

Institution: Aston University

Unit of Assessment: 11 Computer Science and Informatics

1. Unit Context and Structure, Research and Impact strategy

1.1 Context and Structure

Aston University was founded in 1895 to support business, local industry and the community, with science and engineering at its core (Institutional Level Environment Statement, ILES1.1). Inclusion and impact are two strong themes running within Aston's strategy and our success in these areas was recognised in 2020 by several national awards including the **"University of the Year"** accolade from The Guardian and the **"Entrepreneurial University of the Year"** award from The Times Higher Education (ILES1.2).

Within Aston, the College of Engineering and Physical Sciences (EPS) maintains a high-quality collaborative research environment with focused investment in areas where we can demonstrate internationally leading research with significant impact. The College is submitting research to UoA11 and UoA12. Since 2014, we have enhanced our agile and supportive environment to enable staff to win international, national and regional funding leading to impactful research. Reflecting this, most of our publications involve international co-authors (significantly above sector-average for UoA11) and the majority of our impact case studies are international in scale. For example, Bastin's development of biodiversity tools at the European Commission's Joint Research Centre (JRC) has had world-wide impact.

The EPS structure (Figure 1) results from the wider re-organization within the University in 2020 (ILES2.1). EPS comprises three Schools, each of cognate disciplines: Engineering and Technology; Informatics and Digital Engineering; and Infrastructure and Sustainable Engineering. ASTUTE, EBRI and AIPT, described below, are our overarching Research Institutes. This structure supports an interdisciplinary approach to research and impact, as well as addressing a growing requirement for multi-disciplinary skills for scientists and engineers at all levels (ILES2.9). Aston's submission to UoA11 comprises Computer Scientists and Mathematicians who sit within the School of Informatics and Digital Engineering and ASTUTE.

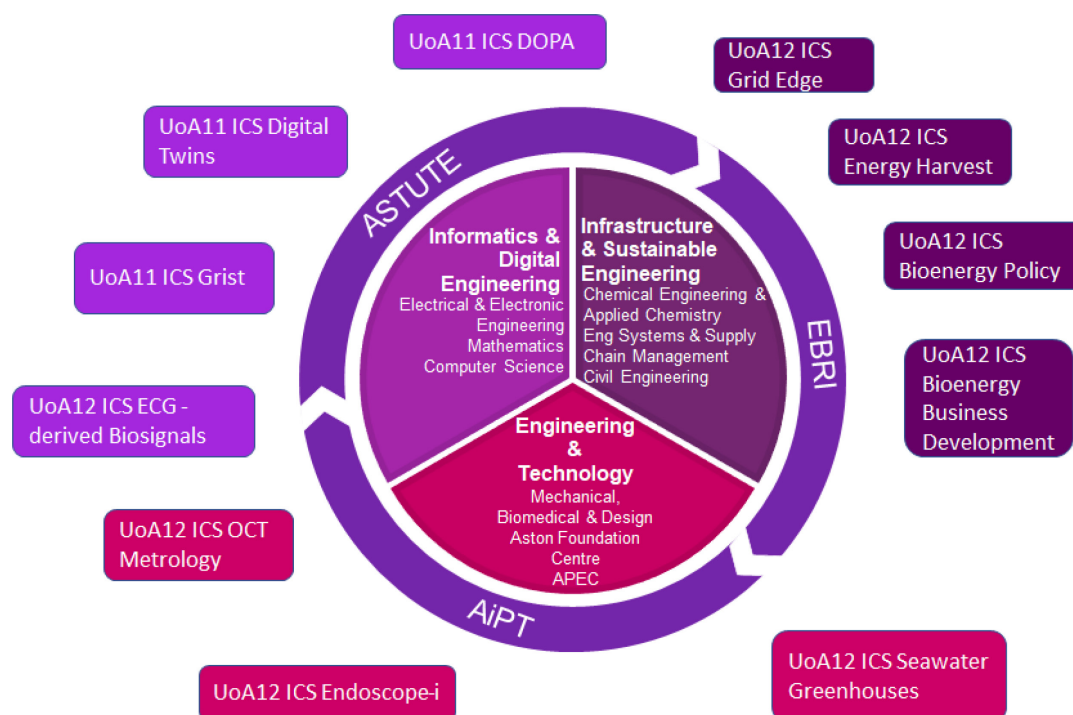


Figure 1: College structure showing Schools, Departments and Research Institutes and related impact case study areas

Unit-level environment template (REF5b)

Knowledge Exchange (KE), underpinned by our research expertise, is fundamental to the College ethos and aligns with Aston's strategy that emphasises the importance of impact by structuring thinking directly around Aston's three beneficiary groups: (i) its students, (ii) business, professions and the public sector and (iii) the region and society (ILES1.1). Our research contributes significantly to the regional economy where we have strong collaborations with large companies and SMEs (ILES1.4). Aston is a leading UK university for consultancy and Knowledge Transfer Partnerships (KTPs) – reflecting our strong links with SMEs – and this enables us to identify trends within sectors and opportunities for more in-depth interactions and value-added partnerships.

Aston has the largest current KTP portfolio (27) of Midlands Universities, and the 8th largest portfolio in the UK. ASTUTE staff won awards at Innovate UK's '**Best of the Best**' KTP Awards in consecutive years: in 2020, *The Most Effective KTP initiative*, for their work developing the Computer Science Industry Club (Section 4.5) to support KE, and in 2019 in *The Best Future Innovator* category for a collaboration with Sarissa Biomedical. Industry Club member, Majestic (a Birmingham-based independent technology company providing the largest commercial link database in the world) won the **Princess Royal Award for Training** in 2018 for their work in a partnership with Aston University to develop a placement year for gifted students. Additionally, one of our ERDF funded innovation projects – **Think Beyond Data** – will on completion have contributed over £4m GVA to the regional economy.

Research Institutes

Following REF2014, our priority has been to develop more cohesion between subject-specific research areas. To address this, we have three multi-faceted, collaborative Research Institutes. The Aston Institute of Photonic Technologies (AIPT) and the Energy and Bioproducts Research Institute (EBRI) were two of the four initial University Research Institutes (URIs) created in 2019 (ILES2.5). Each URI represents an area of critical mass undertaking excellent research with impact. The Aston Institute for Urban Technologies and the Environment (ASTUTE) was established as a third College Institute in 2018. ASTUTE consolidates interdisciplinary research activities in informatics, materials and logistics to respond to the strategic research challenges in developing low-carbon and sustainable urban environments. Our aspiration is for ASTUTE to obtain URI status in the next REF period. Category A staff submitted to UoA11 are all members of ASTUTE. In addition, reflecting the interdisciplinarity and collaborative nature of our research across the College, 55 Category A staff returned to UoA12 are also members of ASTUTE.

The research areas of each of the Institutes are:

- **ASTUTE** brings together technologies and capabilities that are key to enabling sustainable living in the city of the future. At the heart of the Institute's vision is the idea that technologies should be developed for the benefit of the urban citizen, contributing to an improved quality of life by enhancing mobility, creating a greener, more sustainable environment and extracting the maximum benefit from the vast quantities of data generated by modern pervasive computing systems. ASTUTE enhances the relationship between researchers from different but complementary fields such as logistics and data analytics or machine learning, enabling them to tackle the major interdisciplinary challenges facing the modern city under the pillars of Digital Engineering, Mobility, Health and Energy.
- **AIPT** focuses on the science and technology of light, integrating both blue-sky and applied research with education and industrial collaboration. Areas of research excellence include optical communications, fibre devices, biophotonics and free-space optics.
- **EBRI** carries out world-leading research into new and innovative ways of converting biomass into sources of sustainable energy, using thermochemical, biological and catalytic processes. EBRI members engage with colleagues nationally and internationally on supply chains, business models, policy, regulation and system performance.

1.2 Research Strategy

Aston's Research Strategy (ILES2.3) is to prioritise impactful, collaborative, excellent and financially sustainable research. Since 2014, EPS strategy has evolved to align with the UK Government's Industrial Strategy Grand Challenges and UN Sustainable Development Goals to enable us to tackle some of the big societal challenges in an impactful way. Examples involving ASTUTE members are showcased in our impact case studies (ICS):

- **Sustainable cities and communities** – where Clark's (UoA11) ICS "Digital Twins for Complex System Engineering" demonstrates the impact of his work with Tata Consultancy Services (TCS) Research. He developed a new agent programming technology for simulating and analysing complex enterprise systems using digital twin principles. The results have been used in the field by TCS to improve their ability to provide client demonstrators and commercial solutions, and the technology has been productized by TCS as TwinX™.
- **Good health and wellbeing** - Buckingham's (UoA11) ICS "The Galatean Risk and Safety Technology, GRIST: a web-based system for collaborative mental-health assessment and management" describes a mental-health clinical decision support system that is delivered by Aston as a cloud-computing service. It is used around the clock by NHS, charity and private hospital practitioners to assess and manage risks associated with mental-health problems. A second ICS, "ECG-derived biosignals for improved healthcare outcomes and a Real-time Adaptive Predictive Indicator of Deterioration (RAPID)" describes how research by Herzallah (UoA12) and Lowe (UoA11) led to product improvements in adult and paediatric healthcare after novel algorithms were implemented into a commercial system developed by world-leading digital healthcare company, Isansys.
- **Life on Land** – where Bastin's (UoA11) ICS "Development and application of the Digital Observatory for Protected Areas" stemmed from a research collaboration with the European Commission's Joint Research Centre that ultimately saw Bastin as lead developer of the Digital Observatory for Protected Areas (DOPA). DOPA's suite of tools and services are a reliable, transparent and evidence-based source of policy-relevant data for government departments, agencies and Non-Governmental Organisations (NGOs) worldwide, including the UN's Convention on Biological Diversity and the European Commission.

The strategic aims of EPS are:

Excellence – Strengthening our research environment

This strategic strand is led by the Executive Dean (PVC-ED) and the Heads of Institutes (Hols). The key areas of priority are:

- **Strengthen the interaction between related research activities in informatics, logistics and materials.** This has been achieved by aligning existing areas of activity to strategic research priorities on infrastructure and urban systems. This led to the formation of ASTUTE, supported by some strategic appointments in Civil Engineering. By grouping staff thematically, we have created a more supportive and effective research environment with growing interdisciplinary research (IDR) links e.g., Saad (ASTUTE) is an investigator on the £6m [TRANSNET](#) programme grant, where he is applying machine learning techniques to optical communications with AIPT.
- **Strengthen our Institutes as centres of excellence by investing in their facilities and infrastructure.** This led to investment for AIPT of £7.7m in estates, £1.4m in equipment and £500k in research funding to ensure state of the art facilities. Similarly, for EBRI it resulted in £1.5m investment in estates, £1m in equipment and £1.5m in research funding. For Computer Science and Mathematics, we have implemented a £4.5m programme of office refurbishment to bring staff and PhD students into higher grade spaces with communal areas to encourage team support and cross fertilisation of ideas.

Unit-level environment template (REF5b)

- **Create a vibrant research community.** To address this, we have built on the IDR approach to capitalise on connected staff (ILES2.9 and 2.10). To increase research networking, various IDR activities have been instigated such as “show-and-tell” and workshop events for researchers and external visitors in areas such as Digital Engineering, Photonics and Sustainable Engineering. We also pump prime the development of international collaborations using Aston’s International Collaboration Fund, e.g., the hosting of Professor Takeshi Akinaga (Akita University) by Generalis in 2019 led to the subsequent award of an EU RISE project (824022).

We will continue to support the development of the Institutes, for example, by further strengthening the high-quality research environment (increased peer mentoring and reviewing for papers and grants), impact (newly launched innovation weeks), business development activities and increasing support for KE activities (ILES4.12). We continue to horizon-scan and nurture emerging areas, e.g., we are currently developing activities in circular economy and health engineering. In addition, we will increase the involvement of social scientists, whose expertise will contribute to the early social acceptability of rapidly developing technologies, such as driverless electric cars and artificial intelligence. These issues align closely with the Living with Technology and Data and Infrastructure focus of ESRC’s plan.

Excellence - Strengthening our people

This strategic strand is led by the PVC-ED, Associate Dean (Research) (ADR) and Hols. The key areas of priority are:

- **Grow the number of active researchers in the College and increase the numbers of researchers working within the Institutes.** The number of REF Category A staff has grown to 34FTE in UoA11 (from 18.20FTE in REF2014). This growth is due to recruitment of new staff on Teaching and Research contracts, plus the change to submission of 100% eligible staff. In addition, we have used strategic senior appointments to strengthen and consolidate specific research areas, e.g., Sawyer in Digital Health and Clark in Multi-agent Systems. Future growth areas for EPS are sustainable engineering and digital engineering, the latter encompassed by UoA11.
- **Develop our future research leaders.** Mentoring (ILES3.9) and training have proven to be effective, e.g., Xu came to Aston as Senior Lecturer in Manufacturing Engineering in 2017. Strong support led to a rapid development in his research leadership skills. He was promoted to a personal chair in 2020 and is now leading the Digital Engineering initiative within ASTUTE.
- **Strengthen the diversity and inclusivity of our research community.** We are making significant progress in this ongoing project (see Section 2). EPS has moved from Athena Swan Bronze to Silver in this REF period and will apply for Gold in 2021.
- **Improve the PhD experience.** Alongside the work of the Aston Graduate School (ILES3.15-3.19), we developed a comprehensive PGR training programme with an annual cohort of 15-30 PhD students (typically 7-8 in UoA11). Funding secured from the EPSRC Doctoral Training Programme as well as University investments is underpinning this initiative. For PGRs currently registered in UoA11, 33% are female and 48% are BAME indicating that we are on track to meet our 2025 diversity targets (see Section 2).

Impact Strategy

This strategic strand is led by the Deputy Dean (Enterprise and International) (DDEI) working closely with the Hols. The key areas of priority are:

- **To increase the amount of industry driven research and commercial activity.** Support from professional services colleagues in Research and Knowledge Exchange (RKE) (ILES1.3, 3.10, 4.5) has facilitated a threefold increase in the annual awards from Industry sources over the REF period with a further twofold increase in annual awards from ERDF projects focused on KE.

Unit-level environment template (REF5b)

- **Promoting links to regional companies.** ERDF funding has been used to work directly across all Institutes to support over 500 SMEs over the REF period. For example, ASTUTE has supported ERDF projects in data analytics, machine learning, supply chain management, low carbon industry, additive manufacturing and smart materials. In addition, a series of seminars has been established in ASTUTE to bring together companies in a particular sector with relevant academics along with Business Development Managers in RKE (ILES4.4), who proactively seek out opportunities for KTP projects (ILES2.6) (e.g., a workshop on Digital Engineering (10/2019) had speakers from MTC, Rolls-Royce and Arcadis).
- **Supporting impact through investment and flexible contracts.** We have used secondments and investment in equipment to support academics in accelerating impact. For example, Cornford worked part time at Aston to 2018, during which time he was able to use his research in machine learning and statistical methods to grow the Birmingham software development base of IGI Ltd, a company that specialises in geochemistry & basin modelling consultancy. Bastin's work with the JRC was also enabled by two secondments.

Through our Institutes and related business development support activities (ILES4.13) we robustly monitor our impact pipeline and support activities at different stages of maturity with financial support, appropriate networking and marketing. An annual programme of 'Innovation Weeks' is being used for team building and to train staff and PhD students who can move technology further along the technology readiness levels and address some of the skills gaps we see in SMEs. To encourage staff in this area, impact has been made a key element of Aston's Research Strategy and is explicitly considered in promotion applications (ILES3.3).

Collaboration Strategy

This strategic strand is led by the ADR with the Hols and DDEI. The key areas of priority are:

- **Increase international collaborations for staff and students** using both internal funding (e.g., the International Collaboration Fund (ILES2.9)) and applications to organisations, including the Leverhulme Trust, Royal Society, the Daiwa Foundation and the EU RISE scheme. Of all outputs published by staff in UoA11 during the REF period, 65% of publications have overseas co-authors, 5% ahead of the sector average for the disciplines.
- **Continue to build and support our industry collaborations.** Over the REF period we have developed a portfolio of regional projects to support SMEs (see examples in Section 3.2) and increased our KTP portfolio (Section 4.5). We also launched the award-winning Industry Club in computer science and then rolled out the model across EPS (Section 4.5).
- **Helping to cement Aston's position as a Civic University.** We are positioning ASTUTE as the go-to place for regional bodies seeking solutions to the challenges that lie in the way of Birmingham transitioning to a zero-carbon future. This has required us to establish good relationships with the West Midlands Combined Authority, the Local Enterprise Partnerships and Transport for West Midlands and we are planning knowledge sharing sessions (learning-lunches) with the Digital team within Birmingham City Council. ASTUTE is a member of the Birmingham Smart City Alliance. As leaders of the Greater Birmingham and Solihull Institute of Technology (GBSIoT) Applied Research stream we are organising joint industry-academia hot-topic-based workshops and case studies to encourage increased collaborative funding applications.

Sustainability Strategy

This strategic strand is led by the ADR with the Hols. The key areas of priority are:

- **Broaden the portfolio of funders and increase the amount of UKRI and commercial funding.** We work with professional services departments to ensure the financial sustainability of EPS research. Colleagues from the funding teams of RKE and Finance (ILES4.4) work closely with the ADR, Hols and Departmental Research Directors to share intelligence about the funding landscape and strategically plan our response, pooling

resources and contacts appropriately. The core professional services team meet monthly to ensure that information about funding opportunities is shared effectively, and that the necessary resources are put in place to support the pipeline of bidding activity. The Strategic Funding Manager and International Funding Manager work with individuals and Research Institutes to plan grant capture strategies and refine grant applications. EPS has increasingly adopted a cohort-based approach to support groups of individuals who are preparing bids to the same type of call, for example, the EPSRC New Horizons call where we had two successful awards, one from an ECR. Similarly, colleagues in RKE run an annual Grant Writing Programme to support a group of researchers who are applying for their first Research Council grants (ILES4.5). All bids go through the University's internal Peer Review process prior to submission, with the objective of supporting researchers to improve the quality of bids submitted. Due diligence checks, match-funding decisions and sign-off of bids also go through a clearly defined process designed to improve the University's management of our institutional commitments and to ensure financial probity and sustainability (ILES2.8).

- **Increase the proportion of staff actively seeking and winning funding by improving support for early-stage researchers.** All ECRs now complete a Career Development Plan and it is one of the ways we operationalise the Concordat to Support the Career Development of Researchers (ILES3.13). The Career Development Plan is a framework that brings together all the help available internally supporting ECRs to plot their own professional development pathway. At Aston, the ECRs participate in the "ECR Forum" (ILES3.14) to enhance their ability to work across disciplines, build effective networks and provide focused developmental opportunities.

The success of our College strategy is reflected in EPS being in a much stronger position than in 2014, with our combined research income and income-in-kind for this REF period being £58m, up from £23m in REF2014 (£6.2m, up from £4.1m in UoA11). EPS has contributed just over half of the University's annual research awards over the REF period. The Research Institutes are providing support for staff and students with the critical mass needed to further strengthen external recognition and momentum.

2. People

2.1 Overview

The leadership and governance of EPS has been strengthened significantly since REF2014. Changes include the appointment in 2017 of Professor Sarah Hainsworth OBE FREng, as Pro-Vice-Chancellor and Executive Dean, and the appointment of Professors Tony Clark and Kate Sugden as Deputy Deans in 2018. All three have strong track records in impactful research and understand the challenges of balancing teaching and research commitments. Professor Patricia Thornley took over the Associate Dean (Research) role from Professor David Webb in 2019, ensuring a continuation of strong and effective research leadership. The ADR works with the Director of Research Degree Programmes (Dr Aniko Ekart) and PGR Tutor (Professor Wen Cao). These two roles exist to specifically support research students within the College and share the administrative load, a move that has turned out to be highly beneficial in the pandemic. Our Research Institutes are headed by Professors Webb (ASTUTE), Sergei Turitsyn (AIPT) and Thornley (EBRI).

2.2 Staffing Strategy

Significant work has been undertaken over the REF period to ensure that EPS operates in an efficient, cohesive and inclusive manner, allowing people to develop their research careers in a supportive environment. The EPS staffing strategy places equal value on (a) the appointment of external staff in areas that need stronger leadership or to build critical mass, and (b) the development and support of the existing team to create future research leaders.

Unit-level environment template (REF5b)

Since REF2014 we have increased the number of staff in the College to reduce a high student staff ratio and ensure that the staff have time for research (Figure 2). For this REF return, Aston committed to a 100% submission of eligible staff. In UoA11, this has resulted in almost double the number of staff being submitted to REF2021 (34.0FTE, all of whom are on Teaching and Research contracts (6 ECR)) compared to REF2014 (18.2FTE). At the same time, the research only staff population in EPS has also seen significant growth of 47% from 62 to 91FTE, providing a vibrant community of early career researchers.

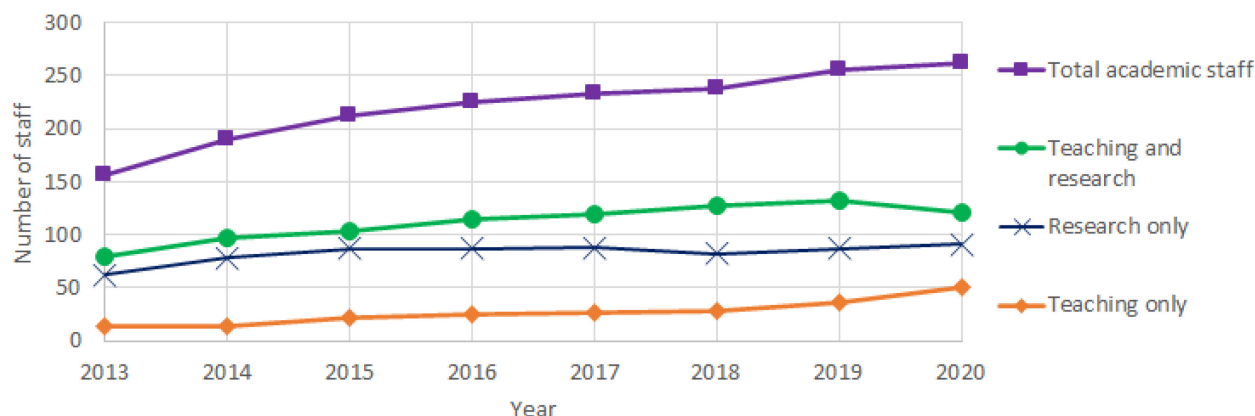


Figure 2: Staffing Levels for EPS (UoA11 and 12)

New academic appointments are made where there is clear alignment between the appointees' expertise, our existing research activity and our beneficiaries-led research strategy. This has enabled us to build a genuinely collaborative and interdisciplinary research environment. For example, the recent appointment of Alexakis in Civil Engineering not only brings research expertise in structural monitoring to that Department, but he also contributes to optical sensing in AIPT and machine learning in ASTUTE.

2.3 Equality Diversity and Inclusion (EDI) Strategy

Aston is committed to EDI in recruitment, promotion and access to education (ILES3.4-3.6). EPS (UoA11 and 12) has been a leader within the University in this area (for example, it was the first College to achieve Athena Swan Bronze and Silver awards) with significant activity across gender, race and inclusion. The driving philosophy behind our work in this area is that the creation of an inclusive environment is a pre-requisite for the promotion of EDI, and this requires activity against different strands:

- Diversity in Leadership** – The EPS Senior Management team (July 2020) was 43.5% female and 56.5% male which is exceptional for an engineering-and-science-focused College. In terms of ethnicity the split is 77.3% white, 22.7% BAME – this is above the sector average but would benefit from further improvement to reflect our region and student population. We have just appointed our first female Head of Computer Science – Professor Lumsden.
- EPS has been at the forefront of Aston's Athena Swan initiatives obtaining Silver in 2014** – Prior to the COVID pandemic we were planning to submit a Gold application in autumn 2020 but this is now delayed until 2021. Our Athena Swan activity in EPS has led to an improvement in EDI data analytics across the University. Actions put in place in EPS in the REF period include selected training, mentoring and wide advertising of vacant roles within the College to allow staff to build experience. As part of the Athena Swan initiative, we have developed a teaching load model that looks more broadly at the time contribution for teaching-related activities as well as standard lecturing time to reach a more equitable distribution of load and ensure all T&R staff have time for research.

- **Race Equality** – EPS's Director of Operations (Gill-Knobbs) leads on Aston's Race Equality Charter, which Aston signed up to in 2019, supported by the Associate PVC for EDI. The University-wide Group (ILES3.5, Figure 4) is currently working through the results of the Race Equality Charter Survey and this will generate targeted activities to support staff and students. The Group also instigated the process for Aston to join the BBSTEM Alliance (Black British Professions in STEM) to support our Black research students where numbers are low. The motivation for this came from a working group set up specifically for Black staff and students following the BLM movement early in 2020. BBSTEM was founded by EPS graduate Kayisha Payne and provides support in terms of industrial mentors and corporate insight days which students can access for free. There is also support for PhD students through an online community. A BAME staff network has been established and includes research staff. The network will be running research focused events and providing support for researchers.
- **LGBT+** – EPS Deputy Dean Kate Sugden chairs Aston's Working Group on LGBT+ staff (2019-20) (ILES3.5, Figure 4). This also contributes to the open and inclusive culture of the College and wider University.
- **Gender Pay Gap** – The University aims to eliminate its Gender Pay Gap of 19.5% (2017) by 2025 by focusing on consistency of starting salary and pay parity on promotion and within professorial bands (ILES3.6). EPS has a significantly smaller pay gap than elsewhere in the University; over the REF period, EPS has decreased its pay gap from 5.5% (2013) to 2.4% (2020). This has resulted from more consistent mentoring around promotions and more openness in advertising available roles and responsibilities and training programmes - changes brought in as part of Athena Swan.
- **External Diversity Activities** – EPS staff have also shown significant contribution in this area. For example, Hainsworth is Chair of the RAEng Diversity and Inclusion Committee (09/2019-present) and was Deputy Chair for 2 years before that. Through this Committee, she has made a significant contribution to the development of the RAEng Fellowship Fit for the Future campaign and the delivery of the new Diversity and Inclusion Framework. Sugden was elected the Diversity Champion for IET Council (2018-19) and is currently on the Board of Trustees for Foothold <https://www.myfoothold.org/>, a charity supporting engineers and their families with unexpected life challenges. RAEng Visiting Professor Dawn Bonfield's work supported the addition of "inclusive engineering design" into accreditation by the Joint Board of Moderators (JBM) as well as similar revision of the Engineering Accreditation guidelines, AHEP.
- **Widening Participation** – Mindful of the development of our future researchers we have twice hosted the transformative RAEng Graduate Engineering Engagement Programme at Aston to increase the transition of engineering graduates from diverse backgrounds into the engineering sector. We have also encouraged Research Institutes to provide paid internships for students to experience working in a research environment. We supported the formation of the WEST (Women in Engineering, Science and Technology) society in 2017, and Bonfield pro-actively mentored these students, who rapidly gained confidence and experience. In 2020, WEST progressed from a student affiliated group to a newly formed social enterprise, and engaged in a funded project in Nigeria, all with the help and advice of Bonfield. Through WEST we have sponsored students to attend the annual Women's Engineering Society. Finally, Aston contributes to the Widening Participation strand of the Institute of Coding.

2.4 Support for Staff

Research Culture

In EPS we promote a positive research culture to support our academics and researchers throughout the research lifecycle, including:

- Opportunities to discuss and formulate ideas for research proposals through mentoring; staff networks and line management; an active seminar series led by the Research Institutes; and publicising of relevant upcoming funding opportunities by RKE.
- Research proposal development, in particular for ECRs (including coaching, writing cohorts and formative peer review), with strong support from EPS staff and RKE (ILES4.4-4.5).
- Support for all aspects of research integrity and ethics including support for ethical approval (ILES2.11-2.12).
- Support for the dissemination of outcomes of research that transcends traditional publication routes (Aston Open Data Policy (ILES2.14) and Open Access Policy (ILES2.15)) and includes dedicated staff in RKE proactively providing links to potential partners in business, government and industry to translate the outcomes of research into impact (ILES4.12).
- To highlight the importance of research in our strategy, EPS introduced protected weeks within the annual timetable when staff can focus exclusively on research activities.

Training and support for ECRs and postdoctoral researchers (PDRs)

We are fully committed to implementing the key principles of the Concordat to Support the Career Development of Researchers and indeed Aston has held the “HR Excellence in Research Award” since 2010 (ILES3.13). The University-wide ECR Forum includes the ECR Development Programme (ILES3.14), which includes a range of training courses and workshops run by two specialist members of staff. New research staff receive a Welcome Pack that gathers in one place all the information and documents they will need relating to university services and career development. The activities run by the ECR Forum, including the Annual ECR Interdisciplinary Conference, provide an opportunity for PDRs and ECRs to meet potential collaborators and friends from across the University and develop a mutually supportive network.

As part of their induction, academic ECRs are assigned a dedicated research mentor: a colleague who sits outside their line management structure, has a strong research track record, and who acts as a confidential, independent, critical friend. New female appointments are given the option of a female mentor. Additionally, the University facilitates cross-College mentoring relationships (ILES3.9).

The Institutes provide vibrant “homes” for new researchers, so that they can experience interdisciplinary interactions beyond their departmental affiliation, engage in constructive research development and knowledge exchange, and meet with research users in the industrial, business and policy communities, via our regular seminars and workshops.

Staff Training

In addition to University-wide training provision (ILES1.5iv, 2.10, 2.12, 3.10, 3.14, 3.16, 4.13) we have introduced a series of initiatives within EPS, which we continue to adapt as the research landscape changes. Recent examples are set out in Table 1.

Table 1: EPS Staff Training Provision

Training for PhD students and PDRs	Alongside the extensive Graduate School introductory programme there is also: An Introduction to Research in EPS; Support for Fellowship applications
Training for ECRs	Introduction to Research in EPS; Building a Track Record; Working with EPSRC; Working with Industry; Working with the EU, Research Support; Introduction to REF; Supervising Postdocs and PGRs; Impact and How to Generate It; Publishing Considerations, Planning for Future Promotion based on Research; Early Career Fellowships
Training for all staff	Health and Safety Awareness; Equality and Diversity*; GDPR*; Cyber Security*; Research Student Supervision*; Introduction to Unconscious Bias*, Recruitment within the Equalities Framework – *courses compulsory for all EPS staff

Staff Grades and Promotions

The annually monitored data shown in Figure 3 gives the distribution of staff in EPS split by gender. Grade 7 is Teaching Assistant level. Grades 8 and 9 are Lecturers. Grade 10+ are Senior Lecturers and above.

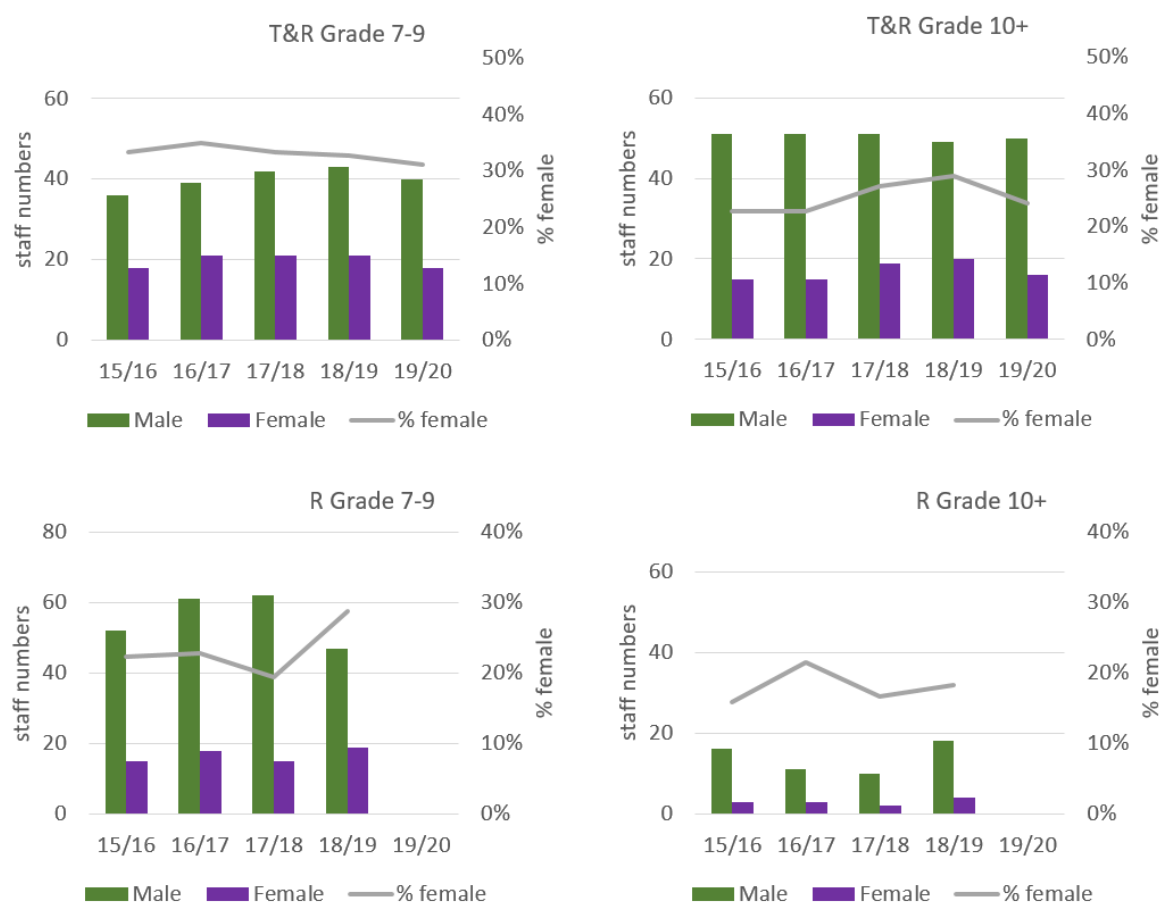


Figure 3: Gender split of T&R and R staff

EPS manages promotions in a fair and equitable way. Over the REF period, 130 applications for promotion were received by the College. Of these, 15 were promoted directly (to grade 8 or 9) and 63 (for higher grades) went forward to the University Promotions Board. The overall success rate there was 85.7%, 89% for female staff and 90% for BAME staff compared to 84% for male

Unit-level environment template (REF5b)

staff and 83.3% for white staff. Overall, there is no significant statistical difference in success rates between the protected groups observed.

Selection of Outputs

Section D of our [Code of Practice](#) sets out the process for selecting outputs, with the peer review process for outputs set out in Appendix 6. Two workshops were run for EPS staff to explain these processes, and those involved in selecting outputs also participated in a comprehensive EDI training session which was developed in conjunction with Advance HE. A further workshop was run for ECR staff to introduce them to the REF process.

Our REF Individual Circumstances process (Code of Practice, Appendices 7 and 8) was run independently by RKE. In line with our commitment to an inclusive return, all employees who submitted a declaration of individual circumstances were invited to indicate if they would be like to be contacted by an HR Business Partner to discuss their circumstances, and any support that they may have required.

As part of our REF preparation, we have conducted three Equality Impact Assessments of output attributions. Colleagues in RKE and HR have compared outputs attributed to all Category A staff (using FTE, not headcount) with those outputs attributed to those with protected characteristics (gender, age, disability and ethnicity). The inclusive nature of our return is reflected in our final Equality Impact Assessment (conducted 01/2021).

UoA11 proposed 234 outputs in total, of which 71 are attributed against an FTE of 34 Category A staff against an attribution target of 85. The UoA11 selection displays a consistent percentage of attributions (mean 37%) across all protected characteristics (Figure 4). Small sample sizes explain any differences.

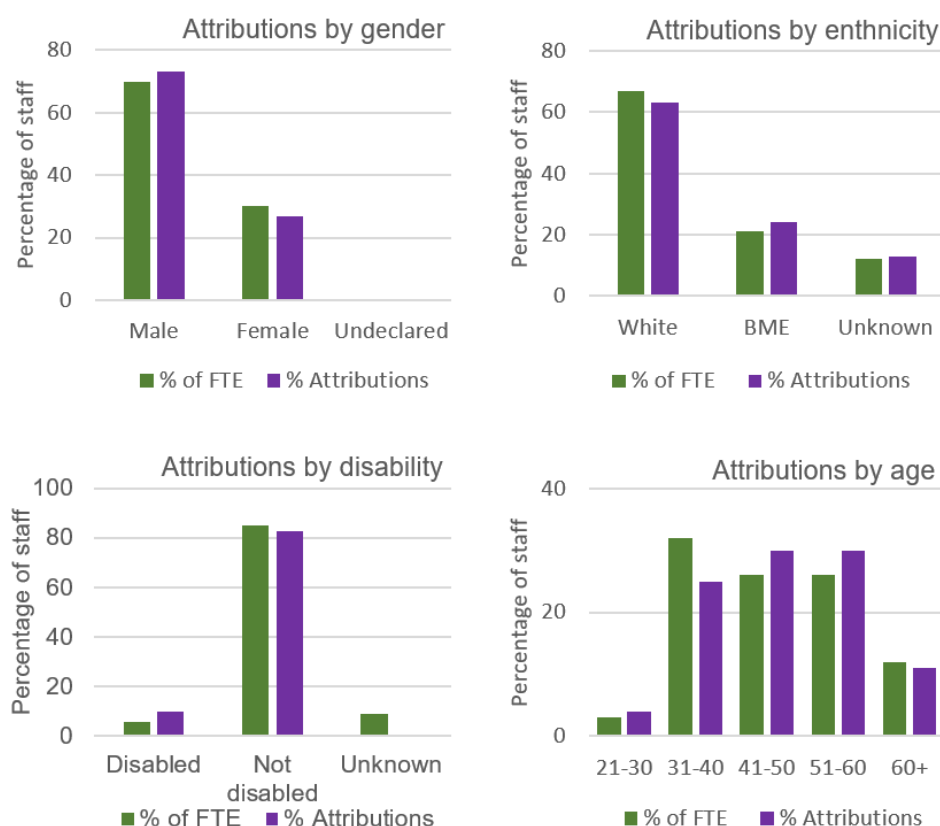


Figure 4: Alignment of %FTE and output attributions by protected characteristics for UoA11

2.5 Strategy for Training and Supervision of PGR Students

Aston's Graduate School (AGS) was established in 2010 to provide a supportive environment for all research students across the University (ILES3.15-3.18). Integrated with this central provision is subject-specific postgraduate training and development provided within EPS, providing a strong local research environment, where PhD students are supported in their development towards becoming independent researchers.

Since 2014, the following significant changes have been made in terms of how we recruit and manage PhD students, in order to achieve and develop a vibrant research environment:

Recruitment – A rigorous student recruitment process is in place to ensure that PGRs have the best possible chance of successfully completing their PhD on time. All interview teams must include an independent senior academic with a track record of successful PhD supervision who is able to advise on the suitability of the candidate. English Language training is offered to students for whom English is not their first language (ILES3.19). Typically, 15-30 fully-funded studentships are allocated annually via a highly competitive call, in which both the quality and strategic fit of the project and the suitability of the proposed student are assessed by an experienced panel. Students are increasingly recruited to related cohorts to provide peer support. Strategic priority for these studentships has shifted from an initial focus on co-funding studentships with industry (aligned with our industry-focused research strategy) to concentrating on pump-priming the research careers of our new lecturers, following a significant expansion of new academic staff in EPS. All staff with supervision responsibility are required to complete mandatory supervision training, which must be updated every three years, regardless of career stage (ILES3.16).

Arrival – Following each quarterly start date, there is a comprehensive welcome and induction session provided by the Director of Research Degree Programmes, where students are guided through all the relevant documentation, development opportunities and the expectations placed on them. In consultation with the supervisor, the student undertakes a training needs analysis to identify the development needed to support both their PhD work and their future career goals.

During the PhD – AGS provides comprehensive PGR support for all students (ILES3.15-3.19). A formal quarterly and annual monitoring process is in place to ensure students are making sufficient progress and are well supported by their academic supervisors. In addition, international students are invited to networking events for international students and staff, to help them feel included in the research community and make links with others who may have similar experiences.

In response to data from the 2017 Postgraduate Research Experience Survey (PRES), several new initiatives were instigated including:

- Increased contribution of up to £1500 towards attending a conference to present a paper or poster. This is available to all students who have completed their qualifying examination.
- A Postgraduate Student-Staff Liaison Committee to provide a direct link between PGR students and senior management via the AGS Management Committee (ILES3.15). In addition, student representatives meet with the ADR and Director of Research Degree Programmes to discuss any College-level issues they may be having. As an example, reports of issues with aging computers led to a College policy whereby all incoming PGRs are given a new PC on arrival.
- We introduced an EPS PGR Conference in 2018, organised by postgraduate student representatives of the Liaison Committee. This was much appreciated by the students and the idea has been taken up by AGS, which now also facilitates University-wide weekly events such the Interdisciplinary Seminar Series (ILES2.10).

Student networks – Our PhD students are integrated into the research community and relevant networks to provide peer support. Our office spaces have been redeveloped to ensure that students sit within the academic groups and share communal spaces. The Women in Science and Technology group provides networking support across all student groups and regularly hosts visiting speakers from industry. ASTUTE holds monthly research seminars for all its staff; these have an interdisciplinary focus and help create links between different research specialisms.

Unit-level environment template (REF5b)

These are organised by an ECR to help develop management and organisational skills and raise their profile.

Graduate Outcomes – The most recent (2017/18) Graduate Outcomes survey available for the assessment period (27 EPS responses) showed that 96% of EPS PGR graduates found graduate level positions. 30% took up Postdoctoral Research Assistant positions, 15% secured academic positions, 18% continued in further education, and the remaining 33% went into professional-level work in industry.

Diversity of PGR student body – EPS has prioritised diversification of our PGR population by ensuring fair recruitment processes. The Home BAME PGR student population has risen from 39% (2015/16) to 43% (2019/20). In terms of gender, our objective is 40% female PGR by 2025 and we have improved steadily from 29% female PhD students in 2015/16 to 38% female in 2019/20. Our current intake across the College is 50% female and 64% BME, indicating we are on track to meet our diversity targets. This improvement stems from targeted interventions, such as: (a) involving our own UG students more in projects related to research, (b) supporting student networks that cross over the PG/UG divide so that there are appropriate role models, (c) more widespread advertising of opportunities (d) interview practices including mixed panels.

Figure 5 shows diversity data covering the REF period for the Computer Science and Mathematics Departments, which map closely to UoA11.

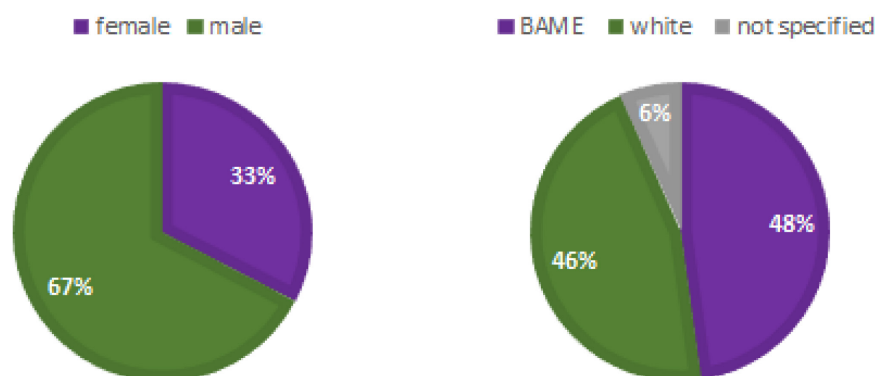


Figure 5: Diversity data for Computer Science and Mathematics PGR students - over the REF period

3. Income, Infrastructure and Facilities

The overall aim of EPS in this REF period has been to build the strength of our teams, infrastructure and facilities in areas where we can deliver impact on an international scale and use this to drive growth in research activity.

The move towards Institutes, and the increasing focus of our research into related disciplines, allowed us to invest in infrastructure to benefit large groups of individual researchers. Through this approach, we have brought together research teams to create a more dynamic, interactive and supportive environment. This has included £4.5m investment in new, clustered staff workspaces which co-locate Computer Science and Mathematics academic staff, researchers and research students. Where appropriate, researchers are encouraged to belong to, and access, more than one Research Institute to encourage interdisciplinary interactions, for example, there are Civil and Biomedical engineers from ASTUTE who have AIPT laboratory space and Mechanical Engineers working in EBRI and ASTUTE. The total capital expenditure over the REF period on EPS research was £16.6m.

3.1 Research Income and Awards

The UoA11 Income has grown from £4.1m in REF 2014 to £6.2m in REF2021, the annual breakdown for which is shown in Figure 6.

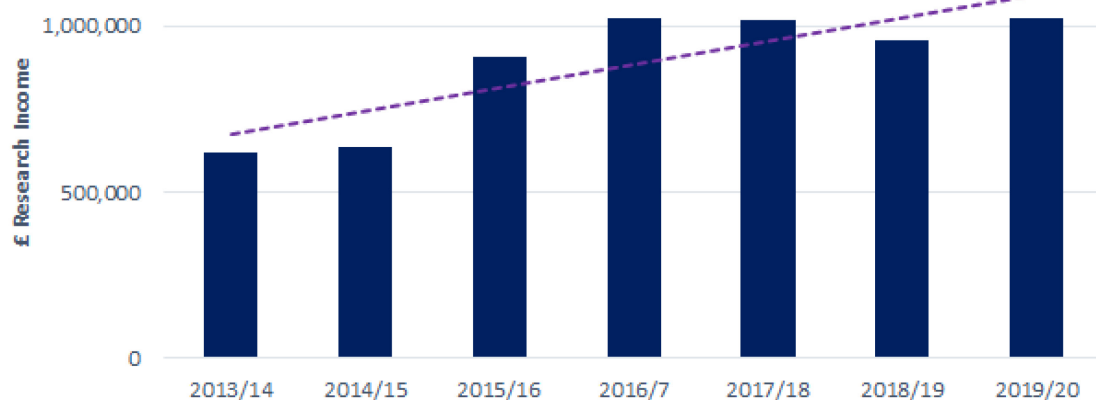


Figure 6: UoA11 Research Income

UoA11's annual research awards have grown from less than £750k in 2013/14 to over £2m in 2019/20 (Figure 7). At College level, EPS has grown its annual research awards substantially from £8.4m in 2013/14 to an average of £15.7m/year in the last three years of this REF period. This growth will drive an increase in research income in the next REF period.

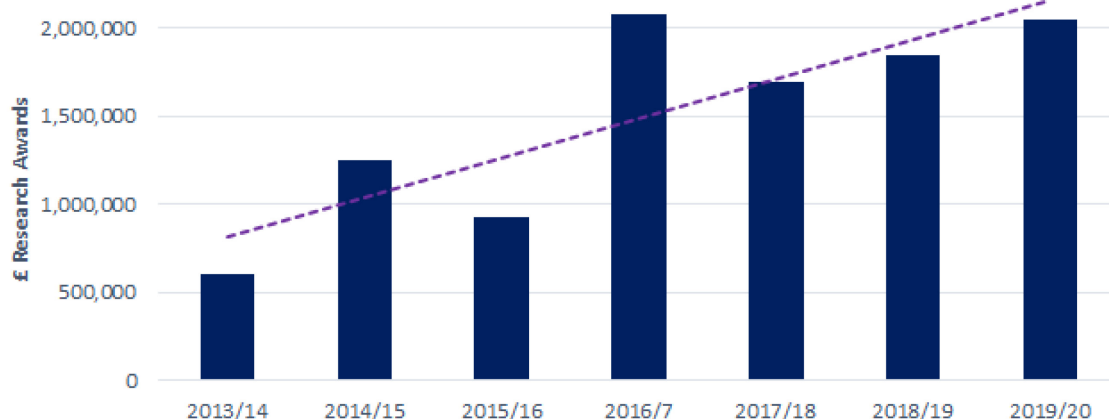


Figure 7: UoA11 Research Awards

3.2 Infrastructure and Facilities Pertaining to Research

Our investment in infrastructure and facilities has underpinned the growth in income and awards. For UoA11, it is important to note that these activities take place within a larger support framework at both College and University level. Specialist centralised research support is led by the PVC Research and the Executive Director of Business Engagement (ILES4.4). EPS benefits from a high-performing team who generate fruitful industrial connections, support large collaborative grant applications and project manage large projects. This has resulted in the College's strong position in KTP grants where we are a sector leader and have substantial EU research funding (16 of the University's 19 current KTP projects are in UoA11). Furthermore, there exists a critical mass of colleagues with experience in successful knowledge exchange, who act as impact champions and mentors. All our Institutes have embedded business engagement teams that use ERDF funding to provide the infrastructure and support collaboration with regional businesses, which is matched by an equal funding contribution from the University. The facilities and infrastructure for each of the Research Institutes is summarised below.

Aston Institute for Urban Technologies and the Environment

In addition to having access to the AIPT and EBRI facilities described below, ASTUTE also has facilities that support the variety of research activities in the Institute, including:

- The Aston Laboratory for Immersive Virtual Environments, resulting from a £3.9m investment in 2015, provides motion capture, room-scale virtual reality and EEG recording equipment, enabling research into visual perception, social cognition, and social vision. This is complemented by the Aston Interactive Media Lab, which is dedicated to human-computer interaction, primarily applied to mobile technologies.
- The Aston Robotics, Vision and Intelligent Systems lab houses a variety of predominantly social robots and aims to improve mankind's quality of life by enabling intelligent robots, virtual agents and autonomous systems with perceptual and cognitive capabilities.
- Investment of £80k from GBS Institute of Technology has enabled a laboratory dedicated to Cyber Security. Vulnerable network systems can be simulated, attacked and defended within an isolated environment.
- Our significant activity around data analytics and AI is supported by a range of computing options. Researchers can access individual GPU-based workstations, a new shared server (8GPU, 20 core, 512 GB, £50k), cloud-based processing (e.g., Amazon Web Services) and the Tier 2 HPC facility of Midlands Innovation (ILES1.5).
- We have a wide range of facilities supporting our research on future transport including equipment to test high-performance electrical machines, power converters and EV batteries to enable bespoke design as well as the ability to assess the performance of engines running on biofuels
- Researchers investigating functional materials have accessed £2.4m of beam time during this REF period.

Since the formation of ASTUTE in 2018, the number of KTP projects in the Institute has increased from 5 to 17. In terms of fundamental research, Aston's two successes in the recent EPSRC New Horizons call were both from ASTUTE members (one an ECR) and 2020 saw the submission of a successful EU FET proposal in collaboration with colleagues in Health and Life Sciences plus international partners.

ERDF projects continue to deliver measurable benefit to our regional beneficiaries. The [Think Beyond Data](#) project aimed at enabling SMEs to make better use of their data, to develop new services and products, to leverage large public datasets, and to develop a workforce that is highly skilled in leading-edge analytical techniques. An evaluation report by Hatch Regeneris (2020) noted that the team supported 60 companies, with estimated additional GVA expected to reach almost £4m, providing £6.45 GVA for every £1 ERDF funding invested. This excellent value for money is reflected in the subsequent extension of the project.

A second project, Smarterials - [Promoting Functional Materials](#), in SMEs, sits between ASTUTE and EBRI. This project commenced in 09/2018 and will run until 08/2021. It is designed to help 66 SMEs develop their use of functional materials and grow their business through a partnership with Aston University built on research, testing and expertise in material science. The collaborations with industry have been diverse: from working with a fuel additive manufacturer to verify the efficiency gains that it brings to an engine, to working with a wind turbine developer to create prototype designs from optimum materials.

Aston Institute of Photonic Technologies

AIPT has outstanding facilities and infrastructure enhanced by recent major strategic investment by Aston University. This includes a £7.3m investment in 2017 into a new, 1200 square metre, state-of-the-art suite of 30 laboratories for the Institute, including optical communication, fibre device fabrication, laser, medical and biophotonics laboratories. In parallel, Aston invested around £5m into equipment, with a further £3m invested in equipment after AIPT was awarded University Research Institute status in 2019. The breadth of these facilities makes AIPT a partner of choice for many businesses and universities giving AIPT an impressive reach. This includes a portfolio of ~60 industrial and international collaborations, 60 patents, and five spin-out companies. AIPT's global status is further confirmed by the coordination (as a single beneficiary) of a major €3m Marie S. Curie COFUND MULTIPLY Photonics Training Programme, with 50 world leading partners, from MIT to the Max Plank institute for the Science of Light.

Energy and Bioproducts Research Institute

EBRI's dedicated building incorporates unique, state-of-the-art laboratories, collaborative office space, dedicated meeting/engagement rooms, and social facilities to support its academic and industry facing teams in accelerating the commercial development of low-carbon energy and products. The facilities are the result of a £20m investment to support the development of a regional bioenergy supply chain and to promote the adoption of innovative new bioenergy technologies across the West Midlands region. EBRI's research extends from fundamental science through engineering challenges, social responses to technologies, economic context and policy development. It leads the £6m national flagship EPSRC/BBSRC-funded Supergen [Bioenergy Hub](#) research centre of excellence which works with academia, industry, government and societal stakeholders to develop sustainable bioenergy systems that support the UK's transition to an affordable, resilient, low-carbon energy future.

4. Collaboration and Contribution to the Research Base, Economy and Society**4.1 Introduction**

EPS values collaboration with academic, industry and policy partners, both nationally and internationally. In addition, wide-ranging activities in Knowledge Exchange such as KTP and business focused ERDF funding have generated strong links to industry – especially the technical SME community.

4.2 International Collaboration and Networks

Our Research Institutes collaborate with high-performing institutions and industry partners around the world, allowing regular exchange of people and ideas. This has in turn enabled our research to create impact on an international scale. For example:

- In our UoA11 ICSs: “Development and Application of the Digital Observatory for Protected Areas”, which resulted in tools that have been used globally, and “Digital Twins”, which arose from a longstanding collaboration of Clark with Tata Consultancy Services (TCS) Research in India. The first ICS arose from time spent working at the European Commission's Joint Research Centre and the second from an ongoing research collaboration that involves annual research visits to the company, where Clark is funded as a Research Advisor. In 2019, Clark's work won a TCS Innovation Award in competition with over 6000 entries.
- Buckingham's collaboration with Johns Hopkins University investigated racial bias during clinical diagnosis in the UK and the US; a Race Equality Foundation [report](#) used the findings to recommend improvements for Black people's healthcare.
- Little, Arora and Raykov worked with a number of international partners including MIT, Johns Hopkins University and the Michael J Fox Foundation on ground-breaking work on

Unit-level environment template (REF5b)

the use of [smartphones for detecting and monitoring the symptoms of Parkinson's disease](#) and the large-scale deployment of [wearable sensor to monitor Parkinson's Patients](#) for the Parkinson@Home study. The end goal of this work is to establish a better platform for the long-term management of Parkinson's disease and improved drug efficacy tests.

- Several staff have longstanding international collaborations: Lumsden and Campelo both hold Adjunct Professorships at Canadian universities (University of New Brunswick and Dalhousie University); Nerukh holds a Visiting Scientist position at RIKEN in Japan and supervises PhD students at Kiev University, supported by funding from the EU Research and Innovation Staff Exchange (RISE) scheme.
- Since 2014, EPS has received funding for 18 international networking RISE projects, as lead and partner, providing £9m to support collaborative research, networking and training with industry and academia across the world. They have enabled collaboration with academics from 40 countries on applied and theoretical projects; examples from UoA11 range from "Computing with Infinite Data" to "Fractures Across Scales, Materials, Processes and Disciplines".
- Aston is within the top ten UK recipients for the highly competitive FET programme and the projects that Aston leads are excellent examples of IDR, e.g., the recently successful application for the £4m NeuChip project with Aston Principal Investigator (PI) Dr Rhein Parri (Institute of Neurodevelopment), Co-PI Prof David Saad (ASTUTE, Mathematics). The project partners are the University of Barcelona, 3Brain (industry), Technion (Israel), CNRS Paris (France) and Loughborough University (UK).
- In addition to the International Collaboration Fund (ILES2.9), UoA11 academics exploit a range of other funding mechanisms including Royal Society International Exchange, RIKEN Japan, Japan Society for the Promotion of Science Bridge Fellowship, EU Twinning, Erasmus+, Leverhulme Trust Distinguished Visiting Professorship, Erasmus+ and British Council. Furthermore, our policy of recruiting from the widest possible field brings staff members from across the globe with ready-made international links e.g., from Computer Science, Campelo has strong links to Brazil (particularly the power industry there), while in Mathematics, Nerukh has ongoing collaborations in Ukraine, and Chattopadhyay with India.

4.3 Academic Outputs (UoA11)

Our networking strategy has produced a significant impact on international collaborative outputs. Of the 1908 published outputs by UoA11 Category A staff in this REF period, 65% were the result of international collaboration vs a sector average of about 60% for the disciplines (SciVal, December 2020). Of the internationally collaborative papers, 53% were from partners within Europe 26% from Asia Pacific and 11% from North America.

4.4 Research Community

In addition to our funded networks, EPS strongly encourages colleagues to contribute to the wider research community. This includes:

- **Journal editing:** Associate Editor (2019-present) of IEEE Transactions on Software Engineering (Bencomo); Editorial Board Member (2019-present) of the Journal of Software and Systems Modeling (Bencomo); Frontiers Research Topic Editor (2020, Bernardet); Editorial Board Member (2019- present) of the Journal of Software and Systems Modeling (Bencomo); Editor (2019) of a special issue of the International Journal of Computer Integrated Manufacturing, Volume 32, Issue 4-5 (Ekart); Editor in Chief (2008-present) of the International Journal of Mobile Human Computer Interaction (Lumsden); Guest Editor (2016–2017) of Science & Justice (Morrison); Guest Editor (2016–2019) of Speech Communication (Morrison); Editorial Board Member (2012-present) of Scientific Reports (Saad); and Associate Editor (2006-present) of IEEE Intelligent Systems (Zhuge).

- **Contribution to conference organisation:** Member (2020-present) of the IEEE Technical Council on Software Engineering (Bencomo); Program Committee Member (2020) for the International Conference on Autonomous Agents and Multiagent Systems (Bernardet), Program Committee Member for 2020 CHI (Human Factors in Computing Systems) (Bernardet); Programme Committee Member (2013-present) of the KES International Conference on Innovation in Medicine and Healthcare (Buckingham); Programme Committee Co-Chair for ISEC 2021 (Clark); Publication Chair (2018), Chair (2019), Co-Chair (2020) for the 7th, 8th and 9th EvoMUSART, the International Conference on Computational Intelligence in Music, Sound, Art and Design (Ekart); Chair (2017), Co-Chair (2018) of the Digital Entertainment Technologies and Arts track at the Genetic and Evolutionary Computation Conference (Ekart); Programme and Steering Committee Member for the European Conference on Genetic Programming throughout the period (Ekart); Conference Chair (2015) for the IMA (Institute of Mathematics and its Applications) Conference on Mathematics of Robotics (Holderbaum); Committee Member, Mobile HCI 2015 2nd Workshop on Designing with Older Adults: Towards a Complete Methodology Workshop (Lumsden); Associate Chair (Papers), Interaction Design & Children 2016 Doctoral Consortium Chair (Lumsden); Associate Chair (Papers) NordiCHI'2020 (Lumsden); Committee Member (2014-2020) for the European Symposium on Artificial Neural Networks ESANN (Saad); and Co-organiser (2015) of the Royal Society meeting on Communication Networks Beyond the Capacity Crunch (Ellis, Saad and Payne (Southampton)).

4.5 Knowledge Exchange

Within EPS we have a variety of platforms to engage with industrial partners, government and Professional Engineering Institutions, which work together to support knowledge exchange and present a coherent pathway for company–university interactions. These include:

- **European Regional Development Funding (ERDF)** - This allows each Research Institute a platform for regional knowledge exchange with six projects associated with ASTUTE running on the REF census date (AgriTech, Smarterials, UK Centric Supply Chains, Low Carbon SMEs, Think Beyond Data, ETICC). In 2020 alone, 200 enterprises were supported by EPS through these projects. All ERDF-funded business support programmes are independently evaluated upon completion. Analysis from these evaluations show participating companies benefit from faster growth, sustainable job creation, graduates retained in the region and increased GVA; for an example, see the description of **Think Beyond Data** in Section 3.2.
- **Knowledge Transfer Partnerships (KTPs)** - We have grown our KTP activity, with strong centralised support and referrals from the ERDF projects and the Industry Clubs. Aston's portfolio is dominated by EPS projects; there have been 32 KTP projects over the REF period, totalling £6,374,896 in funding, and 19 of these have been from UoA11. In terms of outputs, analysis of KTP reports showed Aston generated on average 1107% return-on-investment (ILES1.4). We host a high profile annual KTP poster event, which allows our beneficiaries and research teams to network and understand the benefits of knowledge exchange and promote wider KE opportunities. In UoA11, recent KTP success includes the [2019 Future Innovators Award](#) for KTP associate Gallo working with Sarissa Biomedical.
- **Industry Clubs (ICs)** - The [award-winning](#) EPS model of ICs, which originated in Computer Science (CS), has since been rolled out across the College and has generated significant benefit to both students and researchers. The objective is to harness cutting-edge industry expertise to generate high-level graduate opportunities, enhance the skills of students and develop new research opportunities. The CS IC brings together students, academic members of staff and around 15 local technology businesses who provide both financial and in-kind support. It has supported >80 placements and graduate roles, guest lectures, company input into student projects, Insight days and curriculum input. Within UoA11, the ICs have provided the basis for 15 KTP projects worth > £3m, joint funding for

Unit-level environment template (REF5b)

4 PhD studentships (Geospatial Insight, Beazley and Arcadis) and a £590k EPSRC project (EP/T017627/1).

- **Collaborative Research Grants** – In UoA11 we have also had success with collaborative Innovate UK research projects, including Lumsden's "Mapmydiabetes", a collaboration with Mapmyhealth Ltd providing mobile diabetes education and self-management support, and He's "Big Data Content Analytics with particular reference to Probabilistic Neural Topic Models", which involved the development of a content analytics toolset with Foldingspace.
- **Informing policy** Buckingham's research applying computer science in the health sector has had significant impact (ICS 'The Galatean Risk and Safety Technology – Grist'); his work on clinical bias due to race has prompted the [Race Equality Foundation to recommend improvements for Black people's health care](#). The international scale of the policy impact of Bastin's development of the Digital Observatory for Protected Areas is highlighted in Section 1.2.

4.6 Wider Contribution to Society

The Aston Strategy 2018-23 has our beneficiaries approach at its core (ILES1.1), and EPS has a strong history of outreach and masterclasses to engage the wider community with our research activities, driving our student diversity and our strong links to business and the region; indeed outreach is explicitly written into many of our grant applications. Examples of our higher profile events where a strong link between science and arts boosts accessibility include:

- **Lightfest** (2015) was a flagship UK initiative for the [UNESCO International Year of Light celebrations](#). Held at the newly opened Library of Birmingham, it was funded as a European Commission Researchers Night activity, attracted 12,500 visitors and involved 100 researchers and 33 additional Aston volunteers. A follow-up event **Cityfest**, focused on Smart Cities was due to run at the Birmingham Museum in 2020 but was delayed due to Covid (re-scheduled for July 2022).
- EPS was invited to participate in a high-profile event in Hong Kong **SPARK: The Science and Art of Creativity** (2019) which was organised by the British Council. The ASTUTE-focused Aston stand concentrated on Smart Cities and how technology, data and logistics linked together. The event was featured in [China Daily Hong Kong](#).
- EPS has been an active contributor to **The Big Bang Fair** with our STEM Superhero exhibits and research volunteers translating science and engineering into superpowers. Colleagues have also regularly contributed to activities such as **Pint of Science** and **Cafe Scientifique**, e.g., "Artificial Intelligence" (Lewis).

Broader Public Engagement - EPS have encouraged (and trained) staff to write for the Conversation (<https://theconversation.com/uk>) to engage the wider public with STEM. Media training and marketing support has also been offered as part of our public engagement strategy and ASTUTE coverage in the period 2018-2020 included:

- 2018 saw the launch of '[Vegetable Maths Masters](#)', a smartphone app to encourage children to consume more vegetables by integrating different methods known to increase interest in, and eagerness to try them. It was developed by researchers at Aston (Farrow (Psychology, UoA3) and Lumsden (UoA11)), Loughborough and De Montfort Universities, in association with the British Psychological Society. Coverage of this appeared in the Daily Mail, The Mirror, HeartFM and various global online news channels.
- 2018 also saw research from Lewis on how smartphone battery life can be significantly extended by moving processing to the cloud widely covered ([BBC World Service](#) (starts at 19 minutes), [The Daily Mail](#), [The News International \(Pakistan\)](#), and [Xinhua News Agency](#)).
- One project from the **Think Beyond Data** ERDF project on route-optimisation for transport was picked up by 25 websites including [The Engineer](#) (2020). The research suggested

Unit-level environment template (REF5b)

commercial vehicle fleets operating in large towns and cities could halve their emissions and better meet clean air targets using technology inspired by the behaviour of ants.

- PhD student, Salawu (supervised by Lumsden), had his work on a new app widely shared. The app uses novel artificial intelligence (AI) algorithms to combat trolling and bullying online. **Bullstop**, is the only anti-cyberbullying app that integrates directly to social media platforms to protect users from bullies and trolls messaging them directly. [The App](#) has 4.7 stars on Google Play.
- Following on from a Nature Communications paper, Chattopadhyay's proposal of a new way to use machine learning to define what poverty really means in different contexts was featured in [ZME Science](#) (2020).

Looking to the future - Aston's College of Engineering and Physical Sciences will build on existing partnerships and forge new links at local, national and international level. By investing in our research infrastructures and the staff and doctoral students who make up our research community, EPS will continue to produce excellent, impactful and sustainable research for the benefit of society throughout the lifespan, and the advancement of science and engineering.