategic aim to improve research quality, the number of articles published in international journals with impact factors >1.0 is also demonstrating an upward trajectory. Additionally, selected conference papers have received best paper awards (e.g. Liu in 2008; Bessis in 2009 and 2012) or extended versions have been requested, following further blind review (Bessis in 2011, 2012; Hill in 2011; Smith in 2012; Anjum in 2012, 2013).

As a centre, DISYS now operates under 5 inter-connected themes: Service Computing (provision of tailored e-infrastructures); Security and Forensics (research into cyber-security, surveillance and trust); Future Internet (research into e-infrastructures); Computational Science (research into analytics and mathematical applications) and access and outreach technology transfer (evidence based production of societal impact to demonstrate our influential capacity).

**Post REF2014 period (2014-2020):**

To achieve our long-term vision, several strategic objectives have been developed to improve impact, increase quality of research, and quantity of staff submitting in this unit:

- We shall increase research impact within the East Midlands by closer engagement with commercial organisations, leading towards at least one spin-off company.
- We shall submit 65% of the entire SCM academic staff to REF2020.
- By REF2020, 80% of academic staff will be research-active and hold a PhD.
- We will concentrate on expanding the existing research themes (providing continuity of activities and staff recruitment) whilst also supporting the creation of new areas. We anticipate that some will acquire funds and a critical mass leading to their evolvement of status to themes, groups or centres. An emphasis on 'Future Internet' will be exploited to balance the critical mass and our collective efforts to respond to Horizon 2020 calls.
- We have obtained University investment of £380,000 to be spent on 8 studentships to start in 2013. We expect that additional studentships will be available on regular basis.
- We will achieve 95% satisfaction in relation to the experience that is reported by research students (93% for 2012-13).
- We have submitted proposals for a Computational, Discrete and Applied Mathematics Research Group (Faculty approved, University approval pending). This research group will become a self-sustaining University Research Centre by 2020.
- We shall develop an additional submission to UoA10 (Mathematical Sciences) for REF2020.

**c. People, including:**

**i. Staffing strategy and staff development**

The proportion of SCM staff holding a PhD has significantly increased from under 19% in 2008 to over 65% in 2013. The SCM strategy addresses the Concordat key principles on supporting the career development of researchers. 75% of the current submission of staff to UoA11, was not submitted to RAE 2008. DISYS's rising reputation has made an impact on attracting high quality applications for academic appointments. For example, in 2011, we received 95 applications for a lectureship in

Computer Science. Over the REF2014 period, we have made a number of early career (research-active) academic appointments. This complemented the recruitment of more established academics during the same period. Our recruitment strategy is to strengthen research capacity and capabilities, and enhance international standing. The University is recognised as meeting the requirements of 'Investors in Diversity' (http://iiduk.com), and as a result the staff base is international, e.g. from Algeria, Canada, China, Germany, Greece, Italy, Pakistan and Romania.

A structured system supports staff during their initial probationary period. All new staff are encouraged to develop their research as part of DISYS and SCM. Teaching duties are constrained during the first year, and staff are assigned a mentor to support their development. A crucial exercise is the development of a specific research plan that aligns the research interests and development needs of particular staff to the needs of SCM. Such plans are developed in consultation with the Head of School and Head of Subject.

Further evidence of staff development is apparent in the promotions of Mahmood (2010), Liu (2012) and Anjum (2013) from Senior Lecturer to Reader; Hill (2012) and Larcombe (2013) from Reader to Professor. These promotions were awarded after stringent external verification of their research standing, reflecting our policy of recognising those who demonstrate a sustained record of research excellence.

School development mechanisms include individual coaching and mentoring, peer review for proposal submission, research away days, and group meetings. Research seminars take place regularly and are advertised to all SCM staff and PG students. Indicative presentations include Barolli (Fukuoka Institute of Technology); Buyya (University of Melbourne); Kołodziej (Cracow University of Technology); Kuonen (Applied Sciences of Western Switzerland (UASWS)); Pitt (Imperial College); Toral (University of Seville); Zhang (University College London) and Zhuge (Chinese Academy of Sciences).

A positive indication of the prevailing research culture is that some academic staff have enrolled for a research degree (Zhang, Smith). An associated effect is that academic staff are increasingly becoming research-active, publishing their work for the first time (Smith, Voorhis). Other staff have re-engaged with the research culture via publications in internationally recognised conferences and journals (Berry, Self, Zhu). External funding has also encouraged staff to become more involved with research projects (Rippin, Voorhis). In addition, staff are encouraged to take advantage of internal funding opportunities including the Deans award (Anjum and Liu in 2012) and the University Research for Teaching and Learning Fund (RTLF). The latter opportunity provides grants between £500 and £5,000 for a discipline-based or pedagogic research project (Liu in 2011 and 2012, Evans in 2012, Thompson in 2012).

For staff development purposes, participation at academic conferences is encouraged and SCM has spent £13,880 in 2008/09, £21,581 in 2009/10, £34,532 in 2010/11, £45,502 in 2011/12 and £51,835 in 2012/13. A percentage of overheads from each research project and from previous RAE funds is also distributed across Research Centre Heads to support the development of the respective Centre. SCM also encourages staff secondments (Bessis, 2011, University Politechnica of Bucharest). All staff are required to undertake training for research supervision, to be completed prior to the commencement of supervision duties. Research supervisors with limited experience can only join teams with a suitably experienced supervisor, who also serves as a mentor (Antonopoulos, Bessis).

The culture of research is promoted at the highest strategic level, through the office of the University Head of Research. All academics prepare personal development plans, reviewed annually by the Head of School and Head of Subject. Departmental plans are presented to the Faculty Assistant Dean for Research, describing the necessary resource requirements, including investment of funds into research studentships and enhancements to facilities. School research leadership is provided by the Assistant Dean, Head of Subject and the DISYS Director who is the REF submission unit leader. There is a Faculty Research Manager who chairs the relevant committee (FRRDC), comprising research unit leaders, School management teams, Heads of Research from across the Faculty, as well as one representative from the Research Office and the student body.

**ii. Research students**

The recruitment of research students is informed by the strategic objectives of the SCM, in conjunction with the academic staff expertise that is available. The SCM management team solicit funding from the University, and then invite academic staff to propose potential projects that align

with current research themes. These projects are then advertised publicly and students are recruited accordingly.

All research students are allocated desks with full IT facilities (like staff). Each student has a supervision team comprising 2 or 3 academic staff. Regular supervision meetings between the student and the team take place, and in month 3, students submit their registration report (RD05) for scrutiny by all FDDRC members. At month 18, each student submits a substantial report (RD07) which is peer-reviewed by an independent internal examiner, who also conducts a viva voce examination.

The University provides an induction and an extensive development programme, comprising over 20 training sessions, to support students throughout their studies. Research student development training includes topics such as liaising with the supervision team, research methods, research ethics, English language for academic purposes, communication skills, health and safety, project management, the use of library and information services, and career development. Students engaging in teaching undertake extra tuition leading to a PG qualification in Learning and Teaching. During the time of their PhD studies, they are restricted to a maximum teaching load of 6 hours contact per week.

Students are encouraged to attend and present their progress in the DISYS research seminar series, and also receive financial support to attend and/or present their work at external events such as international workshops and conferences (Sotiriadis in 2012). Additionally, all PhD students are required to publish their work prior to submission of the RD07 report and viva voce.

Support for students to undertake exchanges via Erasmus agreements is also provided, as well as to attend summer schools or other external training and development as required. For example, in 2012, Sotiriadis spent a month in UASWS and ran experiments in the CoreGrid lab. In the same year, Sotiriadis went to a summer school on Grid and Cloud computing organised by KIT (Germany).

SCM has recruited to one studentship (Sotiriadis in 2011, completed in 2013) and has a budgeted investment of £380,000 on 8 studentships for 2013/14. Studentships cover Home/EU fees, a stipend of £15,600 and a £1,000 development fund p.a. for 3 years.

**d. Income, infrastructure and facilities**

During the post-2008 period and up to the end of July 2013, we have gained external funding worth £0.5m. Specifically:

- Cystic Fibrosis and Digital Games:
  - Bioscience and Health iNet grant (Sep 2010 till Jul 2011) - £38,627;
  - Innovation Fellowship (Sep 2010 till Aug 2011) - £15,000;
  - Lachesis Pathfinder grant (Sep 2011 till Aug 2012) - £25,000.
- Futures Housing KTP (Oct 2010 - May 2012) - £90,000 total (60% TSB, 40% from company).
- JISC project with Nottingham University (Feb 2012 till Mar 2013) - £40,000.
- XAD Comms. KTP – from Apr 2012 (for 2 years) for £86,221, TSB (total £128,700).
- Roche Global - £85,000; first instalment of £25,000 received Jun 2012; followed by £30,000 received Mar 2013; followed by £30,000 received Oct 2013.
- Sino-UK Exchange (British Council) – travel grant of £36,000 for 2 years till Dec 2014 (from Jan 2013; decision was made in Nov 2012).

As part of developmental opportunities, each staff member is given a PC and tablet to support their work. From the 2011 DISYS budget, high-performance computing equipment was purchased to support research active staff, UG and PG/research students to conduct large-scale simulations and experiments. An additional £40,000 was invested by the SCM to install a dedicated private Cloud, which is used for both internal and external projects.

**e. Collaboration and contribution to the discipline or research base**

Our continuous outward-facing activity and growing reputation have led to increased invitations for collaboration and contribution to the field. Effort is devoted to Cloud computing, with an upwards trend evident with respect to IoT. A range of selected, indicative, key activities follows:

**Collaborative arrangements, partnerships, networks**

- Bessis arranged an Erasmus agreement with the CoreGrid lab, UASWS (2011/12).
- Bessis won a hosting award for research secondments in DISYS through UNITE, an EU mobility project (2011-13). Collaborative agreements have been signed with:
  - University Polytechnica of Bucharest (Pop), Ulster University (Deak) and Indiana University (Zelenkauskaite), who have visited and researched under DISYS supervision

on Cloud computing and IoT for 6 months in total.
    - Bessis, Sotiriadis and Asimakopoulou (visiting researcher) who went to University Polytechnica of Bucharest for 5 months in total.
- Liu arranged research collaborative agreements supporting the exchange of staff and research students with Tongji University and Jiangsu University (2012).

**Joint research projects**

- Day, Ma and Oikonomou attracted funding from i-Net; a collaboration with Queens Medical Centre, Nottingham University Hospital (2010).
- Voorhis and Dakin attracted KTP funding with Futures Housing Association (2010).
- Hill attracted funding from JISC, in collaboration with Nottingham University (2012).
- Anjum attracted funding with XAD Communications Ltd., from TSB for a KTP (2012).
- Liu and Antonopoulos attracted funding through the Sino-UK HE Research Partnerships for PhD Studies (Ministry of Education, China and Department of Business, Innovation and Skills, UK) (2013).

**Involvement in university research panels, or international research strategy boards**

- Anjum is a European Grid Infrastructure (EGI) Champion (2012).
- Antonopoulos and Bessis serve as mentors for newly appointed PhD supervisors.
- Bessis is a member of the peer review panel for non-collaborative external applications.

**Scholarly awards**

- Bessis was a visiting Professor in University of Seville (2009/10 and 2010/11) and received a best paper award from GDC-2009, INTERNET-2009 and IEEE INCoS-2012.
- Liu received a best paper award from RNEC-2008, and the outstanding leadership award of IEEE CPSCom-2013.

**Examination of doctorates**

- Anjum in Coventry University (2012) and Queens University of Belfast (2013).
- Antonopoulos in University of Essex (2009, 2010), Brunel University (2011), University of Plymouth (2012), University of West England (2012).
- Bessis in UASWS (2011), Brunel University (2011), Ulster University (2011), Aston University (2012), Glamorgan University (2012) and Greenwich University (2012).
- Hill in Royal Holloway, University of London (2011, 2012), Sheffield Hallam University (2013).
- Liu in Brunel University (2012).

**HEI examinations and professorships conferment panels**

- Bessis served as an HQAA (Greek QAA) expert evaluator for the Department of Applied Informatics & Multimedia, ATEI of Crete, Greece (2011).
- Bessis was a Professorships Conferment panel member for The Federal University of Technology, Nigeria (2011), ATEI of Kalamata, Greece (2011), University Polytechnica of Bucharest, Romania (2012) and ATEI of Crete, Greece (2012).

**Refereeing academic publications or research proposals**

- Bessis reviewed funding proposals for Leverhulme Trust (2012, 2013), Royal Society (2012) and ESRC (2013).
- Bessis reviewed more than 200 manuscripts submitted in international conferences and journals including the Journal of Parallel and Distributed Computing, Future Generation Computer Systems and IEEE Transactions on Systems, Man, and Cybernetics.
- Evans reviewed an EPSRC (2012) application for funding and reviewed more than 30 manuscripts submitted to international conferences and journals including Usenix/IFIP Middleware, IEEE PASSAT, PerSys, PETS, and IEEE Communications Letters.
- Liu reviewed an EPSRC proposal (2013) and more than 100 manuscripts submitted in international conferences and journals including IEEE Transactions, Philosophical Transactions of Royal Society, and Future Generation Computer Systems.
- Zhu reviewed several journal paper submissions including for the IEEE Transactions on Medical Imaging, Pattern Recognition, Computing, and Computational Intelligence.

**Organisation/chairing of international conferences, tracks and workshops**

- Angelopoulou chaired CEWE-2012, CEWE-2013 international workshops on Cybercrimes and Emerging Web Environments in conjunction with EIDWT.
- Anjum co-chaired (with Antonopoulos) the ITAAC-2011, ITAAC-2012 and ITAAC-2013 international workshops on Intelligent Techniques and Architectures for Autonomic Clouds in conjunction with IEEE/ACM UCC.

- Antonopoulos chaired the international conference series of Advances in P2P (2009-2012).
- Bessis co-chaired several international conferences including the INCoS-2010: Intelligent Networking and Collaborative Systems, PARELEC-2011: Parallel Computing in Electrical Engineering, CISIS-2011: Complex, Intelligent and Software Intensive Systems, ANT-2013: Ambient Systems, Networks & Technologies, EUSPN-2013: Emerging Ubiquitous Systems & Pervasive Networks. Since 2010, he is the founding chair for the CT: Collaborative Technologies and EIDWT: Emerging Intelligent Data and Web Technologies. He co-chaired several tracks in the areas of grids, clouds and IoT including for the IEEE CloudCom (2011) and IEEE AINA (2011).
- Hill was General Chair of ICCS2011: International Conference on Conceptual Structures (ICCS). He has organised the CINS-2010: International Workshop on Computational Intelligence in Networks and Systems in conjunction with INCoS.
- Liu co-chaired several international conferences on, including the IEEE CPSCom-2013: Cyber, Physical and Social Computing, IEEE HPCC-2013: High Performance Computing and Communications, CUTE-2013: Ubiquitous Information Technologies and Applications, IEEE iThings-2012, SKG-2012: Semantics, Knowledge and Grids. He co-chaired tracks for IEEE HPCC-2013, CUTE-2013, and IEEE iThings-2012. He co-chaired several international workshops including DSOC: Dependable Service-Oriented and Cloud computing (2010-12) in conjunction with HPCC and MWNS: Mobile and Wireless Network Security (2012) in conjunction with IEEE TrustCom.
- Smith co-chaired (with Hill) the OAWN-2012 international workshop on Opportunistic Ad-hoc Wireless Networks in conjunction with EIDWT.

**Editorial positions**

- Antonopoulos is founding co-Editor in Chief of the Journal of Cloud Computing: Advances, Systems and Applications, Associate Editor of the Journal of Peer-to-Peer Networking and Applications (Springer) and has edited two books on cloud computing (Springer), and Peer-to-Peer Networking (IGI Global).
- Bessis is the founding Editor-in-Chief (2010-current) of the International Journal of Distributed Systems and Technologies (IJDST) and an associate editor of the International Journal of Big Data Intelligence. Edited a special issue on IoT in the Concurrency and Computation: Practice and Experience, 8 conference proceedings and 8 books (4 Springer and 4 IGI titles). His latest books are in IoT and Big Data.
- Hill edited two books on Cloud computing (Springer).
- Liu is an associate editor of Peer-to-Peer Networking and Applications (Springer) and he edited 1 book and 3 special issues (Future Generation Computer Systems, Peer-to-Peer Networking and Applications and Distributed Sensor Networks). He is an editorial board member on the International Journals of Distributed Systems and Technologies, Advances in Internet Technology and Advances in Intelligent Systems.

**Invited keynotes and seminars**

- Anjum delivered 1 invited talk at the ICOSST-2012: International Conference on Open Source Systems and Technologies.
- Bessis delivered 4 keynote talks at the ARES-2010/CISIS-2010: 4th International Conference on Complex, Intelligent and Software Intensive Systems; ICADWT-2010: 3rd International Conference on the Applications of Digital Information and Web Technologies; NexTech-2010: 2nd International Conference on Advances in P2P Systems and, WCST-2011: World Congress on Sustainable Technologies.
- Evans delivered 2 workshop session seminars at the ESF IoT for Sustainability Workshop 2011 and RFID Europe 2009.

**TCP membership**

- Angelopoulou in: European Conference on Information Warfare and Security (2013) and International Conference on Cloud Security Management (2013).
- Bessis in: ACM Computer Systems and Technologies (2010-), IEEE/ACM Utility and Cloud Computing (2011-), Intelligent Distributed Computing (2011-), Cloud Computing and Services Science (2012-), IEEE CloudCom (2012), IEEE iThings (2012), FTRA Mobile, Ubiquitous & Intelligent Computing (2012-), IEEE CloudCom-Asia (2013).
- Evans in: International Workshops on Data Privacy Management (2009-), Privacy Management in Mobile Applications (2011), Model-Based and Policy-Based Engineering in Information

Security (2011), Foundations & Practice of Security (2011, 2012), International Conference on Networked Sensing Systems (2012), International Conference on Cyber, Physical and Social Computing (2013).

- Liu in: IEEE Connected Vehicles and Expo (2013), Euromicro PDP 2013, IEEE Computational Science and Engineering (2013), IEEE HPCC (2011), Fuzzy Systems and Knowledge Discovery (2010-12), and ComP2P 2008.

Table 1 and associated Figures 1 and 2 below, illustrate the collective outputs produced by SCM staff during their tenure in the School, over the REF2014 period (1st Jan - 31st Jul for 2013 only).

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 (7months) | Total |
|---|---|---|---|---|---|---|---|
| Book chapters | 0 | 0 | 1 | 8 | 4 | 5 | **18** |
| Conference/workshop papers | 18 | 30 | 25 | 51 | 54 | 36 | **214** |
| Books/Journal Special Issues edited | 0 | 0 | 0 | 10 | 13 | 14 | **37** |
| TCP memberships in conferences | 3 | 5 | 1 | 54 | 65 | 50 | **190** |
| Keynotes/invited talks | 2 | 6 | 3 | 8 | 4 | 9 | **32** |
| Research degrees completion | 0 | 0 | 1 | 3 | 4 | 5 | **13** |
| Res. degrees externally examined | 0 | 1 | 4 | 7 | 12 | 4 | **28** |

**Table 1. Summary of research outputs from 2008 to end of July 2013**

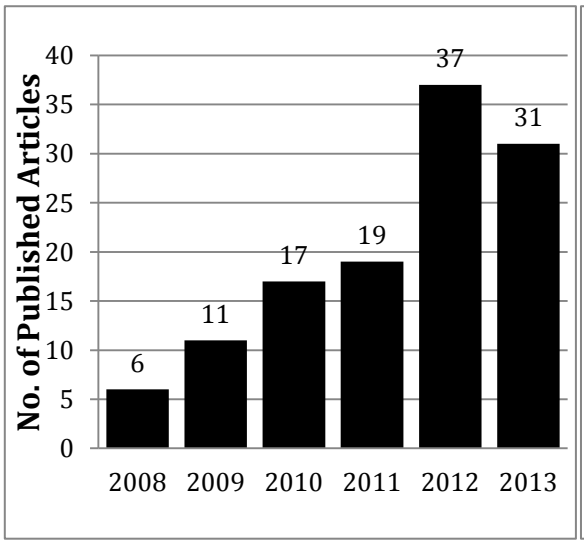


**Figure 1. Journal article outputs per annum**

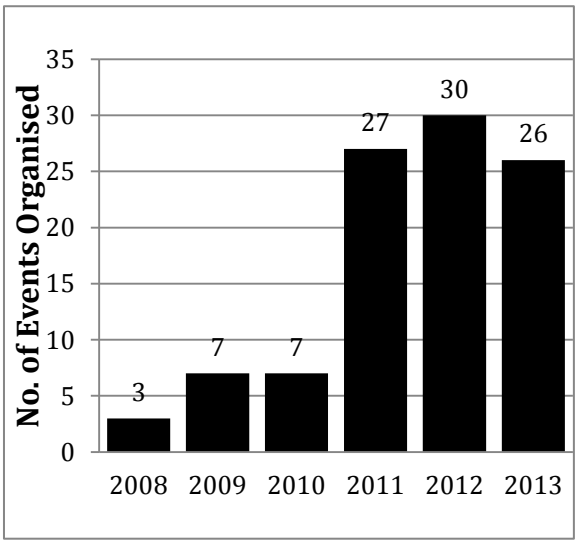


**Figure 2. Events organised per annum**

There are three specific measures to note. First, from a department (27 FTE) submitting to REF for the very first time, 44% of the staff have been included. Second, the volume of published research outputs has increased five-fold since 2008, whilst the headcount has increased by only 1 FTE. Third, the SCM's international research leadership through event organisation indicates the sustainability of these activities going forward.

The transformation that is evident has been achieved during the whole of REF2014 period, through continuous investment in, and development of, early-career and established academics.

For our School, the REF2014 legacy is a collection of holistic academics who value knowledge creation and dissemination equally, and are driven to achieve measurable impact upon society and the economy. The method for achieving this has been the relentless pursuit of a research culture that supports the development of staff and students, whilst directly engaging with industrial partners. This creates an environment that is conducive to sustainable, high quality research outputs and esteem that continue to grow, as evidenced by the figures presented above.