

Institution: University of South Wales

Unit of assessment: B11 Computer Science and Informatics

1. Unit context and structure, research and impact strategy

The Unit of Assessment (UoA) saw the following major advances in its research culture during the REF period:

- Increased income by 95% compared to the previous REF period and widened funding sources.
- Significant external stakeholder engagement leading to a broader spectrum of impact types.
- Extensive reorganisation and reorientation of research and research strategy across the UoA and University.

Context and Structure

15 staff members are returned in the Computer Science and Informatics Unit of Assessment (UoA). They principally are from the School of Computing and Mathematics, within the Faculty of Computing, Engineering and Science, with one each from the School of Engineering in the Faculty of Computing, Engineering and Science (**Roula**), and the School of Health, Sport and Professional Practice in the Faculty of Life Sciences and Education (**McCarthy**).

Six of these 15 UoA staff members (**Cunliffe**, **Higgs**, **Langford**, **Roula**, **Tudhope**, and **M Ware**) were also returned in the REF 2014. The rest are experienced staff whose research now fits within the UoA (**Kulon**, **McCarthy**, **A Ware**); existing staff whose independent research has developed since the REF 2014 (**Binding**, **Eden**, **Miknis**); or more recently appointed staff with established research profiles (**Elmesiry**, **Qasem**, **Usman**). Further staff without significant responsibility for research also contribute to the overall research culture, including through PhD supervision, commercial activity and broader external stakeholder engagement.

One member of staff returned in the REF 2014 is being returned under a different UoA and seven from the REF 2014 have left to take up new academic or industry posts.

During the REF 2021 period, the 15 staff within the UoA undertook research across five broad topic areas, as indicated below:

Geographical Information Systems	Higgs[†] , Langford[‡] , M Ware[‡]
Hypermedia	Binding[*] , Cunliffe[‡] , Tudhope[†]
Biomedical Computing	Kulon[‡] , McCarthy[†] , Roula[‡]
Cyber Security and Forensics	Eden[†] , Elmesiry[†] , Qasem[†] , Usman[†]
Artificial Intelligence	Miknis[†] , A Ware[†]

[‡]Associate Professor; ^{*}Lecturer/Senior Lecturer; [†]Professor; ^{*}Research Fellow

These topic areas essentially mirror those of the REF 2014, though the Mobile Telecommunications area is not included after its lead, Professor Al-Begain, left to become President of the Kuwait College of Science and Technology. While the Faculty of Computing,

Engineering and Science (FCES) still has a commercial interest in Mobile Telecommunications, through its Centre of Excellence in Mobile and Emerging Technologies (CEMET), it is not currently an active research area within the UoA.

Research and Impact Strategy: 2014-2021

The UoA's medium-term strategy, as identified in the REF 2014, was to grow sustainably and increase research capacity through appointments and externally-funded projects. It emphasised the importance of long-term collaborations with external stakeholders and identified major projects within Geographical Information Systems (GIS) (with the Wales Institute of Social and Economic Research, Data and Methods) and Hypermedia (with the ARIADNE and SENESCHAL projects) as immediate areas to build on.

Roughly the same number of staff are being returned in the REF 2021 as in the REF 2014: 15 (13.7 Full-Time Equivalents) in 2021 compared with 14 (13.5 FTE) in 2014. Over this period, the UoA successfully appointed new staff, but this growth was offset by staff leaving to take up posts elsewhere. Key staff in GIS and Hypermedia have been retained, providing continuity in those areas.

Annual PhD completions are slightly lower than in the previous REF period, but remain steady. This is partly due to a more challenging UK funding environment. However, the UoA has been particularly successful in achieving external funding for Knowledge Economy Skills Scholarships (KESS) in partnership with industry, under the Welsh European Funding programme. Thirteen KESS PhD students and three KESS MRes students have received scholarships.

Annual income from grants and commercial activity has nearly doubled, compared with the previous REF period. The University supported the key funded research projects (WISERD, ARIADNE, SENESCHAL) identified in the REF 2014 strategy from central QR funds. This facilitated continued expansion in these areas, including the current WISERD Civil Society2 ESRC Centre and the H2020 ARIADNEplus projects. Additional central support included the competitive University PhD studentship (beginning March 2013) on geosemantic technologies for archaeology resources (GIS and Hypermedia). This followed the University Research Strategy to encourage integrative, interdisciplinary projects between research groups.

At the time of REF 2014, University of South Wales research was structured around five pan-university, thematic Research Institutes. Research Institute membership was selective (based on REF potential), by application only, and subject to an annual review with the Institute Director. Members were granted ring-fenced research time and access to funds. Staff in this UoA submission were members of the Computing and Mathematics Research Institute.

The Institute's strategic plan prioritised external income generation and quality research publications. It included a scheme to incentivise significant external funding bids (via contributions to staff members' personal Quality Research (QR) budgets) and a discretionary fund for supporting research and impact via bids for Research Assistant (RA) bridging funding, specialist equipment, pilot studies, tutorial support and conference travel etc. **Cunliffe, Kulon, Langford, Roula, and M Ware** benefited from discretionary fund support, and most members

received some incentivisation funding. Boosting interdisciplinary collaboration was another priority, exemplified by the collaboration between **Roula** (School of Engineering) and **McCarthy** (Faculty of Life Sciences and Education).

The Computing and Mathematics Research Institute also provided support for research impact. **Kulon**, for example, received £17k of bridging funding for a RA. This funding enabled a six-month clinical trial and was matched by the long-term collaborator, Cardiff and Vale University Local Health Board, to support the project for a further six months.

In 2018, the University moved away from Research Institutes and appointed Faculty Heads of Research. The new framework is more inclusive, open and encouraging, aimed at: expanding the volume of quality research; prioritising people; maximising impact; and diversifying income. The University Research Strategy and its associated policies are now operationalised at Faculty level, principally through the Faculty Research Committee. This Committee oversees resources including QR funding, the prioritisation of research capital and additional time allocations for research. **Cunliffe** and **Tudhope** are members of the Faculty Research Committee, ensuring that researchers from the UoA have a voice in research strategy at both Faculty and University level.

Staff currently have access to a number of Faculty funding schemes. These include a Small Research Grant scheme (e.g. **Kulon** was successful with a 2019 bridging funding bid which supported a collaboration with Cardiff and Vale University Health Board); a Research Investment Scheme (e.g. **Roula** successfully bid for £8,800 to support work on Contactless Bioimpedance Monitoring in 2019); and a Faculty Prospecting Fund to provide travel monies for staff to attend meetings when there is a clear opportunity for generating income.

Geographical Information Systems has successfully built on its programme of work examining geographical variation in a range of public and private services. This has benefitted collaborating stakeholder organisations, such as the Welsh Government's Department for Economy, Skills and Natural Resources and Tenovus Cancer Care. This work is returned as an impact case study in the REF 2021.

Higgs continues to serve as Co-Director of WISERD (Wales Institute of Social and Economic Research, Data and Methods) and directs WISERD's Training and Capacity Building programme. The project was awarded £8m of additional funding from the ESRC Large Centres competition in 2019 and a further £4.6m of funding from its partner Universities. The University has directly supported GIS interdisciplinary engagement in the ESRC WISERD Civil Society (Large Centres ESRC Initiative) Research Centre (2014-2019) through an extension of the RA post and 20% of **Higgs'** time as WISERD Co-Director. The University is further supporting the WISERD Civil Society 2 project (2019-2024) with a PhD studentship and 26% of **Higgs'** and 10% of **Langford's** time.

Hypermedia has continued to expand its work on Knowledge Organisation Systems (ARIADNE/SENESCHAL projects). The work has included a number of collaborating stakeholder organisations, such as the Royal Commission on the Ancient and Historical Monuments of Wales, Historic England, Historic Environment Scotland, and the Archaeology

Data Service. From central QR funds, the University has supported Hypermedia's interdisciplinary research on archaeological semantic interoperability via key continuity bridging funding (**Binding**) across the series of externally-funded AHRC and EC projects. Ongoing work includes projects funded by Historic England and H2020. This work is returned as an impact case study in the REF 2021.

The University further supported research impact via a series of internal and external consultant workshops and one-to-one sessions with researchers. Sponsored annual University-wide impact awards also stimulated and highlighted impact achievement, with external guests attending the award ceremonies. Both impact case studies submitted as part of this submission have won University impact awards:

Best International Impact 2018: **Binding** and **Tudhope**, for their innovative work in transnational data integration. This involved collaboration with partners across 11 countries to improve the accessibility and visibility of Europe's archaeological resources.

Best Future Impact 2019: **Higgs**, for his work with Tenovus Cancer Care to optimise the location and delivery of mobile cancer services, improving access and helping to reduce patients' stress, anxiety and fatigue.

Overall, the UOA'S REF 2014 strategy has been pursued successfully.

Research and Impact Strategy: 2021-2027

The University's high-level organisation and management of research has changed significantly since the REF 2014. In 2019, the University's "USW 2030 Vision" strategy document identified four interdisciplinary Accelerated Development Areas (ADAs) to be targeted for future investment: Sustainable Environment; Crime, Security and Justice; Health and Wellbeing; and Creative Industries. These ADAs will guide the future direction of research activity, promote interdisciplinarity, and provide a focus for the allocation of QR funding and investment by the University. The ADAs will provide new opportunities for interdisciplinary collaboration across the University. Staff within the UoA retain a high degree of autonomy, and existing research programmes and areas of expertise will likely be maintained within the new ADA framework. The medium-term strategy from 2014, of growing capacity at a sustainable rate and building on existing strengths remains. The emphasis on applied, interdisciplinary and collaborative research continues.

The UoA's current strategic objectives are to:

- Maintain the trajectory of increased funding.
- Achieve a sustainable increase in PhD student numbers.
- Increase the number of staff with Significant Responsibility for Research (SRR) and grow research activity among staff without SRR.
- Encourage and support the cultivation of long-term collaborations with external stakeholders, with an emphasis on measuring impact and quantifying benefits.

Geographical Information Systems will continue its successful involvement with WISERD to improve the development of public policy and practice in Wales and build on existing collaborations with governmental and non-governmental partners, such as Sport Wales, and the Care and Social Services Inspectorate Wales. It will strengthen its relationship with the Senedd/Welsh Parliament to better inform government policy. It will also explore the potential of drone surveying.

Hypermedia will build on existing successful collaborations with cultural heritage partners, such as Historic England, and identify new funding opportunities to support these collaborations. There are plans to develop Knowledge Organisation Systems (KOS) services with new collaborators and networks. New collaborations include work on conservation technologies with the University of Arts, London, Stanford University Library and other partners.

Biomedical Computing will continue existing successful collaborations to develop new diagnostic tools, with healthcare partners, such as Cardiff & Vale University Health Board and the Institute of Dermatology. The next stage for some work programmes will be clinical trials.

The lead for Cyber Security and Forensics, Professor Blyth, left the University to take up a post in industry. Recognising the area's strategic importance, new appointments were made (**Elmesiry, Qasem** and **Usman**). This expands the breadth of expertise, and the Internet of Things has been identified as a key topic for future development. The University of South Wales, the Welsh Government and Thales (a multinational technology company) are working together to establish a National Digital Exploitation Centre, which will include an Advanced Cyber Institute for academic research. The recently established Pan-University Cyber Network is an opportunity to further grow interdisciplinary working.

Artificial Intelligence currently has only a small number of staff with SRR, so there is a need to build capacity. This additional capacity is likely to come through staff development. The recently established Pan-University AI Network provides additional opportunities for collaboration and growth.

2. People

Staffing strategy and staff development

The Faculty of Computing, Engineering and Science's (FCES) Faculty Strategy and Action Plan 2017-2020 (FSAP) requires that all new academic staff are active practitioners or researchers, and assigned a research mentor. Academic staff recruitment will focus on Early Career Researchers, and new staff will need a PhD and a record of publications. Staff recruitment is guided by strategic growth goals in specific research areas, such as the appointment of **Elmesiry, Qasem** and **Usman** in Cyber Security and Forensics, and teaching requirements.

The FSAP includes a target for a 20% increase by 2021 (relative to its 2017 base) in the number of staff who have generated a research, pedagogical or professional output in the previous two years. A process of undergraduate and postgraduate module rationalisation has been undertaken to reduce overall workload and provide staff with more time for research and

scholarship. Existing staff are also encouraged to undertake a PhD and 50% funding is available via the University Continuing Personal Education scheme. Two members of staff have completed PhDs during the REF period, one is currently in progress, and a further proposal is being considered by the Faculty Research Degrees Committee.

Staff development is managed through the Development and Performance Review Scheme. Staff members meet annually with their Line Managers to review achievement against previous objectives, set new objectives and identify any development needs. A mid-point review is held to review progress against existing objectives.

Staff career development is fully supported by the University through a range of internal and external opportunities. For example, Research and Innovation Services (RISe) provides a variety of specialist workshops and masterclasses to help academics develop successful funding applications and deliver impact from their research. 60% of staff in the UoA have undertaken this training during the REF period. **Roula** also participated in the Welsh Crucible Scheme in 2013. This external and competitive pan-Wales programme develops future research leaders and encourages cross-disciplinary research. As part of the scheme, **Roula** was awarded a grant to undertake a research project with Cardiff University entitled 'Social communication in autism spectrum disorder: The role of synchrony explored using computer pattern matching'.

Staff involved in research student supervision undergo mandatory continuous training on regulations and good practice through multi-day workshops and drop-in sessions. New staff are required to complete the University's PgCert in Teaching and Learning in Higher Education. Upon completion, staff are awarded Advance HE Fellowship. Experienced staff are also encouraged to gain this status via application.

Appointments to Associate Professor and full Professor are made by the University's Higher Academic Awards Committee (HAAC) in recognition of research excellence and in line with the University's Research Strategy. Each appointment is reviewed every five years by the HAAC. **Kulon** was appointed Associate Professor in 2013. The four Professors and five Associate Professors in the UoA have all been reviewed and reappointed during the REF period.

Research and Innovation Services (RISe) runs Advance HE's Postgraduate Research Experience Survey (PRES) every two years. It also runs Vitae's Careers in Research Online Survey (CROS) and the Principal Investigators and Research Leaders Survey (PIRLS) annually. Feedback has resulted in numerous improvements, such as changes to the Development and Performance Review Scheme to better reflect research objectives and achievements.

Research Students

Date period	Number of Doctoral Degrees
01-08-2013 to 31-07-2014	4
01-08-2014 to 31-07-2015	8
01-08-2015 to 31-07-2016	5
01-08-2016 to 31-07-2017	3

01-08-2017 to 31-07-2018	6
01-08-2018 to 31-07-2019	6
01-08-2019 to 31-07-2020	1
Total	33

34 PhD and two MRes students currently are being supervised by UoA and wider computing staff. Postgraduate research students are supervised by a Director of Studies and one or more additional Supervisors. At least one member of each supervision team must have supervised a minimum of two successful completions. Supervisors undertake mandatory continuous training monitored by the Faculty Research Degrees Committee (FRDC).

Students meet with a member of their supervisory team, usually their Director of Studies, on a weekly or fortnightly basis, as required. Supervisory meeting notes are uploaded to the University's research management information system (Haplo PhD Manager), which both the student and supervisory team can access and contribute to. The system also captures student training activities and facilitates effective progress monitoring by the FRDC and Graduate School Board. Individual student progress is monitored annually by the FRDC. The FRDC also oversees suspensions, extensions and changes to supervision teams, and monitors supervisor workload. **A Ware** is Chair of the FRDC and **Cunliffe** is a member. The postgraduate students also have a representative on the FRDC. **Cunliffe** is also a member of the Faculty Ethics Committee, which is responsible for the ethical scrutiny of staff and student research projects.

Between 2013 and 2017, the University's Postgraduate Research Centre provided an environment for research students from multiple disciplines to come together and support each other through their development as early career researchers. In 2018, a University-wide Graduate School was established. This administers (via Haplo PhD Manager) research students' journey to graduation, supports students and supervisors, and facilitates network development and research engagement through a Research Engagement Fund (£750 per student). It also hosts an annual postgraduate conference. The Graduate School is based on the same campus as the School of Computing and Mathematics, providing easy access for students.

New research students are encouraged to engage with the Graduate School's training events, which provide a framework for developing and delivering impactful research. These training workshops are mapped to the domains of the Vitae Researcher Development Framework (RDF). Knowledge Economy Skills Scholarships (KESS) postgraduate students attend an externally-led residential KESS Graduate School during the early or mid-phase of their research programme. Here, the focus is on working effectively with others outside their research environment and interacting with different project stakeholders.

As part of their development, research students can contribute to undergraduate teaching, either informally or as Hourly Paid Lecturers (HPLs). Their teaching responsibilities range from supporting practicals, to preparing and delivering taught activities.

The Faculty offers Graduate Teaching Associate (GTA) posts. These support graduates to develop the skills and experience required to become lecturers. GTAs are enrolled as part-time

PhD students and employed as part-time lecturers. At the end of the five year GTA period, the University aims to move the student into a permanent lecturer's position. One GTA is currently working within the School of Computing and Mathematics.

Research students are allocated their own desk, computer (including necessary standard and specialist software) and storage space in an office shared with other research students. Research student offices are located alongside computing staff offices on the University's main Treforest campus. Remote log-in facilities allow for flexible working.

Equality and diversity

The UoA is fully committed to supporting equality and diversity across the University and the wider subject discipline. All staff undertake mandatory Equality, Diversity and Inclusion training. **Cunliffe** is a member of the School of Computing and Mathematics self-assessment team, working towards achieving an Athena Swan Charter Award for the School. Staff from the School founded the Women in Cyber, Wales sub-cluster in 2018.

While the UoA included one female staff member in the REF 2014, there are none in the current submission. This reflects an underrepresentation of female academics across all grades within Science, Technology Engineering and Mathematics (STEM) subjects at the University, particularly at Associate Professor and Professor level. While the University has launched several initiatives to address this, such as the Women's Development Programme, the impact has yet to feed through to the UoA.

3. Income, infrastructure and facilities

Income

The UoA generates both research and consultancy income. During the current REF period, more than £5.9 million has been generated, compared to just over £3 million in the previous REF period, an increase of 95%.

Date period	Income (£)
01-08-2013 to 31-07-2014	637,274
01-08-2014 to 31-07-2015	1,009,855
01-08-2015 to 31-07-2016	688,515
01-08-2016 to 31-07-2017	798,384
01-08-2017 to 31-07-2018	892,005
01-08-2018 to 31-07-2019	915,405
01-08-2019 to 31-07-2020	1,043,682
Total	5,985,123

Research income was received during the REF 2021 period from sources including the AHRC, ESRC, Historic England, Historic Environment Scotland, WEFO, the European Commission and the Welsh Government. Research and Innovation Services manages grants and provides specialist advice and support for grant applications.

Commercial income, totalling just over £900K, has been generated through work for companies and organisations, such as Cyber Security work with the Defence Science and Technology Laboratory and GCHQ. Business Services provides specialist advice and support for commercial work.

Specialist Research Facilities

The School of Computing and Mathematics is located in a single block on the University's main Treforest campus. All staff and research students have a high-quality research setting with individual networked desktop PCs installed with standard and appropriate specialist research software, such as NVivo, MATLAB (signal and image processing toolbox), and National Instruments LabVIEW software. Staff receive professional IT support from an on-campus team.

The University has four campus library collections, each reflecting the subjects taught on that campus. The main library collection at the Treforest Learning Resources Centre provides immediate access to a wide range of resources and services for staff and students.

The Cyber Defence Centre is a commercial research and consultancy laboratory. It was established in 2017 with £150K of Faculty funding. It initially included staff time buyout and funding for a Research Assistant. The laboratory provides hardware and software support for commercial work undertaken for industry clients, law enforcement and government agencies, including London Metropolitan Police, South Wales Police, Dyfed Powys Police, West Mercia Police, Isle of Wight Police and Avon & Somerset Police.

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

The Centre of Excellence in Mobile and Emerging Technologies (CEMET) is based in the Faculty of Computing, Engineering and Science. The Centre supports Welsh businesses seeking to create new products, solutions and services, through bespoke collaborative development projects using technologies such as AI, Augmented and Virtual Reality, and the Internet of Things. CEMET has worked with 82 companies from across Wales. The programme is part funded by the European Regional Development Fund (ERDF), through the Welsh Government.

The University is a partner in the pan-Wales, ESF-funded Knowledge Economy Skills Scholarships (KESS) programme. KESS supports PhD and MRes scholarships, with the students working in collaboration with a Welsh industry partner. There are currently 13 KESS PhD students and three KESS MRes students within the UoA. Partners have included industry (SymIconnect, CGI, ITSUS Consulting Ltd, Thales, ObjectTech Group Ltd, Tata Steel Ltd), the public sector (Cardiff and Vale University Health Board, National Health Service Wales Informatics Service, Sports Wales) and third sector organisations (Tenovus Cancer Care).

The University of South Wales is a hub for the Technocamps schools outreach programme which supports digital upskilling across Wales. The current project, Enhancing STEM Attainment (September 2018-September 2021), is funded jointly through WEFO (with a £1.2M ESF grant) and the Welsh Government (with a grant totalling £84K). At the University hub, there are five full-time and three part-time funded posts. The University hub has already

delivered the programme to over 700 secondary school pupils. It has also delivered Continuous Professional Development (CPD) sessions to teachers and worked with over 500 primary school pupils. Staff from the University hub actively disseminate their project experience, presenting at the 2020 Online Teachers and Advisors Conference, for example. School of Computing and Mathematics staff have also contributed to Technocamps events, giving guest lectures about their research.

Two companies were established by staff during the REF period. Thermetrix Ltd was established in 2016 and designs and implements bespoke optical instrumentation. The Awen Collective Ltd was established in 2017. It is a software company producing cyber-incident response solutions and digital forensics software for Industrial Control Systems, Robotics and Internet of Things devices. The University provided support to these companies through early stage funding and staff time to develop the companies.

British Bobsleigh and Skeleton (BBSA) has employed a company to produce a sensor system, developed for it by **McCarthy**, which monitors athletes during training. Initial work to support this project was funded by an I2S grant (Innovation and Impact Scheme, HEFCW backed funding to support innovation and engagement). **McCarthy** was awarded Proof of Concept Funding under this scheme, to demonstrate a technology: comparative accelerometer system for enhancing training, protection and performance in elite sport and beyond.

Geographical Information Systems

Since 2008, **Higgs** has served as Co-Director of the Wales Institute of Social and Economic Research, Data and Methods (WISERD). WISERD is a national interdisciplinary social science research institute, designated as a National Research Centre by the Welsh Government. It is a collaborative venture between the universities of Aberystwyth, Bangor, Cardiff, South Wales and Swansea, and is currently funded by an ESRC Large Centres Grant with contributions from the participating universities. WISERD is now a Partner Centre of the ESRC National Centre for Research Methods. **Higgs** directs WISERD's Training and Capacity Building programme and will lead the organisation of training events across WISERD's disciplines, which are delivered to a wider UK audience.

WISERD has been awarded (from October 2019) £8m of additional funding from the ESRC and a further £4.6m from partner universities, including the University of South Wales. As part of this Third Phase of funding, it is undertaking a five-year programme (2019-2024) of policy relevant research to address Civil Society, Civic Stratification and Civil Repair in Wales, the UK and internationally. The research will be inter-institutional and multidisciplinary and produce new evidence on the changing nature of civil society.

As part of its work examining geographical variation in a range of public and private services, GIS has worked with organisations including Sport Wales, the Care and Social Services Inspectorate Wales, the Welsh Government's Knowledge and Analytical Services and Department for Economy, Skills and Natural Resources divisions, and Tenovus Cancer Care. There is also an ongoing collaboration with researchers based at the School of Earth and Environmental Sciences, University of Queensland, Australia.

Langford has been awarded a 2020 Academic Fellowship by the Senedd Commission (the Senedd/Welsh Parliament's corporate body) to pursue research on using network-based accessibility models to examine variations in the provision of financial services in Wales. Key objectives include informing members of the Senedd about geographical patterns in access levels to in-branch banking and ATM facilities across Wales; and the potential impacts on local communities of recent and future reductions in service provision.

School of Computing and Mathematics staff members include a qualified Civil Aviation Authority (CAA) commercial drone pilot, who specialises in drone surveying, photography and mapping. Surveying features such as coastal erosion, non-indigenous plant proliferation and land slip for both research and commercial purposes is an ongoing area of development.

Hypermedia

Hypermedia research outputs have informed the UK historic environment strategy as well as major European archaeological data centres.

Funded projects (**Tudhope**, **Binding**) overlapping the REF period include an AHRC Follow-On Fund project on semantic web services and Linked Data in archaeology, in collaboration with strategic partners at English Heritage, the Archaeology Data Service, RCAHMS and RCAHMSW. This has been followed by a Historic England (formerly English Heritage) funded project on Linked Data for the Historic Environment. A transatlantic Digging into Data project with the Universities of Manchester and Drexel (Philadelphia, USA) also developed tools for the automatic generation of subject metadata.

Building on the UK semantic technologies work, two European Commission archaeological research infrastructure projects led to international collaboration. The ARIADNE FP7 project (2013-2017) for archaeology involved 24 partners, including most existing European national services and data centres. It integrated archaeological data infrastructures to widen access to the various distributed datasets. University of South Wales's role as Leader of the Linked Data Work Package built on the AHRC-funded research. The follow-on ARIADNEplus H2020 project (2019-2022) extends the collaboration (with over 40 partners) and deepens the data integration. USW work on vocabulary mapping made a significant impact on the multilingual capability of the European projects. The mapping focus was continued in an AHRC-funded Linked Conservation Data Phase 2 networking project, led by University of Arts (London) and Stanford University, to enhance UK and USA collaboration and support further work. Other partners include the Bodleian library, British Museum, National Gallery, National Galleries Scotland, Getty Research Institute, and the Library of Congress.

USW also collaborated with the University of Florence, Italy (PIN research agency) on a European Open Science Cloud for Research Pilot Project on Natural Language Processing (NLP) for Italian language archaeological texts, building on work for ARIADNE. Other NLP work includes two Welsh Government-funded projects (**Cunliffe**, **Tudhope**) to develop a Welsh Natural Language Toolkit to underpin NLP Welsh language software development.

Binding has created an archive of European NKOS Workshops from 2000 on Github as a community resource for the Networked Organisation Systems/Services community. **Tudhope**

and **Binding** are also currently involved with the AHRC-funded Matrix Project to investigate supporting tools for archaeological phasing analysis (led by Historic England).

Cunliffe was an Academic Collaborator in the RE-DrAW consortium. Led by the University of South Wales, with Aberystwyth University and the University of Surrey, it was funded by the (AHRC/NESTA) Digital R&D fund for Wales. The consortium funded and supported partnerships in the Welsh creative industries by using mobile and digital technologies to improve audience engagement. Partners included NoFit State Circus and National Theatre Wales/Theatr Genedlaethol Cymru.

Within the REF period, **Cunliffe** has undertaken interdisciplinary collaborative research into the relationship between ICT and minority language maintenance with academics from the University of Waikato, New Zealand; the University of Hamburg, Germany; the University of Maastricht, The Netherlands; the University of Missouri – Kansas City, USA, and Yorkville University, Canada.

Biomedical Computing

As part of an ongoing collaboration with Cardiff & Vale University Health Board's Rehabilitation Engineering Unit (REU), **Kulon** is investigating new techniques to improve the postural assessment of patients with severe neuro-musculoskeletal and postural conditions. The research has led to the development of a new 3D Interactive Digital Human Model (DHM) and a novel heuristic method to dynamically control a digital skeleton to represent spinal shape from a set of anatomical markers. The REU has devoted substantial resources to the research and continues to contribute by making available clinical facilities and laboratories. The REU has used the DHM in clinical demonstrations, such as at seminars held at the Artificial Limb and Appliance Service (ALAS) and Cardiff Medicentre, attended by 20-30 representatives of NHS Trusts' Medical Physics and Rehabilitation Engineering Units. A prototype version of the DHM was described in the Cardiff and Vale University Health Board's July 2017 newsletter, which was sent to 14,000 NHS employees.

A new project – “Clinical Decision Support System for Skin Monitoring and Melanoma Detection using Machine Learning” – began in October 2019, funded via the KESS program. The research is testing whether successful implementation of a machine learning algorithm on a mobile platform can improve General Practitioners' ability to confidently diagnose and manage patients with suspected skin cancer within their practice. This could reduce the need for time-consuming and costly referrals for face-to-face dermatologist consultations. This project is being conducted in collaboration with the Clinical Bioinformatics team, Cardiff & Vale University Health Board and the Institute of Dermatology, University Hospital of Wales, Cardiff, represented by Dr Richard Motley. Dr Motley is Chairman of the Speciality Training Committee for Dermatology in Wales, which oversees the training of dermatologists in Wales, and has pioneered the teledermatology service in Cardiff.

A long-term collaboration between **McCarthy** and co-workers in China (Lui, and co-workers at Harbin University) and Australia (Cascioli) is approaching a solution to aid people with sensory or high nervous system dysfunction who are subjected to prolonged periods of sitting and

therefore predisposed to skin ulceration. The work to generate a sensor-based alert system based on a predictive algorithm should soon be clinically trialled.

McCarthy is collaborating with back pain researchers in the Vrije University Amsterdam, The Netherlands, to use bespoke data analysis software to perform a new variant meta-analysis. This makes available much more data, providing a greater depth of analysis.

Artificial Intelligence

Research work in Artificial Intelligence is benefitting the local economy. For example, the University is involved in a Knowledge Transfer Partnership with Wey Education, an innovative online secondary school, which is using AI to facilitate the delivery of teaching material and automated assessment marking. Meanwhile, Tata Steel is funding two PhD students who are working on techniques to help predict equipment breakdown so preventative measures can be taken before failure occurs. The University is also involved in a tripartite Smart Partnership with Aurora International Consulting and IBM Watson, investigating the use of AI technologies to determine the accuracy and rigour of Risk Assessment reports produced for the construction industry. Two PhD students funded by National Health Service Wales Informatics Service are investigating how machine learning techniques can be applied to health data to ensure that resources are used in the most effective way.

A Ware is a Visiting Professor at ITM Universe Vadodara, Gujarat, India, where he is involved in work on medical information systems. This complements his role as Director of the Welsh Institute of Digital Information – a health informatics collaboration between the NHS Wales Informatics Service (NWIS), University of Wales Trinity Saint David, and the University of South Wales. Over the last five years, **A Ware** also helped to develop in Uganda a cheap but effective means of detecting cervical cancer.

Cyber Security and Forensics

The University of South Wales, the Welsh Government and Thales (a multinational technology company) are working together to establish a £20m National Digital Exploitation Centre. The Centre will provide Small and Medium-sized Enterprises (SMEs) and microbusinesses with a base to test and develop their digital concepts, and a research lab in which multinationals can develop major technology. The University will also run an Advanced Cyber Institute at the Centre for academic research. It will operate a Digital Education Centre to enable SMEs, schools and individuals to acquire the skills they need to protect themselves online. The Faculty has appointed four KESS-funded PhD students, with Thales as the industrial partner.

A School of Computing and Mathematics staff member is a Home Office advisor, working with the UK Forensic Science Regulator on setting UK standards. They are also Chair of the F3 (First Forensic Forum), a member of the Interpol Digital Forensics Expert Group, and a member of the UK Government Digital Forensics Specialist Group. Another staff member from the School has served on the Welsh Government's Cyber Resilience Board.

The University won the 2019 and 2020 Cyber University of the Year Awards, and was a finalist at the 2019 FinTech Awards Wales.

Within the REF period, **Usman** has undertaken collaborative research in applied cyber security with academics from Griffith University, Australia; King Khalid University, Saudi Arabia; Bahria University, Pakistan; Comsats University, Pakistan; Ch. Charan Singh University, India; International Islamic University, Pakistan; Istanbul Gelisim University, Turkey; Yeungnam University, South Korea; Quaid-i-Azam University, Pakistan; and Brandon University, Canada.

Visiting Appointments

A Ware is a Visiting Professor at the University of Kurdistan Hewlêr, Iraq, and at ITM Universe in India. He is also a Visiting Professor at NWIS (NHS Wales Informatics Service).

Cunliffe is an Affiliate of the Center for Computed-Mediated Communication at Indiana University, USA.

Usman is a member of the Network Security Group at Griffith University, Australia. He is also co-supervising PhD students at Quaid-i-Azam University, Pakistan.

There are currently three Visiting Professors and four Visiting Fellows associated with the UoA. The Visiting Professors are: Kurt Ammer (former Medical Vice-Director of the Institute for Physical Medicine & Rehabilitation at the Hanuschkrankenhaus in Vienna, Austria); Andrew Beckett (a Managing Director and EMEA Leader for Cyber Risk Practice at Kroll); and Graham Machin (National Physical Laboratory). The Visiting Fellows are: Keith May (Historic England); Renato Rocha Souza (Austrian Centre for Digital Humanities); Ricardo Angelo Rosa Vardasca (Universidade do Porto); and Andreas Vlachidis (UCL).

Conference and Workshop Organisation

Cunliffe has served as a Programme Committee Member for the International Conference on Web Information Systems and Technologies (2010 to 2020) and for the International Conference on WWW/Internet (2009-2019), and as a Scientific Committee Member for the International Conference on Language Resources and Evaluation (2016, 2018).

Higgs was Conference Chair for the WISERD Annual Conference University of South Wales, July 2018. **Higgs** has been a Panel Member for the RGS/IBG Geographical Information Science Research Group: Best Dissertation in the area of Geographic Information Science, since 2012.

Higgs and **Langford** are on the organising committee for the GIS Research UK conference to be held in Cardiff in April 2021.

Kulon was a Session Chair at the IEEE International Conference on Medical Measurements and Applications (MEMEA 2016), Benevento, Italy.

Tudhope has co-organised nine workshops on Networked Knowledge Organisation Systems / Services during the REF period at the Theory and Practice of Digital Libraries and the Dublin Core Metadata Initiative conferences. Two NKOS Special Issues of the International Journal on Digital Libraries (Springer, 2015, 2018) followed, with **Tudhope** a co-guest editor for both. A

third Special Issue, also co-guest edited by **Tudhope**, was published in the Journal of Data and Information Science (National Science Library of the Chinese Academy of Sciences, 2020). **Tudhope** has served on the Programme Committee for the following conferences and workshops within the REF period: Computer Applications and Quantitative Methods in Archaeology (CAA); Dublin Core Metadata Initiative (DCMI); UK Conference of the International Society for Knowledge Organisation (ISKO-UK Review Panel); Joint Conference on Digital Libraries (JCDL); International Conference on Theory and Practice of Digital Libraries (TPDL); International Workshop on Semantic Web for Cultural Heritage (SW4CH), W4A.

Usman has served in different capacities, including as publication chair, organising committee member and/or TPC member for numerous IEEE conferences. These include: IEEE DASC 2020; IEEE ISST-ITS - TrustCom 2019; IEEE DependSys 2019; IEEE Workshop - ISA in IoS 2018; IEEE ICET 2018; IEEE ICCAIS-2018; IEEE IBCAST 2018; IEEE Intellect 2017 and IEEE IBMSGs 2015 and IEEE UWCSN 2014.

Journal Editorships

Cunliffe (Editor-in-Chief) and **Tudhope** (Editor) have edited The New Review of Hypermedia and Multimedia journal, published by Taylor & Francis, since 1997.

Cunliffe has been a Section Editor for the Australasian Journal of Information Systems since 2018.

Higgs is an Editorial Board Member for the International Journal of Health Geographics.

McCarthy is Associate Editor of Chiropractic and Manual Therapies (BMC/Springer-Nature) and has recently guest edited the journal Sensors (MDPI: Humidity sensors issue). He is currently guest editing a follow-up issue on the application of sensors.

Usman was a lead guest editor of a special issue on Security, Privacy, Trust, and Access Control in Industrial Applications, IEEE Transactions on Industry Applications, May/June 2020. He was a co-guest editor of a special issue on Computational Intelligence for Human-in-the-Loop Cyber Physical Systems, IEEE Transactions on Emerging Topics in Computational Intelligence, 2020/2021. He is also an Editorial Board member of the Smart Science journal. **Usman** is an invited co-guest editor of a special issue on Blockchain Technologies in IoT: Current Applications and Future Directions, Sensors, 2021.

Advisory Board Membership

Cunliffe:

Member of the Welsh Language Technology Ministerial Advisory Board (since 2012).
Involved in the creation of the Welsh Government's "Welsh Language Technology Action Plan" (2018).

Member of the Advisory Board for the Digital Language Diversity Project, funded under the Erasmus+ scheme (2015-2018).

Member of the Advisory Board for the VirtuLApp (Virtual Language App) Strategic Partnership Project, funded under the Erasmus+ scheme (since 2019).

Member of the Advisory Committee of the National Welsh Language Technologies Network, project sponsored by the Welsh Government (since 2020).

Management Committee Substitute (UK), COST Action Management Committee, COST Action CA19102, Language In The Human-Machine Era (since 2020).

Langford:

Academic Fellow appointment by the Senedd Commission (2020), “Exploring geographical patterns in the changing landscape of financial services provision in Wales.”

Usman:

Member of a recruitment panel of ICT executive and lower-level staff at Islamabad High Court, Pakistan. Adviser to the recruitment panels of several ICT and Cyber Security companies.

Invited Keynote and Plenary Talks

Cunliffe:

Invited speaker (jointly with Dr Jeremy Evas, School of Welsh, Cardiff University), Network to Promote Linguistic Diversity Conference on Unlocking the Potential of Technology to Promote Constitutional, Regional and Small-State Language Usage (Cardiff, 2014).

Invited speaker, Mercator/SOAS congress on Multilingualism & Social Media (Leeuwarden, 2014).

Invited speaker, AHRC research network on Television from small nations: building a network for cultural and commercial success. (Cardiff, 2015).

Invited speaker, AHRC Research Network on Language Revitalization and Socio-cultural Transformation (Aberystwyth, 2017).

Invited Keynote lecture, “Can social media provide breathing spaces for minority languages?”, at the Conference on Frisian Humanities (Leeuwarden, 2018).

Invited speaker, Federal Union of European Nationalities (FUEN), Non-Kin-State Working Group, Annual Meeting (Constanta, 2019)

Invited speaker, Minority Languages in the Digital Age. Usage, Maintenance, and Teaching Conference (Griefswald, 2020).

Tudhope:

Invited presentation, virtual heritage conference on Open Science and FAIR data (Findable, Accessible, Interoperable, Re-usable) organised by the University of Tours (2020).

Usman:

Invited article: Enhancing Cybersecurity in Commercial Aviation, *Aviation Business* (2020).

A Ware:

Invited Keynote lecture "Neural Networks: A Brief History and Futuristic Glance", International Conference on Information Science & Communication Technology (Karachi, 2019).

Invited Keynote lecture "Applications of AI: A Pragmatic Perspective", World Congress in Computer Science, Computer Engineering & Applied Computing (CSCE'18), (Las Vegas, 2018).

Invited Keynote lecture "Mining for Data's Golden Nuggets", Frontiers of Information Technology (Islamabad, 2017).

Invited Keynote lecture "The Advance of Intelligent Systems", Second International Conference on Emerging Trends in Engineering Sciences & Technology, (Karachi, 2017).

Prizes and Awards

Cunliffe:

Contributed a chapter to the Palgrave Handbook of Minority Languages and Communities, which was awarded the 2020 British Association for Applied Linguistics book prize.

Elmesiry:

Best paper award, co-author, "Privacy-Preserving Threat Hunting in Smart Home Environments", at the International Conference on Advances in Cyber Security, 2019.

Tudhope:

Outstanding paper award in the 2016 Emerald Literati Network Awards for Excellence, co-author, "Negation detection and word sense disambiguation in digital archaeology reports for the purposes of semantic annotation". Earlier version awarded best post-doctoral paper at 7th Metadata and Semantics Research Conference (MTSR 2013).

Usman:

Best paper award, co-author, "Dynamic Trust Evaluation of Learning Objects", at IEEE ComTech, 2017.

A Ware:

Best paper award, co-author, "NiHA: A Conscious Agent" at 10th International Conference on Advanced Cognitive Technologies and Applications (COGNITIVE 2018).

Learned Societies

Kulon was elevated to the grade of Senior Member of the IEEE in 2016.