

Institution: Swansea University
Unit of Assessment: 11 Computer Science and Informatics
<p>1. Unit context and structure, research, and impact strategy</p> <p>OVERVIEW</p> <p>Computer Science is a thriving academic community conducting distinctive cutting-edge research across Theory, Human Computer Interaction, Visual Computing and Security. We have grown our category A headcount from 22 (REF2014) to 33. We have 15 early career research (ECR) staff that took up their first posts as independent researchers with Swansea since 2016. We provide an environment that develops, shapes, and promotes ECRs, and we regard this as a great strength of our department at Swansea. Our strategic environment building projects – Computational Foundry, Centre for Doctoral Training (CDT), and Challenging Human Environments and Research Impact for a Sustainable and Healthy Digital Economy (CHERISH-DE), promote our ambitions to encourage ECRs to become future leaders, place Computer Science at the heart of a truly multidisciplinary digital landscape, and promote responsible research.</p> <p>REF2014 STRATEGIC DRIVERS</p> <p>A review of our two key strategic drivers, defined in REF2014 for 2014 to 2020:</p> <p>To achieve significant growth:</p> <p>We achieved significant growth taking our research-enhanced staff to 33 members (from 22), launched a new security group, strengthened all groups, and particularly developed our Machine Learning/AI capability within Visual Computing. With new tutors and teaching-enhanced posts, we doubled our academic staff since 2014.</p> <p>To deliver a purpose-built facility for our research:</p> <p>The £31M Computational Foundry project provides a transformative environment for our research, centred around the theme of Securing, Sustaining and Enhancing Life. It fulfils our ambition to be a global beacon for computing in Wales. Through establishing a national and international leadership role, we are transforming the meaning of what it is to be a Computer Science department in the 21st century.</p> <p>Beginning as a vision to drive forward computational research and make Wales a global destination for computational scientists, industrial and public service partners, the Computational Foundry Project received backing from Welsh Government (WG) policy makers who provided vital support to bid for £31M of combined funds and grants from the EU (ERDF), HEFCW and Swansea University. The project delivered the Computational Foundry building at the heart of the new Swansea Bay campus, housing Computer Science and Mathematics in a unified, <i>custom designed</i> environment. The project provides a comprehensive programme of R&D, cross-discipline research, visiting scholars and industrial outreach and partnerships, which are central to our ambition for Wales to have a global presence for computational thinking. <i>All</i> the deliverables for this EU project are research-based.</p>

The Computational Foundry has an international calibration committee which includes in its membership, **Vint Cerf** (father of the internet), **Vicki Hanson** (CEO ACM) and **Ben Schneiderman** (founder of HCI). This committee was established especially to nurture our CDT.



Photograph: Our Computational Foundry

UNIT STRUCTURE

We grew our CatA academic research staff by 50% since REF 2014. 13 staff were promoted, and 17 new CatA staff have been hired on permanent contracts. Staff identify with a primary research group and may associate with other groups or themes. The primary research groups are:

- **Theory** with eleven staff researching fundamental questions and formal methods for designing systems
- **Visual Computing** (VC) with eight in computer graphics, visualization, machine learning and computer vision
- **Future Interaction Technologies** (FIT) with ten in medical and well-being HCI, bridging the digital divide, and mobile and ubiquitous HCI
- **Security** with four working in trust, IoT security and privacy, mobile apps security, and network security.

IMPACT

We are outward-facing researchers, working in partnership, to deliver global impact and change such as edge computing in India and Africa, driving safe and secure medical device policies (US Food and Drug Administration (FDA)), enhancing safety and capabilities of rail networks, and transforming the educational agenda and curricula for Computer Science and STEM subjects (see our three impact case studies).

We deliver value to four types of non-academic beneficiaries:

Large companies: Engineers in international companies and organisations such as Microsoft, IBM, Siemens Rail, Tata Steel, Intel Security, DVLA, Facebook, Google and BBC R&D.

SMEs and microbusinesses: Owners and staff of small businesses engaged with us through our industrial support mechanisms, such as QPC (Innovate UK award).

Public and third sectors: Practitioners, policy advisors, civil servants, and politicians in areas including health (safe medical HCI); education (STEM curricula for Wales' new School Curriculum for 8-16 year-olds; professional development of teachers; engaging with 5-19 year-olds); regeneration (spatially-aware computing for regeneration and heritage); civil society and public debate (digital divide, rural and edge computing in India and Africa); and social and cultural change (history of ICT and its local impact, and exhibitions).

Public: Through the users of products and services that benefit from our work (e.g., on safer HCI, rural and edge computing, mobile phone security and rail transport); through our large-scale outreach and engagement activities; and the increasing number and quality of computer scientists going out into the world where we have doubled our undergraduate students.

Thus, our research has led to economic, health, educational and societal impacts, nationally and internationally.

Civic Mission: Our civic mission flourishes with activities such as supporting the **Swansea Bay City Deal**, establishing the **History of Computing Collection** and the **Hafod-Morfa Copperworks** heritage site, **education** reform and delivery through **Technocamps**, and public outreach including soapbox science, rail integrity exhibit at Didcot, public events on the scientific development of computing, and exhibitions in the University's town centre Oriol Science. Computer Science (Moller and Tucker) leads the creation and development of the new College of Science outreach centre, **CoSMOS**.

RESEARCH STRATEGY

Our papers, projects and their impact are evidence that our research strategy is effective. Our research ethos informs our research strategy. All staff feed into the research strategy through our culture of engagement and working together (see Section 2). The Head of Department, Computational Foundry Director, Head of Research and Head of College develop the business plan to determine size and how to target appointments to achieve financial sustainability. We seek to achieve growth either by appointing at Chair/Associate Professor level for new research impetus (Dix) and direction (Wyner) or ECR level to grow existing groups where there is existing support structures and critical mass. The ECRs of the 2001-2008 RAE are the current major grant holders and in positions of responsibility throughout the department, college, and University (including Head of Department (Beckmann), research director (Roggenbach) and Head of College (MJones)). These leaders encourage and develop the new generation of ECRs with the aim for them to assume leadership roles in the future. Our 15 ECRs are a cohort of bright, energetic individuals to sustain the department through the next decades.

Ethos

We provide a culture designed to give staff the **freedom to pursue their curiosity-driven, intellectually stimulating research** while building the scale and positive impact that Computer Science has for creating a responsible and progressive world: socially, economically, culturally, philosophically, and intellectually.

Research strategy

Our strategy is:

- (a) attract and retain excellent staff;
- (b) help staff fulfil their potential;
- (c) achieve scale and reach with research that will have transformational and lasting impact;
- (d) facilitate quality research that has external influence;
- (e) develop our physical environment.

To realise that strategy we take the following actions.

Developing future leaders: We target ECRs who have clear potential for world-leading work on subjects with impact and which are often multidisciplinary in nature. We have processes to develop ECRs (see staff section). Over the period we attracted 15 ECRs. Four of our promotions to chair were ECRs at Swansea at the start of their careers. CHERISH-DE Swansea runs the UK-wide DE-Crucible which provides leadership and developed a dynamic network of over one hundred ECRs from 35 universities. The programme helps young academics to develop strong networks for collaboration and peer support and challenges these future leaders to become collaborative 'outward facing' researchers. Thimbleby and Tucker are heavily involved with the *Welsh Crucible* which has a similar remit.

Interdisciplinary research: We actively seek opportunities for multidisciplinary work and have collaborated with criminologists, lawyers, medics, architects, psychologists, historians, engineers, sport scientists, geographers, mathematicians, physicists, biologists, urban modellers, linguists, and archaeologists. These have spanned leading institutions in the UK, Europe and globally (see maps in Section 4). We commenced appointments that bridge subjects and research areas. Wyner is a joint appointment with Swansea's Hillary Rodham Clinton School of Law, and Crick with Education. Recent ECR appointments bridge research areas, Fan and Wyner link Theory to Machine Learning, Archambault, Visual Computing (VC) to HCI, Deng links VC to Security, James links Theory to Security. For the EPSRC Trust Identity Privacy Security (TIPS) grant, the Theory, Security and Visual Computing groups work together to solve issues in the TIPS area.

Supporting each other: We have mature support mechanisms for our staff development with many networking and communication events across the department from ECR to senior staff. See Section 2.

Department Sponsored Scholarly Activities: Our Distinguished Lecture Series has evolved into the Founding the Foundry Talk Series and the more recently inaugurated international seminar series. We have attracted internationally eminent computer scientists including Scott Jenson, Ben Shneiderman, Jenny Preece, Moshe Vardi, Susan Dray, David Siegel, Delaram Kahrobaei, Tim Kindberg, Richard Harper. Many speakers undertake a research in residence programme to engage and collaborate with our staff. Each research group organises events open to all staff such as the Visible Lunch, Computer Vision talks, Theory talks, and research visits.

Open Research Environment: All research staff have ORCIDiDs and a Google Scholar or Academia.edu page (ECRs are directed to obtain these as part of induction). As is natural to Computer Scientists, we were early adopters of informal open publishing models (author manuscripts on academic personal web pages or repositories (e.g., ResearchGate, arXiv)). All groups have papers that appear in open journals (e.g., PeerJ, Movement Ecology, IEEE

Access) and have gold open access publications. Moving forward, our priority and policy is that **all** accepted manuscripts (whether they are anticipated to be used as REF outputs or not) are uploaded to Cronfa (Swansea University's institutional repository) with appropriate embargo date. We are supportive and wish to fully comply with the spirit of the **EU Plan S open access agenda**. Mosses (prior to retirement) and MWJones championed the development of Swansea's RIS/Cronfa institutional repository. Tucker, as member of the Academia Europaea UK Hub, organised a workshop in Swansea on Science for Policy: A European Perspective (part of the Academia Europaea's contribution to the major project SAPEA). Researchers from across the groups are enabling reproducible results by publishing source code (e.g., on GitHub) and providing all code required to reproduce figures in publications. Theory, Visual Computing and HCI have all released open data sets and software that are utilised by other researchers. **Increasingly all researchers engage with providing open and reproducible experiments.**

Research Integrity: Dix has been recognised for establishing this area in HCI, winning best paper at CHI 2018 for his advocacy of pre-registration of methodological user studies. We follow comprehensive risk-assessment and ethics approval procedures with full record keeping at the level of College of Science which were developed in Computer Science (by Borgo, Laramée, Pearson, Robinson, Xie). All staff undertake mandatory research ethics and integrity training.

Evolving our Funding Strategy: Economic development, education, and health in Wales is devolved to the Welsh Government (WG). The WG's policies and incentives, including HEFCW funding, steer the strategic development of Swansea University and has encouraged us to create and lead innovative pan-Wales projects that shape and build national computing capability and support the Welsh Knowledge Economy, through the help of WG and EU funds. These add to and support our portfolio of UKRI funding. We have opportunistically taken advantage of European structural funds which have had a transformational impact on our environment as demonstrated by the Computational Foundry and other projects. Excluding the Computational Foundry, EU funding made up 13.8% of our research funds so we are well placed compared with other departments going beyond Brexit. Replacement infrastructure funds from WG and Westminster sources have been promised to our region ([Regional Investment in Wales after Brexit](#), October 2018. Last accessed March 2021.)

IMPACT STRATEGY

Innovation and problem solving are core to computer science, so our approach to impact is to ensure all academics, research assistants (RAs) and research students have opportunities and support to engage with companies, supply chains, public bodies, and the public. We recognise that this leads to: strengthening curiosity; serendipitous new problems, ideas, and topics; a wider vision and deeper understanding of computing; and valuable new applications and improvements to products, processes, services, and policies.

We strengthen research impact by the following approaches that encourage and support the early engagement of researchers with end-users and beneficiaries, foster close relationships, and maximise impact in term of its reach and significance:

Strategic and focused collaborations with partners. These harness our academic knowledge and creativity to a shared research vision driven by users. We mentor and support researchers to build relationships with international companies and public services, providing advice, time, and funds. Examples include Moller, Roggenbach and James' work on specifying

and verifying digital signalling software with Siemens Rail; and Roggenbach's development of specification and testing technologies for app collusion with Intel Security. Collaborations with the public sector include strategic partnership with BBC R&D (with five other institutions, 2013-19) with the aim of transforming the user-experience of broadcasting, led by MJones.

Commercialisation of research and consultancy. Staff work extensively with industry through special consultancy mechanisms. Patents have been handled by Research, Engagement & Innovation Services (REIS) (e.g., Mora's and MWJones' two patents on ray-tracing). Consultancy has been facilitated through our business liaison staff and special units such as CHERISH-DE.

Contributions to government policy and delivery. Computer Science at Swansea has been a creative and trusted partner in many initiatives of the Welsh Government in many sectors over the past three decades. In the REF period, we have major roles in CS research, STEM education, supercomputing, and outreach. E.g., the inaugural public meeting of our research theme Educational, Historical and Philosophical Foundations had talks by Wales' Education Minister, Kirsty Williams, and Graham Donaldson, the author of Wales' national Curriculum Review.

Support for staff to achieve impact. We support all staff to seek and achieve impact over and above the main impact case studies. We nurture impact thinking in our ECRs. The Department has several large-scale projects to create and develop impact. Foremost among these are: CHERISH-DE; CDT (Enhancing Human Interactions and Collaborations with Data and Intelligence Driven Systems); and KESS. R&D projects, knowledge transfer and public engagement is valued and recognised in staff workloads, academic career pathways, and promotions. The Department granted periods of leave to researchers to concentrate on impact.

The Big Picture. The above approaches are complemented by our efforts to maintain a helicopter view of contemporary computer science, by engaging in forms of intelligence gathering and horizon scanning. Mechanisms for sharing individual experiences, news and opinions range from participation on external advisory boards, twice-yearly research celebration days, our monthly discussion forum, and through daily conversations for which the Foundry is ideal. **Staff have autonomy and leeway to pursue research directions they deem to be important regardless of trends.**

REVIEW 2014-2021

Our strategies enabled us to deliver fully on our two REF 2014 drivers (see above). We recruited excellent new academics, developed our new and existing staff, maintained a large regional and global impact, delivered the (very) high specification Computational Foundry building and substantially increased our external research grant capture, much of which is multidisciplinary.

Our strategic projects are establishing best practice for imbuing computational thinking – in primary and secondary school children and their teachers (Technocamps, Moller), the workforce (Degree apprenticeship and Institute of Coding in Wales, Moller), ECRs (CHERISH, Welsh Crucible) and the public as part of our civic mission and public outreach. These programmes and our desire to deliver education, our commercial and civic mission, drive policy and global cultural change were the motivating factors for originating the Computational Foundry.

Our staff are assured in their role in the University to place Computing at the centre of multidisciplinary research. Staff nurture relationships across departments and colleges, leading

to increased activities and workshops between departments, colleges, industry, civic partners, and health boards. In partnership with our colleagues across the University, we leverage each other's close ties with external partners and stakeholders to increase the scale and scope of multidisciplinary impactful research. Our current and future joint appointments are a recognition of this success and are intended to promote and strengthen this into the future.

OUTLOOK 2021-2028

We have followed our research and impact strategy guided by our ethos for this REF period and will continue to follow it for the next period (developing our ECRs, encouraging multi-disciplinary research, open research, etc. as above). Additionally, our **two main objectives** are identified as:

1. **Despite the impact of COVID we feel confident that we can introduce a new group and strengthen the security group.** The FIT group is evidence that we can introduce, grow, and integrate a new strong research direction.
2. Digitality is a fundamental direction of travel for us. We aim to link digital research across the subjects with connections into every discipline. **We will develop further our threads across the University with five strategic appointments that bridge to other areas.** Although recent, we already identify considerable success from our appointments with Law and Education and aim for similar success in the future (e.g., with Engineering, Mathematics, Medical School and Business).

2. People

STAFFING STRATEGY

In the REF period we focussed our efforts on expansion and promotion:

2021

32.9 category A staff (headcount 33)

32.9 submitted

VS

2014

21.6 FTE eligible (headcount 22)

19.6 submitted

All 33 category A staff have permanent contracts

45% are early career researchers (15)

New ECRs:

Theory:

Fan, Pauly

Visual Computing:

Rahat, Tosney-Weir, Walton

HCI:

Clark, Owen, Pearson, Porcheron, Robinson,

Sahoo

Security:

Promotions since 2014

1 Head of College

4 Personal Chair

2 Associate Professor

6 Senior Lecturer

Aligned to our strategy to develop future leaders, we expanded by 15 ECRs with strong scientific records. **In recognition of excellent staff performance** since REF 2014, 13 of our staff have been **promoted**. **All our Category A staff have permanent contracts**, reflecting a commitment to underpinning and building long-term research trajectories. **All staff promoted to personal Chair were ECRs in this UoA at the start of their careers** and 6 recent ECR hires are already promoted to senior lecturer and 1 to Associate Professor providing evidence we successfully develop talent within.

Relation to physical infrastructure: Our staffing policy has led to an ambitious and outward facing department with energy and capacity to bid for, and win, major projects during the last REF period resulting in significant impact on our physical infrastructure in the shape of the Computational Foundry. The Computational Foundry was opened in October 2018 and



provides over 7000m² of accommodation for Computer Science and Maths, of which 3000m² is dedicated **exclusively to computational research labs**. It provides a stunning working environment, centrally located in the Swansea Bay Campus with breathtaking coastal views from most of our offices and labs, contributing significantly to our wellbeing. The building has a high technical and architectural specification. We

allocate space to focussed research collaboration with **10 large laboratories and two additional UX rooms**.

To foster interaction and strengthen collegiality, our academic staff from all four research groups mingle throughout the building, and with mathematicians (Giansiracusa of Maths is a Co-I on our CDT). Part of our strategy is that research students and staff mix throughout, making sure postgraduates have easy access to their supervisory team (in many cases just metres away, sharing the same social spaces). Our large research crucible (photo) is a touchdown point for researchers over the whole building and is where we host weekly *My Research: Why it Matters* and many other events.

Staff Development: We have fostered an open and **friendly culture** for at least 30 years. This is confirmed to our advantage by staff that have moved on to other universities. We take pride in our diaspora who have moved on to chairs at Oxford, Cambridge, Durham, KTH, Darmstadt, VU Amsterdam and others throughout the last 20 years. We also have a friendly, cooperative atmosphere across our research groups and reaching into many other UoAs across campus. This frames our staff development, where we host genuine events to help rather than tick boxes. Most of our events below are suitable for both longer serving staff and ECRs. ECRs need lots of contact with established academics to sustain our positive culture. Everyone pulled together as **COVID-19** impacted our operations. It demonstrated the strength of our community: We saw good collaboration to transition to online learning and continue research operations including using Zoom for events: *My Research: Why it Matters*, Research Café and Research Days. Our department is still expanding in numbers during this difficult COVID period.

SUPPORT FOR STAFF

Support for ECRs: It is central to our culture that **ECRs play a strong role**. We have developed ECRs for 30 years. ECRs have strong loyalty to the department, and they succeed. All four promotions to chair in the period were ECRs at Swansea. Staff appointed as ECRs now hold senior positions. In addition to the usual mentoring and professional development schemes, Computer Science employs the following activities to support ECRs.

Support group for new investigators (meeting monthly). Experienced grant writers help ECRs (and others embarking on their first grant proposals as PIs.) to overcome the barriers to their first application including personal coaching. We aim for a transformative impact where they are assisted to establish themselves as independent researchers, making a name for themselves within their field and building their own group. This includes refinement of the research topic, covering all elements of grant application (budget, project management, impact), signposting help (such as the college research hub that provides bid writing and project costing support), distributing drafts for internal reviews and building relationships with other academics, industrial and governmental partners.

Knowledge Exchange Forum: For new and early career staff (monthly), this aims to share best practice, identify, and raise common issues (and propose solutions), to provide a sense of community and feed into the shaping of the department.

New Colleague Start-up: Each new staff member benefits from **start-up funding** of £2000 per year for three years for travel and/or equipment. New staff benefit from lower teaching demands (half-load in the first year) and lighter administrative duties.

Support for all researchers, including ECRs

Research Café: Monthly meetings to support one another through the grant writing process focussing on different elements, such as making connections, sharing experiences and best practice, exchanging ideas, celebrating submissions and success, disseminating bids and rebuttals. We celebrate and recognise grant submissions, so grant writing is not hidden from sight until successful. We invite expert advisors (for example, guest talks about intellectual property) and research colleagues from other departments to stimulate interdisciplinary research and multidisciplinary bids. We have research speed dating events, supported by access to college funds for seed corn funding (and studentships) which act as a springboard to future collaborative applications. We discuss new research ideas (to get first reactions from colleagues about grant ideas). It provides an additional environment to find research partners.

Trips: We fund opportunity trips that are taken by staff at all stages of their career. For example, a group visit to EPSRC and attendance at EPSRC (capability shaping) Sandpits. Groups also had industrial collaboration visits to partners (such as IBM Hursley, Tata, Siemens, DVLA, Companies House, UK Hydrographic Office, Thailand State Railway, McAfee, Calif.). We also have partnerships with universities in Grenoble and Texas which led to joint PhD supervision.

Hosting events: We organise events to promote industrial, academic, and governmental opportunities and help staff to expand their networks. These include fact-finding missions from external potential partners, who choose to visit us to explore linkups. e.g., IBM, Amazon, Grenoble. For the first year of the CDT, we organised three focussed sandpits on Industry 4.0, Health and Human Interactions. We also hosted a visit by EPSRC to help demystify the application process, be familiar with the latest funding opportunities and meet EPSRC staff.

Space for research: The physical environment of the department has transformed since the previous REF. All staff including ECRs use 10 large, well-equipped research labs, two UX observation rooms, meeting, and seminar rooms. All academic staff have 15m² individual offices, most with excellent sea and campus views. The working environment provides quiet areas (four lounges), meeting rooms for formal meetings and group work and a variety of social spaces from small touchdown areas to the crucible, allowing serendipitous meetings. The research crucible is the heart of our department. It hosts our larger events and

provides an area for breaks and lunch. It has become a multi-functional space well-suited to formal talks, breakout sessions, group work, poster displays, ad-hoc meetings, lunchtime meet-ups and hosting visitors.

Funding: All staff without grants are funded to attend conferences and meetings. All reasonable and justified requests for equipment are funded. Staff bid for college funds for larger equipment, travel and hosting workshops, e.g., in 2018, the college bought £15K of GPUs to support data mining activities and funded the 2019 Proof Society summer school and workshop in Swansea.

Recognition and reward: We provide staff with additional funds to incentivise our priorities. This includes recognising potentially 4* work (impact or publications), grant submission and grant success (by returning a percentage of funds). Staff can accrue funds from all three and are free to spend the money as they see fit on their research (predominantly equipment and travel). Impact case studies are treated as a 4* publication for PDR and promotion purposes. Our staff thrive and get promoted.

Networking opportunities: We help staff to expand their networks across industry, academia, and public sector. Additional events mentioned here provide opportunities to meet academics across subjects. These include monthly College Research Lunches (across science subjects), weekly 10 minute *My Research: Why it Matters* coffee time talks in the research crucible (including Maths, Computing, Law, Engineering, Health and Biology), and formal subject meetings, such as Computer Science and Law where research talks are scheduled in the format of a research day aiming to find common interests and opportunities.

Research days: We organise departmental research days just after teaching ends (December and June) to promote transparency and inclusivity of all staff. These provide an opportunity to catch up with colleagues in a forum specifically to discuss research. The format of individual events changes, but usually takes the form of specialist research talks, general talks, and activities designed to promote discussion about research direction and strategy. This is the primary event for formulating research strategy with all staff present. Traditionally an “away day” in local hotels (Marriott; Village Hotel), they now take place in our research crucible, which is the heart of the Computational Foundry.

RESEARCH STUDENTS

Achievements: Our newly qualified PhDs continue to work for global companies, enter academia or set up their own businesses. Examples include Spencer to Disney and Double Negative, Legg to UWE (Associate Professor), Deng, Owen, James (Lecturers) and Pearson and Robinson (Senior Lecturers) in Swansea and Walker to Computer Associates and now director of Curiosity Software.

Centres for Doctoral Training: We lead the EPSRC Centre for Doctoral Training in Enhancing Human Interactions and Collaborations with Data and Intelligence Driven Systems (2019-2027) and participate in UKRI AI, Machine Learning and Advanced Computing (2019-2024) and STFC Data Intensive Science (2017-2025). We have joint PhD students with Grenoble. Our successful bids for UKRI CDTs were built on our establishment in 2016 of a University-funded Science Centre for Doctoral Training led by MJones.

Skills Development: The CDTs have a focus on training and development with a seminar series covering the themes: Interdisciplinary thinking and methods; Research networking; Responsible Innovation and Inquiry; Public Engagement and Impact; Human-Centredness;

Enterprise and entrepreneurship; Funding; Research-led engagement; Communication skills; Diversity and inclusion in science.

We foster a vibrant community of PhD students who are a key dynamic in our drive to be the most creative place to carry out science globally. The CDTs provide a competitive advantage to our postgraduate researchers, preparing them for academia and industry that increasingly looks for outward "T" shaped thinkers: deeply skilled in a discipline who connect broadly with others. Students attend our Research Days, and most give a presentation during their studentship. It provides them a platform to influence our research strategy. Students are welcome to, and attend our staff events (e.g., networking events, bid writing etc.) Along with teaching experience, we provide our students with the necessary experience to obtain their first job in academia, industry, public bodies or set up their own companies. Five (James, MWJones, Owen, Pearson, Robinson) of our Category A staff completed an undergraduate degree and PhD with us.

Procedures: Previous REF and RAE documentation demonstrate Computer Science has a history of senior staff in core leadership positions for postgraduate training and processes throughout the University, as we are seen to provide best practice in this area. We follow well developed procedures for monitoring and progressing research students, in many cases established by Moller when Dean of the postgraduate college. **Our robust progression monitoring procedures are cited by QAA as best practice.** We provide support for staff and students for monitoring, progressing, and training. Monthly meetings are documented on our electronic system, with major quarterly and annual reviews of progression. Both student and supervisors give input to the process. This allows the early identification of problems if they arise and sets out the expectations of both staff and students in the supervision relationship. Our established skills development programme is a key strength in the new CDTs.

PGR recruitment: The CDT receives more applications than places. Applicants move through a rigorous selection process including interviews, talks and presentation, a two-day sandpit event and final selection. The sandpit event involves industry partners who provide input on final selection. Impact is institutionalised in the CDT through mandatory company involvement initiating and progressing research projects. All CDT projects have an industrial partner.

EQUALITY AND DIVERSITY

Swansea University is a long-standing charter member of Athena SWAN – an initiative first led by Computer Science and chaired by Tucker. By 2019 Swansea held a silver award, one of 13 UK universities, and was the first non-Russell Group university to achieve Silver. The Athena Swansea Strategy Group and Equality Challenge Unit help to deliver the University's inclusivity ambitions. The Computational Foundry holds an **Athena SWAN bronze award**.

Swansea University takes part in Stonewall's Workplace Equality Index (WEI) and in 2020 was ranked 47th, being 7th out of all UK universities. Swansea is also a member of the Race Equality Charter. Computer Science staff take advantage of the usual University family-friendly initiatives. Meeting times are arranged so all staff can attend. Some staff within the UoA have special circumstances recognised when it comes to allocating teaching slots (e.g., timetabled with recognition of childcare). All our vacancies are advertised as suitable for job share, part-time or flexible working. The University's Flexible Working Policy applies to all staff. Specifically, we have examples where staff have attended overseas visits (conferences, research leave) with children where expenses were used for childcare during the conference.

A member of the UoA REF Working Group took maternity leave during the period and **created** and availed of a new policy to have a **six-month research sabbatical** after maternity leave. All our CatA staff are permanent. We have an open, helpful, and friendly culture in the department leading to natural inclusion as indicated by all the listed activities. Our staff lead across University Equality and Diversity policy development including Tucker, who led the initial Athena SWAN initiative in Swansea.

Diversity: The Department has always attracted significant numbers of international applicants to its academic openings, which are widely advertised. Our current 33 academic research staff include colleagues from Canada (2), China (2), France (1), Germany (6), Hong Kong (1), India (2), Singapore (2).

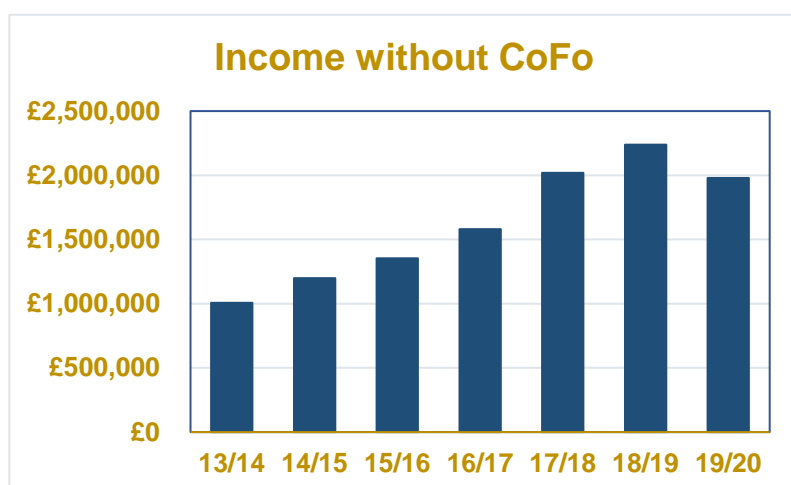
Outputs: In line with the University's Code of Practice and our unit Statement of Intent, the team making the decisions on the final selection of outputs all received mandatory unconscious bias training as well as targeted REF specific training on the fair and transparent selection of outputs for inclusion in the submission. The submission comprises the one best-quality output from each CatA submitted staff member with the balance made up of the best-quality outputs from the available pool of eligible outputs that includes outputs of former eligible colleagues. All our CatA staff are entered for REF and all have permanent contracts.

3. Income, infrastructure and facilities

RESEARCH FUNDING PORTFOLIO

Our research funding had an exceptional positive impact from the research funded element of the Computational Foundry in 2018/19. Therefore, we present figures **with and without the Computational Foundry income**.

2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
£1,008,142	£1,199,647	£1,352,536	£1,579,699	£2,019,209	With CoFo £9,761,849	£1,980,410
£1,008,142	£1,199,647	£1,352,536	£1,579,699	£2,019,209	Without £2,239,269	£1,980,410



At £10.37M funding without Computational Foundry is 60% higher than the period leading to REF 2014 (£6.43M) and at **£17.89M** including the research element of Computational Foundry is 178% higher. Individual years show **progressive and sustainable growth**.

Grants from other sources such as HEFCW are not included in REF4b data but give us significant resources for our impact. These **strategic projects** deliver on our passion as computer scientists. They demonstrate our track record of underpinning our research environment's sustainability through outward facing impactful interdisciplinary longer-term funded programmes. Projects which have a major impact on our environment include the **Computational Foundry (£31M)**, **Technocamps 2 (£5.3M)** which has extensive engagement with 45,000+ schoolchildren across Wales, including the **Teaching the Teachers** programme, where every school in Wales has had 10+ hours of staff development in Computer Science, the **Institute of Coding in Wales (£1.2M HEFCW)**, our **Degree Apprenticeships Programme** and our **Academy for Advanced Computing** which funds six research software engineers based in the Computational Foundry.

Strategic Projects

£31M, 2018-2022 Computational Foundry

£5.3M, 2018-2022 Technocamps 2

£4.99M, 2019-2027 EPSRC EPIC Centre for Doctoral Training

£3.09M, 2015-2021 CHERISH-DE

£1.2M, 2018-2022 Institute of Coding Wales

Other EPSRC Grants over £500K

£944K, 2016-2020 Data Release - Trust, Identity, Privacy and Security

£840K, 2018-2022 The next level of SAT solving for very hard problems

£822K, 2016-2020 Breaking the Glass

£738K, 2018-2021 PV-Interfaces: Self-Powered Interfaces and Interactions via PV Surfaces

£711K, 2014-2018 Re-shaping the Expected Future

Two grants bridged the REF periods:

£1.77M Chi+Med

£844K PPlanCompS

We lead the EPSRC Centre for Doctoral Training in Enhancing Human Interactions and Collaborations with Data and Intelligence Driven Systems, **£4.99M**, 2019-2027) and CHERISH-DE: (**£3.09M**, 2015-2021): a pan-UK project supporting and developing ECRs to be future leaders.

Our funding sources include: EPSRC, MRC, HEFCW, ESF, Royal Society, Welsh Government (WG), InnovateUK, (National Institute for Social Care and Health Research) NISCHR, Leverhulme and companies such as: BBC (for mobile interaction), Sigma (for Visualisation for Business Information Systems), Siemens (railway safety), Grid-tools (software testing and visualization) and DVLA. 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. The CDT has initiated a new era of industrial collaboration where all the first intake are co-sponsored by industrial partners.

INFRASTRUCTURE AND FACILITIES

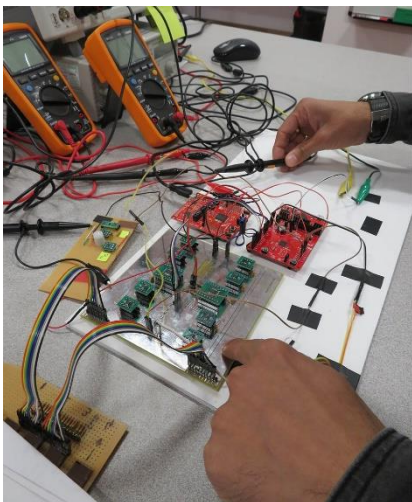
Building: We have more than quadrupled the available research space since 2014 with 3000m² of dedicated (Computer Science) research space in the Computational Foundry and **additional** meeting and seminar rooms and staff offices. It follows all the latest standards for **accessibility** including lifts to all floors, refuges, large doorways and corridors, disabled toilets on each floor in each wing of the building, and we have electrically operated height adjustable tables in several labs (and for staff who require them for medical reasons). We have excellent natural light due to the south facing aspect and the three-floor glass roofed research crucible, four-floor high atrium, and top floor light wells. It achieves excellent environmental characteristics. A team of six senior academics in the department devoted a great deal of time to the design of the building establishing new standards of academic accommodation for the University.

Laboratories and facilities: 10 new labs provide capabilities open to all researchers.

The **VisLab** has a 24MPixel visualisation wall aimed at interactive user studies and visualisation research including an 86" 4K touch screen. It houses our VR and AR equipment and eye tracking device.

The over 100m² **Vision and Biometric Lab** hosts our Machine Learning equipment. This includes the latest nVidia GPUs (2 Quadro GP100s, 3 P6000s, 32 Tegras, with most PhD students in the area having the latest consumer cards – 1080 or 2080 depending on purchase date). We have a 3dMV 4D camera for facial research (with Tam winning a best prize at IEEE Vis 2016 combining Visual Analytics and Machine Learning).

The central space of the laboratory has a ceiling rigging that houses cameras, kinects, and other motion sensors for biometric research. We have Canon EOS controllable cameras, video cameras, high speed video cameras, which are all used to collect (open) data sets.



There are **two Maker Labs**, with one housing fabrication equipment such as a programmable laser cutter, various cost 3D printers and full workshop equipment. The room has excellent air extraction designed during planning and follows the latest health and safety requirements. The **second Maker Lab** is built for electronics projects with soldering stations, plenty of bench space and excellent lighting. The room is generously equipped for research projects with various Arduino and Raspberry Pi devices, lots of sensor chips, OLEDs, and assorted electronic components. There are no restrictions on project use, and no administrative overhead to associate every item with a cost code – researchers are free to use items and suggest items to purchase. This significantly lowers barriers to research.

The **FIT Lab** has more specialist equipment – Artec Eva portable 3D scanner, Photo booth, lighting rig, Canon EOS, large mobile phone, and tablet library (~50 devices), VR equipment (~10 each of HoloLens, Oculus, etc), large electrical component library (overlapping with the maker labs) including Arduino, Raspberry Pi, MakeyMakey, etc, and many other deployments, testing tools and equipment (mobile maker lab, generator, battery packs, laptops, speakers, mini projectors). **Two UX labs** are used for usability testing.

We have an **R&D collaboration lab** where outside visitors or short-term industry projects are housed. Typical events include stakeholder meetings for our CDT where we partner PhD students with industry.

The **Security Lab** has its own gigabit networking which can switch from being isolated or externally connected to conduct cybersecurity experiments. We bought clusters of Raspberry Pis to give large numbers of Linux nodes for experimentation.

The **IoT lab** provides a platform for Cyber-Physical Systems and Internet of Things research. It complements the electronics Maker Lab, Security Lab and Verification Lab to provide a test bed for the integration, security investigation and verification of embedded software with devices. It houses a suite of smart home IoT devices for penetration testing, IoT devices, Cyber-Physical Trust Systems blockchain research (Beckmann), and is the base of other Industry 4.0 projects conducted with Tata Steel and Engineering (Beckmann). Tables are electronically height adjustable to give optimal working environment.

The **Verification Lab** provides an environment for software testing and verification work. It houses the physical railway interlocking experiments.

A **Legacy Lab** has been established to work on digital conservation and preservation, supported by the History of Computing Collection and Information and Library Services.

Organisational Structure: There are two technicians dedicated to the research laboratories, and the head College technician and one further technician are in the Computational Foundry for support across the whole building including research support. The labs support our impact and provide a holistic view of Computer Science from cradle to grave (or beyond the grave with issues surrounding legacy and preservation explored in the Legacy Lab). The R&D collaboration lab are where impactful ideas are born with external collaborators. The various labs (Maker Labs, Vision and Biometric, FitLab, Security Lab) are where ideas are prototyped, and deep discipline related research takes place. For any developed hardware, further labs such as IoT can be used to explore software integration onto devices. It also includes our blockchain research for the validation and integration of time-dependent sensor data. The VisLab can visualise the data, Vision and Biometric lab for analysis, and FitLab and UX labs for user testing and studies. We look at security issues on devices (Security Lab) or prove verification and standards (Verification lab – e.g., Railway Impact case study with Siemens and other rail operators). The R&D collaboration lab acts as a test centre and for feedback on our research with external partners. Our social spaces, contribute by providing stimulation and a vibrancy that fills the building, making it a crucible for research ideas. All labs support our impact and are outward facing.

General Spaces: We have six meeting rooms of various sizes (from 20m² to 100m²), the Robert Recorde room (200m²) and two large social areas. The crucible is surrounded by glass bringing connections between staff and events. There are several sit-down areas and six kitchens (and six dishwashers!) throughout the building. Research groups are mixed throughout avoiding the monoculture that could occur otherwise (this was ground-up rather than enforced when we asked people where they wanted to locate).

High Performance Computing: Tucker has played a leading role in developing HPC facilities and services in Wales especially at Swansea. First, as a Director of HPC Wales Ltd, has been at the forefront of the creation and management of a £40M national technology resource which staff use for computational research. He designed and implemented a comprehensive strategy for HPC at Swansea involving the creation of the Swansea Academy of Advanced Computing, designed to support and grow HPC and data science competence with a Director, (Lucini,

Mathematics), 2 HPC systems administrators, six research software engineers, and computers from Atos-Bull.

Funding: Awarded grants in period have provided equipment and consumables with a budget of **£1.06M**. In addition, equipment purchases are made from QR and University funding (e.g., College funds purchased £15K of machine learning GPUs in 2018 and a £35K HoloLens facility in 2017). Equipment is also funded by project sponsors (e.g., £55K of equipment funding in addition to studentship fees to support the first 12 CDT PhD research projects).

4. Collaboration and contribution to the research base, economy and society

Supporting research relationships: The Computational Foundry is a strong brand to attract visiting scholars, distinguished speakers and to host events. We use a well-tested formula of joint workshops and research “speed-dates” between academics, industry, health service and civic partners. Projects are co-created by academics, industrial and civic partners, and students. Staff are funded to travel to or invite partners including international trips.

CHERISH-DE and our CDT provide excellent evidence for our thriving networks, partnerships, and collaborations. Firstly, the projects were won on the strength of our existing extensive partnerships and research environment. Secondly, they provide a comprehensive infrastructure for engagement and long-term sustainability with our potential partners.

The two programmes contribute £8M of RCUK funding to underpin our research environment. These act as catalysts for new research projects. By July 2020, the CDT had completed one year with an entry cohort of 12 students. The 12 ongoing projects including examples with Facebook, Tata Steel, UK Hydrographic Office, Amicus Therapeutics and Siemens Rail. These sponsors provided an initial £350K of cash studentships for the projects, with £110K from existing research partners and £240K from new partnerships generated because of securing the CDT. In addition to the mentioned CDT projects, our staff have worked with other industrial partners, including IBM, Tech Hub (Swansea), We Predict, GoFore, DVLA, Fram3, ABM University NHS Trust and South Wales Police, Airbus, Amazon, Crown Packaging, GeoLang, Vortex, Ford, Fujitsu, Google, McAfee, Ordnance Survey, Pfizer, AstraZeneca, and QinetiQ.

Indicators of success: In terms of broad impact on the discipline, since 2014 our researchers have published over 500 articles, over 70 of which appear in the top 10% journals (CiteScore) for our respective areas (e.g., IEEE, ACM Transactions) leading to a field citation impact 23% higher than the global average (SciVal October 2020). **Over 250 articles involved international collaboration and over 50 had industrial or clinical co-authors.** Staff lead key conferences (e.g., ACM CHI, Eurovis, BMVC), feature on editorial boards and actively shape the community through advisory board memberships (e.g., EPSRC SAT).

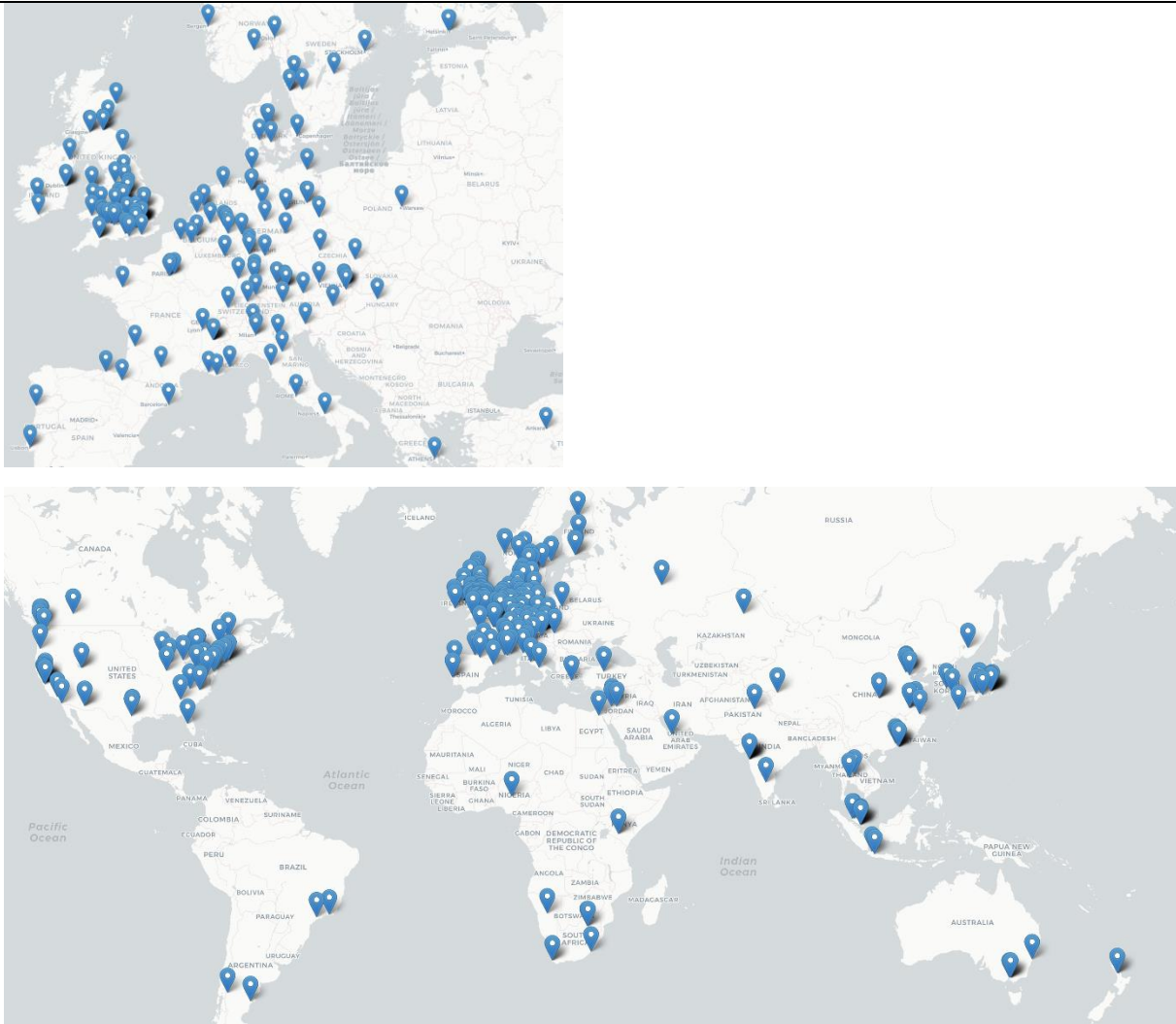
Public and community engagement: Our impact case studies provide ample evidence of reaching out to disadvantaged groups (rural communities in Africa and India) and public through education (Technocamps). Additionally, we celebrate research and connect with the public through major events such as the Computational Foundry Festival of Ideas (annual since 2019), permanent scientific displays for the public and schools (Oriol Science and Hafod Copperworks Heritage site), regular organisation of the South Wales Cyber Security Seminars or community engagement such as Dix’s collaboration with residents in Tiree. Harold Thimbleby continues his world-leading impact on safer medical devices, e.g., working with the FDA in the US on formal methods for device interfaces.

Collaborative examples (industry): We have a long and successful history of **industrial** research collaboration. There are over 50 publications in period with industrial co-authors with many additional research outputs inspired by collaboration and industrial problems. These projects are typically supported by joint research grants and/or industry funding.

Some recent and significant collaborations include:

- Multi-objective optimisation methods for computational expensive problems for reducing harmful emissions with Jianbi Power Plant (China) and a Cyclone Separator (Hydro International, patent number: GB1816265.1).
- Projects with Tata steel applying machine learning to manufacturing processes and sensor data (EP/V519601/1).
- Software model checking for security with CyberCurio.
- Blockchain with MetFilm (EIT funded Media Asset Platform) and Vehicle supply chains with Riversimple (ERDF funded).
- Reimagining digital devices for emergent users with Microsoft, IBM and iHub (EP/M00421X/1).
- Public speech interaction with Uliza and using Bluetooth low energy beacons with Google.
- New forms of mobile deformable screens with BBC (EP/N013948/1).
- Self-powered displays with DST, Google, Hewlett Packard and HAB Housing (EP/R032750/1).
- Conversational speech with Mozilla Research, Voysis Ltd, The British Stammering Association and Jaguar Land Rover.
- Trade finance dual-use goods fraud detection with Traydstream (TS/S002766/1).
- Advanced digital modelling, knowledge representation and analytics in context of Industry 4.0 with Tata Steel and wider UK steel sector (SUSTAIN Manufacturing Hub EP/S018107/1, and EPSRC ICASE)
- CDT and CHERISH-DE projects are listed in the first paragraph of this section.

Collaborative examples (academic): Even though many staff are ECRs hired in this period, collectively, we have over 250 articles involving international collaboration. The range of collaborative activity undertaken (including co-authors, visitors, and research collaborations) is illustrated by the following maps:



A visual summary of existing collaborations.

Some recent and significant collaborations include:

- Kullmann and his collaborators, Heule (Texas Austin), and Marek (Kentucky) used SAT-solving techniques to solve the long standing open Boolean Pythagorean Triples Problem (Nature 534 (7605) 2016). The collaboration created the 200-terabyte proof utilising 4 CPU-years of computation in two days on a supercomputer at the Texas Advanced Computing Centre. The collaboration was a springboard to a £840K grant (EP/S015523/1) for next generation SAT solving.
- Tam and Chen (Oxford, who was previously Swansea) pioneered the use of information theory to quantify visual analytics with machine learning won the 2016 IEEE Vis week VAST best paper award, an honourable mention in IEEE Computing Now 2017; and listed as an exemplar "theory" paper for IEEE Vis 2017,18,19.
- Xie collaborated with researchers in Health Data Research UK and China-ASEAN research institute using 52.5 million medical records on 59,298 dementia patients to find the 10 most important signalling events for predicting patient outcome (hospital admission). The new approach on mass health records is published in the Lancet (Nov 2018) and the new machine learning techniques for large sparse data in IEEE Translational Engineering in Health and Medicine (2020).

- MWJones collaborated with biologists from Swansea, Argentina, QU Belfast, Hannover, Norway, Qatar, Strasbourg and Vienna on Visualisation and Data Analysis techniques for time-series data collected from sensors studying animal behaviour. The resulting software is now in use with over 300 biologists on every continent (including Antarctica).
- Thimbleby (Professor Emeritus from 2021) has an extensive collaboration network including organisations such as the World Health Organisation and Royal College of Physicians, where he is a Fellow and an Expert Advisor on IT. He hosted the EPSRC Programme Grant CHI+MED (EP/G059063/1), in conjunction with UCL, Queen Mary and City University which involved numerous collaborators, including The National Patient Safety Agency; a wide range of collaborators in the medical device industry; Georgia Tech, University of Maryland and Texas A&M. His work on preventable error and resulting formal methods for user interfaces makes an impact on patients and medical staff. He has been an expert witness in NHS criminal cases where his work exposing problems in digital healthcare has stopped nurses going to prison. He has spoken over 500 times to public or medical audiences and is transforming the way the medical world approaches and thinks about IT and errors.
- Seisenberger and Wyner collaborated with lawyers and the Children's Legal Centre Wales to create a chatbot to help children access their legal rights and put them in contact with (human) legal representation. This tackled the difficult problem of using AI to understand the conversational language of children of various ages who will not use correct legal terms, e.g., conversational statements like "Is it legal for my dad to hit me?" and "Is it illegal to make fun of other religions?". The project (published in *Frontiers in Artificial Intelligence and Applications*) was chosen as an exemplar project and they now participate in the Hillary Rodham Clinton Research Programme on Children's rights and protecting children online (funded by the Welsh Government).
- Two FP7 (COMPUTAL, 2012-2016 and CORCON, 2014-2017) and one H2020 (CID, 2017-2021) projects support Berger, Seisenberger, Setzer, Beckmann plus a number of research students: Berger and Seisenberger work with Tsuiki (Kyoto), Spreen (Siegen) and Schwichtenberg (Munich) on proof-theoretic methods for provably correct systems and implemented this in the proof assistants Minlog and Prawf; Setzer works with Abel (Gothenburg), Adelsberger (Vienna), Moser (Vienna), Savenkov (Vienna), and Walkingshaw (Oregon State) on integrating object-oriented programming into dependently typed programming; Beckmann works with Preining (JAIST, Kanazawa and Acelia, Tokyo) on reasoning systems for parallel processes.
- Moller, James, Roggenbach, Seisenberger, and Berger are members of the Swansea Railway Verification Group (SRVG) which spans extensive collaboration: with Siemens Rail Automation (formerly Invensys) on safety of railway signalling systems; in UK's Rail Safety and Standards Board funded DITTO project with Nguyen (Coventry), Potts and Preston (Southampton), and Liu (Leeds); furthermore with Treharne and Schneider (Surrey), Haxthausen (TU Denmark), Peleska (Bremen), and Chen (Birmingham Centre for Railway Research and Education).
- MJones has, for the last decade, reimagined digital devices for future interaction (displays and surfaces) or for use in remote and rural communities or developing areas (see impact case study). He has responded to **national and international priorities** on digital inclusion, responsible innovation and reaching emergent users, building a

large portfolio of RCUK funding with multiple partner organisations and academic institutions. A new three-year collaboration between the world leading speech technology group in Edinburgh and Swansea FIT Lab is supported by EPSRC (£970K, 1st Dec 2020 start) to open intelligent voice assistant interfaces to the resource constrained “unheard”. Jones has also helped shape national and international priorities through his membership of EPSRC SAT and RCUK Programme Advisory Board for Digital Economy boards, his groups’ participation in EPSRC sandpits and leading role for ACM CHI.

- Archambault (among other staff in particular Torsney-Weir and Rahat) **responded to an urgent national call for COVID-19**. He integrates with the Royal Society Rapid Assistance in Modelling the Pandemic: RAMP and the Scottish COVID-19 Response Consortium (SCRC) providing visualisation and visual analytics expertise (IEEE VAST Best Paper Honourable mention for “In Search of Patient Zero: Visual Analytics of Pathogen Transmission Pathways in Hospitals”). He is also PI for projects Visual Analytics for Explaining and Analysing Contact Tracing Networks (UKRI COVID-19 Response Call EP/V033670/1 £361K in collaboration with Warwick) and Welsh Government funding for Visual Analytics of Epidemic Simulations with Many Actor Behaviours (WG Ser Cymru III COVID-19 call £107K). Archambault and Torsney-Weir are both Co-Is on RAMPVis (led by Min Chen of Oxford – previously Swansea) (UKRI COVID-19 Response Call EP/V054236/1 £534K). Archambault is a lead on the contact tracing effort.

Leadership indicators:

Advisory Board Membership and Other Strategic Leadership Roles: Moller was President of the British Colloquium for Theoretical Computer Science (BCTCS) 2004-2019. Tucker was General Secretary of the Learned Society of Wales (2010-17). Tucker is Board Member of the Academia Europaea UK Hub. Moller and Tucker were members of the National Assembly of Wales Cross Party Group on Science and Technology. Moller is a member of the Welsh Government’s ICT Steering Group and its Digital Learning Council. Moller and Tucker are expert advisors to the Welsh Government’s National Curriculum Reform programme in Area of Learning and Experience (AoLE) for Science and Technology, and to the Qualifications Wales group creating new qualifications in Digital Technology. Moller is on the WJEC Subject Development Group reviewing Digital Technology, ICT and Computing curricula at GCSE and A-level. MJones has been a member of EPSRC Strategic Advisory Team for ICT. MJones has been and Pearson is a member of RCUK Programme Advisory Board for Digital Economy. MJones is a member of a 5G advisory group to Welsh Government. MJones and Roach are proposers of the Digital Economy and Society pathway of the pan-Wales ESRC DTP. Beckmann is chair of The Proof Society and council member for Association for Symbolic Logic for Association Computability in Europe (CiE) and for Blockchain Connected in Wales. Thimbleby is Expert Advisor for MHRA and for RCP. Roggenbach initiated and chairs the European Technical Working Group on Formal Methods in Railway Control. Other staff have roles as advisory board members, steering committee members, chairs or co-chairs for Domains, AVoCS, WADT, IFIP WG 1.3, CALCO, MIUA, BMVA, VISUAL and others.

Conference and Workshop Organisation: Staff have organised, co-chaired or chaired over 50 academic conferences, workshops or events. MJones was co-Chair of ACM CHI 2014, Toronto and co-Chair of Mobile HCI 2017, Vienna. Laramée was Co-Chair of Eurovis 2014,

Swansea and chair of CGVC 2018, Swansea. Xie, MWJones, Tam were general chair, programme chair and organisation chair of BMVC 2015, Swansea and Xie was programme chair of BMVC 2019, Cardiff. BMVA summer school was hosted in Swansea three times (2014-2016). Moller chaired The London Mathematical Society Computer Science Colloquium 2015 at The Royal Society. Berger was chair of BCTCS 2020, Swansea. Pauly, Seisenberger, Archambault have organised 5 Dagstuhls. Pauly was Programme Chair of CiE 2020, Salerno. Seisenberger and Berger were organisers of Continuity, Computability, Constructivity 2015, Munich. Archambault co-founded and was co-chair of Machine Learning Methods in Visualisation for Big Data (2016-2020). Staff have acted on the programme committee of further conferences and organised workshops alongside primary conference events.

Invited Keynote and Plenary Talks: Thimbleby and MJones are ACM Distinguished Speakers. Academics of the department have presented 200+ invited talks at conferences, international workshops and Dagstuhls. E.g., Thimbleby recorded 69 conference keynotes since 2014 as part of his impact on medical error reaching 3000 clinicians and more than 8000 people. MJones presented at the Hay Festival 2017 and Cheltenham Science Festival 2018 (outreach to a wider public audience). Other staff have 100+ invited talks at conferences, institutions, summer schools and festivals, including British Science Festival, Big Data Analysis and Data Mining, Distinguished Lecture, King's College London.

Fellowships of Learned Societies: Three staff are FBCS (Thimbleby, Tucker, MJones). Thimbleby is FRSA and in recognition of his impact on preventing medical errors elected as Fellow of Royal College of Physicians and Royal College of Physicians (Edinburgh). Tucker is Founding Fellow of Learned Society of Wales (LSW) and Member of Academia Europaea. Moller is a Fellow of the IMA and LSW. MJones is FRSA. Beckmann is FLSW.

Journal Editorships: Beckmann is managing editor of the Perspectives in Logic book series, and on the editorial boards of Annals of Pure and Applied Logic, Computability, and Archive for Mathematical Logic. MWJones (2014-2018) and Laramée (2017-2020) were associate editors of Computer Graphics Forum. Tucker is on the editorial boards of Formal Aspects of Computing, Science of Computer Programming, Journal of Logic and Algebraic Methods in Programming, Journal of Applied Logic and SN Computer Science. Thimbleby is on the editorial board of Journal of Personal and Ubiquitous Computing and advisory board of Journal of Interaction Science. Moller was editorial advisor of LMS Journal of Computation and Mathematics. Setzer is on the editorial board of LMCS Logical Methods in Computer Science. Xie is on the editorial boards of Journal of Informatics, International Journal of Machine Learning and Computing and IET Journal of Computer Vision.

Monograph Series: Tucker is a founding and active editor of: Cambridge Tracts in Theoretical Computer Science (CUP); History of Computing (Springer); History of Information Security (Springer) and Scientist of Wales (UoWP).

Special Issues: Staff have edited/co-edited 15 special issues of journals, such as ACM TiiS, IEEE CG&A, International Journal of Computer Vision, Information Visualization and Computability. Staff have acted as conference proceedings editor for 14 conferences.

Awards and Prizes: Among 25 best paper wins or research awards, the highlights are: Tam won best paper at IEEE VAST 2016 and ICCM Distinguished Paper Award 2019. MJones had best paper honourable mentions at CHI 2015 and with Robinson and Pearson at CHI 2016, 2017 and 2019. Clarke had two honourable mentions at CHI 2019.