Institution: Swansea University
Unit of Assessment: 11 - Computer Science and Informatics
a. Overview

The Department of Computer Science at Swansea has three strong research groups. Theory has ten staff researching formal methods for designing systems. Visual Computing has eight staff in computer graphics, visualization and computer vision. Future Interaction Technologies (FIT) has four staff in medical and well-being HCI, bridging the digital divide, and mobile and ubiquitous HCI.

Theory	Arnold Beckmann, Ulrich Berger, Jens Blanck, Oliver Kullmann, Faron Moller, Peter Mosses, Markus Roggenbach, Monika Seisenberger, Anton Setzer, John Tucker.
Visual Computing	Daniel Archambault, Rita Borgo, Philip Grant, Mark Jones (MWJones), Robert Laramee, Benjamin Mora, Gary K. L. Tam, Xianghua Xie.
HCI – Future Interaction Technologies (FIT)	Parisa Eslambolchilar, Matt Jones (MJones), Stephen Lindsay, Harold Thimbleby.

The Department also houses the initiatives Research Institute of Visual Computing (RIVIC), Software Alliance Wales (SAW), Technocamps and High Performance Computing Wales (HPC Wales). The Department is part of the College of Science, established 2011, that adds value by streamlining administration and management to provide more time for academic research and acts as a platform for further multidisciplinary activity.

b. Research strategy

Our vision is to nurture and grow a dedicated community of computer scientists who pursue transformative research and believe that better computer science is vital in building a progressive world: socially, economically, culturally, philosophically and intellectually. We have created a research environment that embraces the breadth of the discipline, bringing together theoretical and experimental computer scientists to work on hard, ambitious, and exciting agendas. We focus on world-class excellence in each of our subareas and promote working together, to challenge each other's perceptions of what makes excellent computer science and to identify opportunities for collaboration. Our strategy aims to: (i) secure resources for research; (ii) facilitate research conduct; (iii) have substantial external influence; (iv) have a quality driven outlook; and (v) develop the next generation of computer scientists. The implementation of our strategy is aligned with the following processes:

- **Developing leaders**: We target early career researchers (ECRs) who have clear potential for world-leading work on subjects with impact and that are multidisciplinary in nature. Over the period we have hired 6 such ECRs. In addition, we will increase the number of externally funded projects, to further attract highly talented postgraduate research students (PGRs) and post-doctoral and other research assistants.
- **Funding speculative, entrepreneurial initiatives**: We provide funding and time for staff to make connections with other researchers and partner organisations worldwide. In the REF period this has included extended periods as visiting fellows within research arms of Nokia and IBM; international networking trips; attendance at Research Council agenda-setting workshops; participation at funding sandpits; and major initiatives relating to science and technology in Wales (e.g. Tucker is Founding Fellow and General Secretary of the Learned Society of Wales).
- **Supporting strong international community shaping:** We organise teaching and administrative duties and provide additional funding to support members of staff in major leadership roles along with memberships of scientific advisory boards, Research Council programme advisory bodies and other national and international bodies. In the REF period these included a Director of a Newton Institute programme in 2012 (Beckmann); from 2011 to 2014, the role of General Chair for ACM CHI 2014 (MJones); and, from 2012 to 2014, role of General Chair for Eurovis 2014 (Laramee) and all of the above-mentioned board roles.
- **Promoting discussion and understanding**: We seek outstanding researchers for our Distinguished Lecture Series. Since 2011, internationally eminent computer scientists have presented inspiring talks on grand challenges in Computer Science. Lecturers included Brian

Randell, Tom Rodden, Muffy Calder, Dame Wendy Hall, Simon Peyton Jones, Ben Shneiderman, Gregory Abowd, Martin Campbell-Kelly, Ross Anderson, Sir Alan Wilson, Bjarne Stroustrup, and Paul Curzon. We provide funding for group seminar series.

- **Building links within the Department**: We organise biannual research away-days to promote transparency and inclusivity by bringing together all research staff and students. We hold monthly lunches for networking and communication across the Department.
- **Interdisciplinary Collaboration**: We pursue opportunities for multidisciplinary work and have collaborated with criminologists, medics, architects, psychologists, historians, engineers, sport scientists, geographers, mathematicians, physicists, biologists, urban modellers and archaeologists. These have spanned leading institutions in the UK, Europe and globally (see e.).
- **External Stakeholder Engagement:** We actively seek leading industrial, governmental and non-governmental research partners. Many of our funded projects are grounded by such relationships, including: Microsoft Research (UK and India), Nokia Research (Finland), Invensys Rail (UK), Huwaei (China), B-Braun (UK), IBM Research (India) and the Home Office (UK). The Department has been selected as one of six research teams forming the BBC R&D User Experience Partnership that runs from July 2013 for 4 years.

We have two strategic drivers in operation as we look forward to 2020:

I. We aspire to **double in size**, taking our research staff complement to 40. We will strengthen our existing groups, and plan to introduce two new areas of research.

II. Our further ambition is to house our expanded range of activities within a purpose-built facility on the new **£250M Science and Innovation Campus**. This will take the form of a **£15M ICT Precinct** that will enhance our collaborations across disciplines and with industry, and provide us with high-end facilities and a corresponding environment.

Swansea had an effective and successful 2001 to 2008 strategy, strengthening our scientific work, strengthening our existing groups and introducing a completely new area (Human Computer Interaction, in the form of the Future Interaction Technology Lab) with social impact in mind. With these strong foundations, over the period 2008 to 2013, we have expanded our vision becoming increasingly multidisciplinary in outlook with enduring and growing external partnerships with criminologists, medics, architects, behavioural psychologists, historians, engineers, geographers, mathematicians, physicists, sport scientists, biologists, urban modellers and archaeologists (we have published with over 300 co-authors not in the UoA in this period, of those over 150 are international and over 100 are outside Computer Science). By following our strategies, we have recruited excellent new lecturers and substantially increased our external research grant capture, much of which is multidisciplinary. In total, our grant funding reported in RAE 2008 of £3.5M has now risen to £6.47M, an increase of 85%. We were 5th for RCUK income in 2011/12 (HESA).

As well as standard funded projects, we have also seen our research environment's sustainability underpinned through longer-term funded programmes including an **EPSRC Programme Grant for medical human computer interaction** (Thimbleby, MJones, Eslambolchilar, 2009–2015); substantial funding from the 5-year **Wales Research Institute of in Visual and Interactive Computing (RIVIC)** (Chen, MWJones, 2009–2013), and an **EPSRC Platform Grant for the FIT Lab** (MJones, Thimbleby, Eslambolchilar 2009–2014). Our aspiration to see Computer Science have a wider impact has substantially benefitted from two major Welsh Government and EU funded projects over the REF census period: **Software Alliance Wales (SAW)** (impacting on small and medium-sized enterprises); and **Technocamps** (leading to extensive engagement with 5,000+ schoolchildren in the region).

Taking our plans forward, we are now in a very strong position to see Swansea thrive as a beacon for what scientifically deep and rigorous Computer Science research can achieve when it integrates theoretical and experimental perspectives in a multidisciplinary and highly engaged fashion. Evidence to support this is shown in Section (e); in the outputs submitted for the current census period; and in our long-term commitment to impact, as described in the *Impact Statement*.

c. People, including:
I. Staffing strategy and staff development

Staffing strategy: In the REF period we focussed our efforts on expanding two of our groups, Visual Computing and HCI, whilst maintaining the largest group (Theory). We appointed 6 ECRs with strong scientific records: Arandjelovic, Archambault, Borgo and Tam in Visual Computing, Lindsay and Wilson in HCI; two of these have now moved on: (Arandjelovic to Australia, Wilson to Nottingham). Our continuous effort to promote personal development has been demonstrated by staff movements and promotions. The founder of our Visual Computing Group (Chen) left for a new Chair at Oxford and retains close links with us. An HCI lecturer (Buchanan) left for a post at City, and a Theory lecturer (Harman) transferred to a senior managerial post as Director of our Software Alliance Wales industrial engagement project. **In recognition of excellent staff performance** since RAE 2008, 11 of our staff have been **promoted** (1 to Chair, 2 to Readers, 7 to Associate Professors, 1 from Tutor to Lecturer) and 2 were appointed permanent faculty on completion of their 5-year research fellowships. All of our Category A staff are on permanent contracts, reflecting a commitment to underpinning and building long-term research trajectories.

Our staff and research students are located in the Faraday Tower, which has been refurbished to a high standard. The splendid location on our campus in Swansea Bay, with breath-taking coastal views from most of our offices and labs, contributes significantly to our wellbeing. We allocate space to focussed research collaboration (currently the FITlab, the PLanCompS project, and our Railway Verification group) and to our industry-facing unit, ITWales, to ensure their integration in the Department. To facilitate interaction and strengthen collegiality, all of our corridors accommodate academic staff from all three research groups. It is also part of our strategy for research students and research staff to be mixed together in labs and offices, and to make sure they have easy access to their supervisors and principal investigators.

Career development support: We maintain high levels of personal support for both intellectual and career development, through mentoring systems, research groups, and University courses. For example, we help each other with grant applications, and provide significant funding for curiosity driven conference and research collaboration visits beyond those supported by specific projects (approx. £2K p.a. for each member of academic staff, £500 p.a. for research students). The most important support for research we offer is time which is reflected in our TRAC return that shows we spent between 56% and 62% time on research annually during the period. We have 24 permanent lecturers, 1 tutor and 287 FTE students (July 2013) (11.5 Staff/Student Ratio (SSR)); this places us well above the upper quartile SSR of 14.2 in the UK (Guardian University Guide, May 2013) and above half of the Russell Group universities. This results in a reduced teaching and administrative load for research active staff, in order to boost individual research performance, group activities and research grant capture. ECRs have light loads to start with (1 module p.a., no heavy administration duties), departmental funding for equipment, conferences and research visits, and considerable personal support. In 2012 Swansea University won both a Times Higher Leadership and Management Award and a Universities Human Resources (UHR) Excellence award for its Performance Enabling programme.

In addition to the lower teaching and administrative loads that provide thinking space for staff research, over the REF period we have operated two mechanisms for granting longer, sabbatical-style leave with greater flexibility than the University's traditional year-long Sabbatical Scheme. First, we encourage academic staff to take 1–12 months of research leave when the need for it arises, with their teaching and administrative obligations covered by colleagues: examples have included a six month period at the Newton Institute; extended periods at Nokia Research Finland; two year-long research leaves; and lab tours in USA and China. Second, the College of Science (of which the Department is a part) has a Research Leave scheme: staff apply to the College Research Committee for periods of up to six months.

As noted in Section (b), our strategy includes a focus on integrative, impact-engaged work that develops leaders. Researchers from Swansea have gone on to take senior software engineering or research roles in the US at Apple, Google, Disney and Skype in the period.

Concordat to support career development of researchers: The University is fully committed to the implementation of the 2008 Concordat. It was one of the second tranche of HEIs to be awarded the European HR Excellence in Research badge, and it is actively involved in the Vitae network, having had a representative on the regional steering group until the spring of 2012. Results of CROS (Careers in Research Online Survey) and PIRLS (Principal Investigators and Research Leaders Survey) in 2009 and 2011, reveal that activities undertaken for research staff have been effective, with our staff feeling better supported, more valued, and more engaged than the national trend. Our staff are encouraged to take advantage of the many developmental opportunities offered to them, such as the Bridging the Gaps and Building Global Engagements programmes.

Personal research fellowships: Thimbleby won a Royal Society Leverhulme Trust Senior Research Fellowship in 2008. Other staff have been appointed to fully-funded research fellowship posts, free of teaching obligations: Blanck completed a 3-year Wales Institute of Mathematical and Computational Sciences Fellowship in 2012, and Xie completed a 5-year RCUK Fellowship in 2012. In addition, Mora obtained 100% ESPRC research funding for a year (2010–2011).

International appointments and current scholars: The Department has always attracted significant numbers of international applicants to its academic openings, which are widely advertised. Our current 24 academic staff include colleagues from Canada (2), France (1), Germany (6), Hong Kong (1), Iran (1), Italy (1), Sweden (1), and USA (1). In the REF period over 100 collaborators from overseas have visited us (examples in Section (e)).

Equality and diversity: Swansea University is a charter member of Athena Swan, securing the Bronze Award in 2009 – an initiative led by Computer Science and chaired by Tucker. A Strategic Equality Plan helps to deliver the University's inclusivity ambitions. Computer Science staff take advantage of onsite nursery facilities and participate in the University's Childcare Voucher Scheme. All vacancies are advertised as suitable for job share, part-time or flexible working. The University's Flexible Working Policy applies to all staff.

c. II. Research students

PGR recruitment: Ratio of PGR FTE to academic staff FTE for the last four years has risen from 1.2 PGRs in 2008/09 to 1.8 PGRs in 2011/12. This is well above the sector upper quartile figure of 1.6 PGRs per academic in 2011/12. Our TRAC data shows we spend between 13% and 17% of our time on supervision of PGR students. We take a traditional view of recruitment, matching student interest and supervisor expertise, seeking committed students who want to make a difference to the discipline. We follow conventional recruitment avenues, such as public announcements and our extensive international networks (e.g. successful PhD candidate Fredrik Forsberg came here through our strong research connections with Uppsala). We have been successful in winning University-funded PhD studentships, particularly multidisciplinary ones, and in attracting industrial sponsorship (e.g. Microsoft, Invensys Rail).

Training and support mechanisms: Swansea's Graduate and Academic and Professional Enhancement Centres provide a comprehensive skills development programme for research students covering all the areas identified in the Vitae Research Development Framework. Students are encouraged to undertake training, and are given (optional) opportunities to experience teaching and other academic activities in the Department. Some of our research students have attended "Entrepreneurial" training workshops funded by EPSRC and run by the University's Department of Research and Innovation (DRI). Our students attend group away-days, and several established seminar series, including regular seminars via video conferencing (together with Bath University). Seminars attract talks from other disciplines where multidisciplinary research takes place (Engineering, Humanities, Medical, Biosciences, Geography, History, Psychology). We fund students to attend summer schools (e.g. Marktoberdorf and EPSRC/BMVA Summer School on Computer Vision) and conferences (e.g. Eurovis, for publication presentation, BCTCS). Swansea (through RIVIC) has played a central role in the annual Visual Computing (VC) graduate school where students participate alongside international VC researchers, presenting their own work. We have facilitated student research visits to world leading institutions (e.g. LMU (Munich), Utah, Fudan Shanghai, Cambridge, Pennsylvania), industry (e.g. Microsoft, IBM, Nokia) and government bodies (e.g. US Food and Drug Administration). This is demonstrated by the frequency of international co-authors on research student papers. Our support extends to conference

attendance by MRes students (e.g. an MRes student presented and won the Best Paper award at Eurovis 2009). Some of our research students have had internships (e.g. two students went for several months to pursue research at IBM Research India).

Progress monitoring: We follow conventional procedures, such as double supervision, progress monitoring via our Department Research and College Committees, pastoral support, and career development. Our quality processes have set the agenda across the university, with Moller appointed Dean of the University Postgraduate Research Faculty (2007–2010).

d. Income, infrastructure and facilities

Research funding portfolio: We secure significant funding to support our operations. Our ratio of research grants and contracts income per academic FTE over the last four years has almost doubled, taking us from £36,600 in 2008/9 to £62,900 in 2011/12. We are positioned well above the sector upper quartile figure of £52,370 in 2011/12. We were 5th for RCUK income in 2011/12. Grants from sources such as HEFCW and ESF are not included in the REF4 data, but they give us significant resources and are included in this Section. Grants and consultancy contracts with a total budget of **£17.6M** have been awarded since 1/1/2008. Our funding sources include: EPSRC, HEFCW, ESF, Royal Society, Welsh Government (WG), MOD, NISCHR and companies such as: Microsoft (for mobile interaction design work), Sigma (for Visualisation for Business Information Systems), Invensys (railway safety), Grid-tools (software testing and visualization) and EADS (network security and visualization). The variety and scale of funded projects and companies involved provide a stream of research opportunities for staff, students and researchers as well as funding equipment and infrastructure. Some of the awarded grants continue beyond the REF census date and grants awarded prior to the start date that were still active in the period are not included in the £17.6M figure. Only money awarded for Computer Science at Swansea is included.

Grants over £500K: Each of the three groups contributes large grants that provide focal areas of research activity that are closely matched to the current research directions of the UoA. Thimbleby (£745K), EPSRC: *Formally based tools for use interface analysis design*; Chen/MWJones (£1.2M Swansea element), HEFCW: *The Wales Institute of Visual Computing*; Williams/Harman (£503K), ESF: *Go Wales*; Williams/Harman (£4.26M), ESF: *Software Alliance Wales*; Chen (£667K), EPSRC: *Illuminating the Path of Video Visualization*; Thimbleby (£1.77M), EPSRC: *Chi+Med: Multidisciplinary Computer-Human Interaction Research for the Design and Safe Use of Interactive Medical Device*s; Williams/Moller (£1.9M), ESF: *Technocamps*; Moller (£752K), ESF: *FD in Computer Science*; MJones (£552K), EPSRC: *Scaling the Rural Enterprise*; and Mosses (£854K), EPSRC: *PLanCompS: Programming Language Components and Specifications*. Thimbleby is PI (Tucker co-I) on £790K, EPSRC *Bridging the Gaps* portfolio designed to encourage and support multidisciplinary research in the University (hence not included in the departmental total above).

We explore other funding sources, with a recent success from Leverhulme and EU, and pending applications with ERC, BBSRC (cross-discipline work). We will continue to target EPSRC as our main source following on from recent successes and seek to increase industrial research funding.

Infrastructure and facilities: Our Department includes 638m2 of recently refurbished research lab space, including the FITlab, which has specialist equipment such as Phidgets, custom built Sensor Hardware Accessory for Kinesthetic Expression (SHAKEs), Arduinos and sensors, pico-projectors, various iOS and Android devices, and medical equipment such as infusion pumps for usability testing and HCI experiments. The Visual Computing group has a Xeon Phi mini-supercomputer with 260 cores, a Makerbot 3D printer and a biometric laboratory (4D facial capture camera, Point Grey Gazelle high speed video cameras (280fps, 2038x1088px), kinects, multiple video and still cameras). Our laboratories and equipment are supported by 2 technical staff adjacent to the main research laboratory. Awarded grants in period have provided equipment and consumables with a budget of **£209K**. Additional equipment purchases are made from QR and university funding.

In addition to the above and traditional computing research laboratories and equipment (frequently upgraded desktop PCs, projectors, mobile hardware, GPUs), much of our research is “in the wild”. In this REF period we have, for example, carried out mobile experimental research embedded in communities in India, physical activity research over 10 weeks in Bristol and Merthyr Tydfil and created installations in publically accessible places (e.g. Wales Botanical Gardens). The Visual

Computing group has carried out experiments at Terry Griffiths Matchroom, at the Tang Soo Do world championships, Welsh Rugby Union's (WRU) world-class indoor training centre and by invitation to the WRU box at the Millennium Stadium during international rugby tournaments. The CHI+MED group works with NHS Abertawe Bro Morgannwg University (ABMU) Health Board and infusion pump manufacturers B-Braun.

Facilities through collaboration: Collaborations with renowned international labs and universities (e.g. Purdue and Intel's VC lab) allow us to enlarge our research fields and to harness cutting-edge technologies like the Perspecta Display (Purdue). Closer to home, our multidisciplinary research has used facilities across campus such as Engineering's Nikon X-ray and CT inspection device, Medical School's 3 Tesla MRI scanner, Sports Science motion capture laboratory, Psychology's facial motion capture, Biosciences bespoke animal tags (used for data collection all over the world). MWJones is involved with Biology on the £393K Wolfson Laboratory Refurbishment Grant to create new processes for analysing and visualising biological data.

High Performance Computing: HPC Swansea is a programme created and coordinated by Tucker to expand research in calculation, simulation and exploration of big data in science, engineering and medicine across the University. The programme has recently acquired: an IBM System DataPlex (£500K funded by the University); an IBM Analytics at £1M; a Fujitsu at £6M funded by HPC Wales Ltd; and two dedicated support staff. Computer Science is currently training 90+ people per year in HPC.

New campus development: We are in the early planning stages for a new Computer Science led research and industrial innovation precinct to be situated on the University's new innovation campus. This **£15M ICT Precinct** is envisioned to accommodate all our research staff and associated projects in an environment that will include purpose built high end laboratory spaces for human motion and emotion tracking, immersive performative user experience design, physical, embedded and tangible computing and additional areas.

Impact on Environment: All researchers in the Department enjoy access to world-class equipment and facilities. These are provided by our large income in the period (RCUK, Industry, European and Welsh Government), through international collaboration, through multidisciplinary research and because we research "in the wild" within communities or with partners who themselves have world-class facilities (e.g. the WRU indoor training ground).

e. Collaboration and contribution to the discipline or research base

Overview: Members of the Department are highly collaborative and multidisciplinary. Since 2008, we have over 300 co-authors that are external to this UoA, including: over 150 international; over 100 outside Computer Science; and over 20 industrial/clinical. As noted in Section (b), this success has been a function of our strategy and support for these ways of working. In terms of broad impact on the discipline, since 2008 our researchers have published over 400 articles, many of which appear in the top destinations for our respective areas (e.g. IEEE, ACM Transactions). Staff lead key journals (e.g. Journal of Logic and Algebraic Programming) and conferences (e.g. ACM CHI) and actively shape the community through advisory board memberships (e.g. EPSRC SAT).

Exemplars of research collaborations (with academic, industry and other bodies) and interdisciplinary research across research groups:

Visual Computing: MWJones and Laramee with Biologists (Swansea – Wilson, Sheppard) and researchers from Delft (Post, Botha, Blaas) introduced novel data visualization and data analysis approaches for accelerometry data from animal behaviour data tags. Work has been reported online by NewScientist and other websites and achieved the best paper award at Eurovis 2009, and is being integrated into software by company Grid-Tools. MWJones and Laramee have also worked with flow engineers (Swansea – Croft, Malki, Masters) and researchers from Oregon (Chen, Zhang) and Utah (Hansen) on visualisation techniques for flow visualisation and streamline analysis. Mora has collaborated on advanced 3D displays and rendering with Purdue (Ebert, Maciejewski) and Intel (Wald). Tam, Borgo and Grant have collaborated with psychologists from Korean University (Wallraven) and Brandenburgische Technische Universität Cottbus (Cunningham) on visualization of natural image statistics. Borgo has worked on ice sheet

visualisation with Geographers (Scharrer, Murray) and other visualisation techniques with psychologists (Reppa, Thornton) and researchers from Stuttgart (Hoferlin, Weiskopf). Xie collaborates with computational engineers (Nithiarasu, van Loon, Sazonov) and clinicians at Morriston (Smith), Bristol (Hall), Plymouth (Roobottom, coronary) and Wolverhampton NHS hospitals (Cotton, Heyman) on medical applications, including heart functional assessment, coronary disease modelling, valve assessment, and aorta valve implantation. Xie's other collaborative work includes deformable modelling (Bristol, MFLU in Thailand), dynamic texture analysis (UJI in Spain), and efficient 3D pose estimation and tracking (Aberystwyth). The entire Visual Computing group has collaborated as part of the Welsh Institute of Visual Computing (RIVIC), and have jointly organised an annual Visual Computing graduate school (2009–2013) attracting international visual computing speakers and visitors to Swansea (e.g. Ertl, Ebert, Kobbelt, and many others). Industrial needs have driven research, e.g. a vast data mining exercise has been undertaken for the Welsh Rugby Union (WRU), and new ways of visualising and interacting with their data have been published by MWJones and Laramee along with a sports scientist (Griffiths) and head of performance analysis at WRU (Long).

Future Interaction Technology Lab: Much of the work of the FIT Lab has been embedded in the Grand Challenges faced by society and real end-users. The CHI+MED (Computer-Human Interaction for Medical Devices) EPSRC Programme Grant with UCL, Queen Mary University of London and City University, with industrial and NHS collaborators pursues integrative research in CS, psychology, life sciences and engineering. International collaborators on this grant include Georgia Tech, Maryland and Texas A&M. We have developed mathematical and formal analysis of interfaces (Thimbleby); continuous and dynamic interaction (Eslambolchilar); and ubiquitous contexts (MJones). Further health and well-being work has seen Eslambolchilar collaborate with social scientists (at Kingston University) and engineers (at Swansea) to consider persuasive technology methods. Lindsay's work with healthcare researchers (Swansea and Newcastle) focuses on developing novel technologies for older adults' healthcare needs and approaches to engaging people living with cognitive impairment in the participatory design of digital technologies. We have helped develop the research base of Human Computer Interaction for Development (HCI4D) in the UK and internationally addressing issues of "digital divide". We collaborate with academic partners (in sociology, product design groups and economics) in India, South Africa and UK and industrial research groups in Microsoft Research (Bangalore); IBM Research (India) and Nokia Research (India); and, the Ordnance Survey. The group also has an excellent track record in exploring novel interactions in challenging "wild" contexts through mobile and ubiquitous technologies involving geographers (Nottingham), computer scientists (Glasgow), criminologists (UCL), management psychologists (Bath) and build environment specialists (Kent).

Theoretical Computer Science: We have internationally leading collaborations in the following areas. In Computability, Tucker, with Zucker (McMaster), focuses on computing with continuous data. Tucker, with Beggs (Swansea Mathematics) and Costa (Lisbon) has invented a theory of computable measurements. Berger, Blanck, Seisenberger and Tucker collaborate on computable analysis as part of the EU FP7 project COMPUTAL with 12 research institutions across 3 continents. In Specification, Mosses leads the EPSRC PLanCompS project with Royal Holloway, City and Microsoft Research Cambridge to develop a novel component-based framework of programming languages. Roggenbach combines algebraic specification with data and processes for modelling and testing of jet engines with Rolls-Royce and electronic payment systems with Zuhlke, Zurich and Six Card Solutions, Hamburg. In Proof Theory, Berger and Seisenberger developed a new style of program extraction, enabling the synthesis and verification of new algorithms from coinductive proofs. In the EU FP7 project CORCON (Correctness by Construction) they collaborate (together with Blanck, Setzer) with 16 institutions across 4 continents. Beckmann, in collaboration with Aehlig (now Google Munich) and Buss (UCSD), develops new search problem classes relevant for computational complexity, using his Dynamic Ordinals. In Verification and Satisfiability, Beckmann, with Pudlak and Thapen (Czech Academy of Science), connects open problems about the complexity of model checking for powerful verification languages to open problems about SAT solving. Kullmann implements his new SAT solving paradigm "Cube and Conquer" in collaboration with Biere (Johannes Kepler University in Linz, Austria), Heule (University of Texas at Austin, USA), and Wieringa (Aalto University, Finland). The industrial needs of railway networks has driven the research agendas of the Swansea Railway Verification Group

(Moller, Roggenbach, Seisenberger, Setzer) with Romanovsky (Newcastle University), Isobe (AIST, Japan), Schneider and Treharne (Surrey University), Nga (Nottingham) and Invensys, developing new formal methods for railway safety and capacity improvement.

Leadership

Advisory Board Membership and Other Strategic Leadership Roles: MJones is a member of the EPSRC Strategic Advisory Team; and the RCUK Digital Economy Programme Advisory Board. MJones was a Visiting Fellow at Nokia Research and appointed to their Scientific Advisory Board. MJones has been a mentor on an RCUK Sandpit and has facilitated further sandpits in Mexico and Finland. Moller is Chair of BCS Academy Research Committee and expert advisor to Welsh Government's National Digital Learning Council; a member of the Welsh Government's ICT Steering Group; and a member of the Welsh Assembly Cross Party Group on Science and Technology. Thimbleby is on the Board of NHS Connecting for Health initiative; and on the ICT Spend Overview & Scrutiny Board (reporting to Cabinet Office). Tucker was a member of the Welsh Assembly Cross Party Group on Science and Technology (2007-11) (now Moller). Tucker is General Secretary of the Learned Society of Wales (LSW).

Conference and Workshop Organisation: In 2011 MJones was appointed co-Chair of ACM CHI 2014. He served as the Chair of the Mobile HCI Conference Steering Committee (2010–2011). Laramee was appointed in 2012 to Co-Chair Eurovis 2014 at Swansea. Xie was Chair of Medical Image Understanding and Analysis 2012 at Swansea. Blanck and Tucker co-organised Physics and Computation 2012 at Swansea. Beckmann was co-organiser of Computability in Europe (CiE) 2012, Cambridge and 2008 (as co-PC), Athens; Logical Approaches to Barriers in Computing and Complexity, 2010, Greifswald (also PC). Berger was co-organiser of British Logic Colloquium 2009, Program Extraction and Constructive Proof 2010 (Brno), Domains 2011, Continuity, Computability, Constructivity 2013. Kullmann co-organised and PC for Satisfiability 2009 at Swansea. Moller has been President of the British Colloquium for Theoretical Computer Science since 2004.

Invited Keynote and Plenary Talks: The Department has presented more than 100 invited talks at Dagstuhls, conferences and international workshops. For example, Thimbleby gave 7 published conference keynotes (e.g. IEEE International Conference in Healthcare Informatics, Philadelphia, 2013) and 17 unpublished conference keynotes; and MJones keynoted at Nokia's global UX conference (Helsinki, 2009), and Ambient Intelligence (Salzburg, 2009).

Fellowships of Learned Societies: Four staff are FBCS. Moller is a Fellow of the IMA. In the REF period, Thimbleby (already Fellow of the IET, Honorary life fellow of the RSA) was elected Fellow of the Learned Society of Wales, Royal College of Physicians (Edinburgh) and honorary Fellow of the Royal College of Physicians. Tucker is a Member of Academia Europaea and a founding fellow of the Learned Society of Wales formed in 2010.

Journal Editorships: Beckmann is on the editorial board of the Archive for Mathematical Logic and Computability. MJones is an Editor of Personal Ubiquitous Computing. Kullman is Editor-in-Chief of Journal on Satisfiability Boolean Modelling and Computation. Mosses is on the editorial board of Science of Computer Programming. Thimbleby is on editorial boards of Interacting with Computers, Science of Interaction, Personal and Ubiquitous Computing and The Journal of Designing in China. Setzer is a member of the editorial board of Logical Methods in Computer Science. Tucker is Editor of the Journal of Logic and Algebraic Programming (Berger is also a board member) and a member of editorial boards of: Science of Computer Programming, Journal of Applied Logic, Formal Aspects of Computing. Xie is a member of the editorial board of the IET Journal of Computer Vision.

Special Issues: Staff have edited/co-edited more than 20 special issues of journals, such as ACM TOCHI, IEEE CG&A, Journal of Logic and Computation and Annals of Pure and Applied Logic.

Awards and Prizes: MWJones won Best Paper at Eurographics 2013; MWJones & Laramee won Best Paper at EuroVis 2009. Eslambolchilar and MJones won a Best Paper award at Mobile HCI 2009. Grant won Best Paper at Eurovis 2008. Lindsay won a Best Paper award at ACM CHI 2012. Thimbleby won 4 prizes including a Best Paper award at ACM CHI 2013. Kullmann won Best Paper at HVC 2011 and SOFSEM 2013. In 2010, MJones was awarded an IBM Research Faculty Award to work with the Spoken Web Group (Delhi) on access solutions for users with low computer literacies, and a 5-year Royal Society Wolfson Research Merit Award, commencing January 2014.