

Unit-level environment template (REF5b)

Institution: Aston University

Unit of Assessment: 12 Engineering

1. Unit Context and Structure, Research and Impact Strategy

1.1 Context and Structure

Aston 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 successes in these areas were 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).

The College of Engineering and Physical Sciences (EPS) maintains a high-quality collaborative research environment with focused investment in areas where we can demonstrate international leading research with significant impact. Over the REF period we have enhanced our agile and supportive environment to enable staff to win international, national and regional funding leading to impactful research. Examples of this include applications of bioenergy to reduce open field straw burning in the Philippines and India, and collaborative research on high-speed optical communications with global telecommunication systems providers.

The EPS structure, see 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).

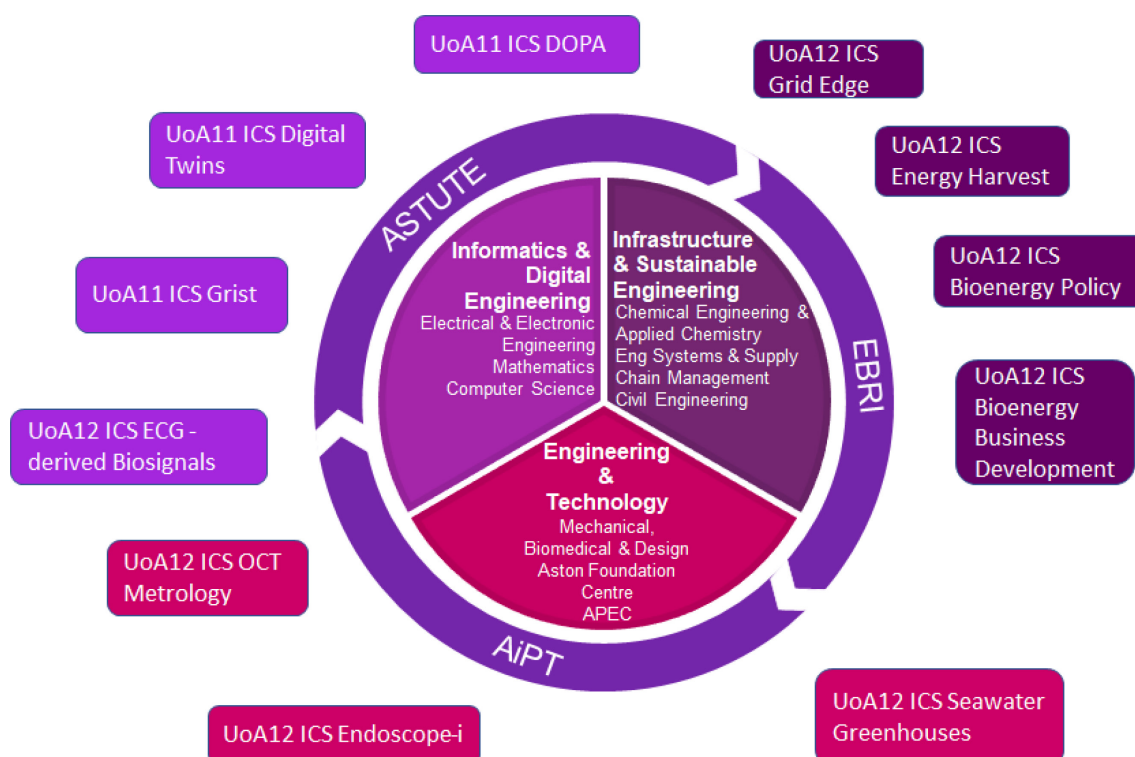


Figure 1: College structure showing Schools, Departments and Research Institutes and related impact case study (ICS) areas

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Knowledge Exchange, 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 beneficiaries: its students, businesses, and the West Midlands 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 university for consultancy and Knowledge Transfer Partnerships (KTPs) – reflecting our strong links with SMEs – and this enables us to identify trends within sectors and identify opportunities for more in-depth interactions and value-added partnerships.

Research Institutes

Since 2014, our priority has been to develop more cohesion between subject-specific research areas. We have addressed this by the formation of three multi-faceted, collaborative Research Institutes. 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.

Researchers aligned with AIPT and EBRI have predominantly been submitted to UoA12; ASTUTE researchers are split between UoA11 and UoA12. The research activities of each of the Institutes are as follows:

- The **Aston Institute of Photonic Technologies (AIPT)** is one of the largest photonics research centres in the UK. AIPT has over 100 staff carrying out world-leading research focused on integrating blue-sky and applied research in photonics. Education and innovation are priorities, as is the translation of scientific breakthroughs into technology that has industrial, economic, and societal impact. Founded by industrial researchers (from BT and Plessey), AIPT maintains close contact with industry, with over half of its academics having industrial experience.

Areas of research excellence include optical communications (where ~20% of publications are co-authored with industrial partners), nonlinear photonics, fibre devices including fibre lasers, nanophotonics, biomedical photonics, applications of machine learning in photonics, and industrial applications. AIPT has over 60 live projects worth more than £30m and the largest portfolio of EPSRC projects at Aston. AIPT's industrial and international collaborations have resulted in more than 800 joint papers since 2014, including highly cited research papers published in the top journals, such as Nature Photonics, Optica, Nature Communications and others, all demonstrating excellence in the field. Since 2014, AIPT has published with over 450 other organisations.

In 2018, Doran and his team were recognised in the MadeAtUni "[UK's Best Breakthroughs](#)" list of the last century for their pioneering work in long-distance optical communications which has been fundamental to enabling the vast growth in data transmission via the internet. Since 2014, Doran, Ellis and Zhang have been elected as Optical Society of America Fellows (joining previously elected Turitsyn, Sumetsky and Rafailov), whilst AIPT investigators have been recognised by awards including the Royal Society "Wolfson Research Merit Award" (Sumetsky, 2014) and EPSRC Fellowships (Ellis, 2014; Forsyiaik, 2015). AIPT provides an outstanding environment for training of researchers, coordinating ten Marie Skłodowska-Curie Actions Innovative Training Networks (MSCA-ITNs) since 2014. Since 2014, AIPT has hosted 30 individual MSCA Fellows confirming its status as an attractor for training in photonics for talented Early Career Researchers (ECRs) around the world. In the past five years, three AIPT researchers (two female) have won prestigious Royal Academy of Engineering (RAEng) Fellowships and one has won a UKRI Future Leaders Fellowship.

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- The **Energy and Bioproducts Research Institute (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. Achieving an affordable, resilient and low-carbon energy future is essential, and we aim to use sustainable resources to make this a reality. The processes developed will contribute to making a net-zero carbon economy possible, while allowing traditional manufacturing sources of fuels, chemicals and materials to be replaced with cleaner and safer alternatives. EBRI members engage with colleagues nationally and internationally on supply chains, business models, policy, regulation and system performance. As the world strives to meet ambitious targets for reducing carbon emissions and combating climate change, EBRI is exploring the science behind new, more efficient thermochemical, biological and catalytic means of converting biomass and waste feedstocks into valuable products. EBRI leads the £5.2m national EPSRC/BBSRC-funded centre of excellence in bioenergy (the Supergen Bioenergy Hub). Its staff are international leaders in their fields – e.g., Thornley was the recipient of an international “Atlas Award” in 2015 for “research that could significantly impact people’s lives” and Chair of the advisory board for the Committee on Climate Change’s 2019 “Biomass in a Low Carbon Economy” report. Recent prizes include the “Innovation in V2G Award” and the “Electric Vehicle Innovation & Excellence Award” for the ViGiL (Vehicle-to-Grid Intelligent Control) project.

In the REF period, EBRI staff have created two spin-out companies: award-winning Grid Edge in 2016 (see ICSGridEdge) who are using cloud-based artificial intelligence software tools to allow building operators to predict, optimise and control their buildings’ energy profiles, reducing carbon emissions and costs, and improving user comfort. In India, award-winning A2P was created to work on the supply chain challenges of gathering rice straw to make into fuel as opposed to burning it in open fields (see ICSEnergyHarvest). They are now working with World Wildlife Fund India to extend the business model they have developed.

- The **Aston Institute for Urban Technologies and the Environment (ASTUTE)** brings together a broad range of technologies and capabilities that are key to enabling sustainable living in the cities 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, data analytics and machine learning, enabling them to tackle the major interdisciplinary challenges facing the modern city under the pillars of Digital Engineering, Mobility, Health and Energy.

ASTUTE staff won Innovate UK’s “[Best of the Best](#)” KTP award in 2020 for their work developing the Computer Science Industry Club to support Knowledge Exchange. Industry Club member, Majestic, won the “[Princess Royal Award for Training Award](#)” in 2018 for their work in a partnership with Aston to develop a placement year for gifted students.

1.2 Research Strategy

Aston’s strategy (ILES2.3) is to prioritise impactful, collaborative, excellent and financially sustainable research. Over the REF period, EPS’s strategy has evolved to align with the UK Government’s Industrial Strategy Grand Challenges and UN Sustainable Development Goals, which enables us to tackle some of the big societal challenges in an impactful way. This is illustrated by our impact case studies:

- **Sustainable cities and communities** – see ICS: (UoA12) Grid Edge – changing the way we use and store energy and (UoA11) Digital Twins for Complex System Engineering.
- **Good health and wellbeing** – see ICS: (UoA12) ECG-derived biosignals for improved healthcare outcomes and a Real-time Adaptive Predictive Indicator of Deterioration

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(RAPID); (UoA12) Endoscope-i – new products and medical diagnostic practices; (UoA12) Advances and commercialisation in the field of optical coherence tomography; and (UoA11) The Galatean Risk and Safety Technology, GRiST.

- **Affordable and clean energy** – see ICS: (UoA12) Bioenergy Policy and (UoA12) EBRI – business development in bioenergy and sustainable supply chain.
- **Life on land** – see ICS: (UoA12) Energy Harvest – reducing pollution from open field burning of rice straw; (UoA12) Seawater Greenhouse – impact on sustainable food production in arid climate; and (UoA11) Development and application of the Digital Observatory for Protected Areas.

The key 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 AIPT and EBRI's position as centres of excellence by investing in their facilities and infrastructure.** This has resulted in significant 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, EBRI has received investment of £1.5m in estates, £1m in equipment and £1.5m in research funding. We have also implemented a programme of office refurbishment to bring staff and PhD students in connected areas into higher-grade spaces with communal areas to encourage team support and cross-fertilisation of ideas.
- **Create a vibrant research community.** To address this, we have built on the interdisciplinary research (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 (2019-20). We also pump-prime the development of international collaborations, which has enabled us to increase the numbers of MSCA-ITNs, RISE and British Council funding, e.g., Thornley won a successful British Council SASAC PhD programme grant after such support. This allows us to both host international researchers and undertake collaborative research at their location.
- **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 strategic appointments in Civil Engineering. By grouping staff thematically, we have created a more supportive and effective research environment with growing 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.

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 Knowledge Exchange activities. We continue to horizon-scan and nurture emerging areas, for example, we are currently developing activities in circular economy and health engineering. In addition, we will increase the involvement of social scientists critical to understanding how rapidly developing technologies, such as driverless electric cars and artificial intelligence, can best be made socially acceptable. These issues align closely with the Living with Technology and Data and Infrastructure focus of ESRC's plan.

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Excellence – Strengthening our people

This strategic strand is led by the PVC-ED, Associate Dean for 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 103.85FTE (from 47.63 for UoA13 and UoA15 combined 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., Professors Thornley in Bioenergy, Clark in Multi-agent Systems, Rahman in Civil Engineering and Meglinski in Biomedical Engineering. Future growth areas for EPS are sustainable engineering and digital engineering.
- **Develop our future research leaders.** Mentoring (ILES3.9) and training have been effective, e.g., in the last five years, three ECRs in AIPT have been awarded RAEng Fellowships (Sorokina, Perego and Chernysheva); their success was enabled by encouraging individuals to take leadership of areas of research that they have developed, organising workshops, and including them in large collaborative proposals.
- **Strengthen the diversity and inclusivity of our research community.** This is an ongoing project where we are making significant progress (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 led by the Aston Graduate School (ILES3.15-3.19), we developed a comprehensive PGR training programme with an annual cohort of 15-30 PhD students. Funding secured from the EPSRC Doctoral Training Programme (DTP) and MSCA-ITNs, as well as College investments is underpinning this initiative. Our current intake across UoA12 is 54% female and 57% BAME (home/EU), indicating that we are on track to meet our 2025 diversity targets (section 2). Recent student successes include Sirovica (supervisor: Martin) who was the first winner from the UK to win the prestigious "[The ADM Paffenbarger Award](#)" that recognises the best student research paper in the field of dental materials (2016) and Islam (supervisor: Granollers-Mesa) who won "best poster" at the UK Catalysis Conference (2021).

Impact Strategy

This strategic strand is led by the Deputy Dean for 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 and 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 Knowledge Exchange.
- **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, EBRI is working collaboratively with businesses and professions to help deploy the sustainable supply chains, technical knowledge and financial advice needed to make renewable biofuels that will benefit everybody. Also, a series of intersectoral seminars has been established to bring together companies in a particular sector with relevant academics, e.g., a workshop on Digital Engineering (10/2019) had speakers from MTC, Rolls-Royce and Arcadis, and attendees from JLR, Renishaw, Arup, BM3 and regional universities. In addition, Business Development Managers in RKE (ILES4.4) have been proactive in seeking out opportunities for KTP projects, with 19 currently in EPS (ILES2.6).
- **Supporting impact through investment and flexible contracts.** In some instances, we have used secondments to support academics in accelerating impact which has resulted

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in impact case studies. For example, a secondment agreed in 2020 (0.4FTE with the company) allowed Prince to continue work on Covid-related safety equipment with Endoscope-i whilst still having the support of the university infrastructure and equipment. This resulted in a new [PPE device](#) being designed, manufactured, tested and distributed within nine months. Three founding directors of [Grid Edge](#) used flexible contracts (0.5FTE) and RKE support to establish the company in 2016 and secure initial investment. Grid Edge has gone on to secure £2.9m of funding and a further £1.3m in R&D competitions.

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 we have developed impact as a key element of Aston's research strategy and impact 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 (for example, the International Collaboration Fund (ILES2.9)) and more applications to organisations including the Leverhulme Trust, Royal Society, EU RISE and the Daiwa Foundation. 59.9% of UoA12 publications were a result of international collaborations.
- **Continue to build and support our industry collaborations.** Over the REF period we have developed a portfolio of regional projects to support SMEs, increased our KTP portfolio, secured two Industrial Fellowships and one Manufacturing Fellowship. We also launched the award-winning Industry Club in Computer Science and then rolled out the model across the College. Business development projects have been sharing best practice and will continue to do so to optimise effectiveness. For UoA12, SciVal shows 9.2% of publications resulted from academic-corporate collaboration and we would expect this to continue to rise over the next REF period driven by the increased number of industrial research collaborations.
- **Helping to cement Aston's position as a Civic University.** For example, EBRI works with national and regional energy policy makers to support knowledge-based decisions. 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 and "learning-lunches" with the Digital team within Birmingham City Council. 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

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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. In UoA12 our combined research income and income-in-kind for this REF period is £52m, rising from £19m for UoA13 and UoA15 combined in REF2014. 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. Research Leadership was further strengthened by Professor Patricia Thornley taking over as Associate Dean for Research (ADR) from Professor David Webb in 2019, ensuring a continuation of strong and effective research leadership. Our Research Institutes are headed by Professors Sergei Turitsyn (AIPT), Webb (ASTUTE) and Thornley (EBRI). 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.

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 that allows people to develop their research careers in a supportive environment. The EPS staffing strategy has been split between (a) the appointment of external staff in areas that needed stronger leadership and/or to build critical mass and (b) the development and support of the existing team to create future research leaders.

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 UoA12, this has resulted in more than double the number of staff being submitted to REF2021 (103.85FTE, 91 of whom are employed on Teaching and Research contracts (including 14 ECRs) and 14 of whom are independent

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researchers (including five ECRs)), compared to REF2014 (47.63FTE in UoA13 and UoA15 combined). At the same time, the research-only staff population of EPS has also seen significant growth of 46.6% from 61.97FTE to 90.86FTE, providing a vibrant research environment for early-career researchers (ECRs).

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.

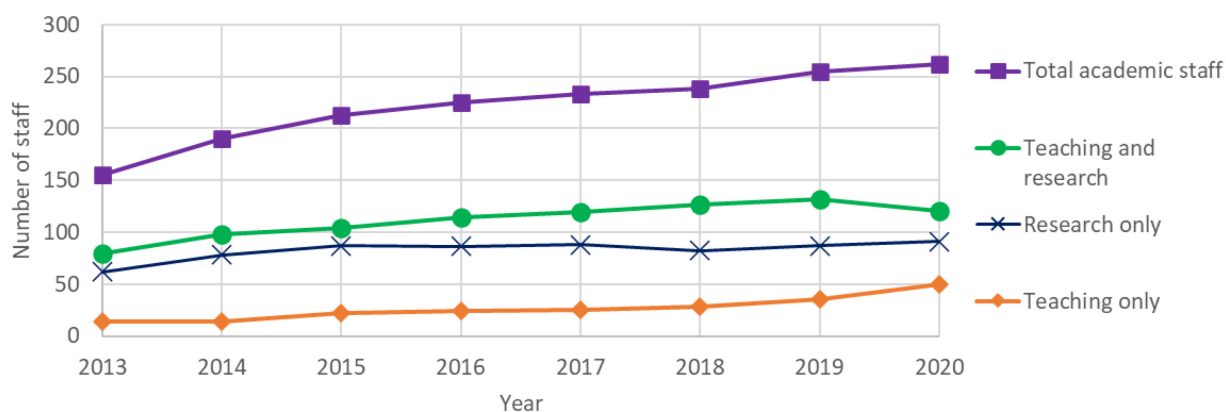


Figure 2: Staffing Levels for EPS (UoA11 and 12)

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 equality and diversity, and this requires activity against different strands:

- Diversity in Leadership** – The EPS Senior Management team (07/2020) 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 – above the sector average, but would benefit from further diversity to reflect our region and student population.
- 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 (lead by Röder), but this is now delayed until 2021. Our Athena Swan activity in EPS has led to an improvement in data analytics in all areas of EDI across the University. Actions put in place in EPS in the REF period included: selected training, mentoring and wide advertising of vacant roles within the College to allow staff the opportunity to gain experience. As part of the Athena Swan initiative, we have developed a teaching load model that looks more broadly at the time contribution for student-facing 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. From 2017 to 2020, we were delighted to host a funded RAEng Visiting Professor in Inclusive Engineering (Dawn Bonfield MBE). Bonfield worked with staff across EPS to integrate inclusive Engineering into our teaching.

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- **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 result in 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 further 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+** – 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 School and wider University. During the first year, the Group developed and launched the Aston LGBT+ Staff and Student Charter.
- **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, 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 two 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. 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 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 proactively 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. This work also inspired an exceptional talk by AIPT PhD student, and WEST founder, Gabriella Gardosi, at TEDxYouth@Brum entitled [Don't belong in STEM? That's a good thing](#). Through WEST we have sponsored students to attend the annual Women’s Engineering Society conference.

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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, focused on 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).
- Aston is a participant in TALENT, a £3m Research England funded project to lead and influence change to advance status and opportunity for technical skills, roles and careers and recognise their important role in research. TALENT is led by the Midlands Innovation (MI, ILES1.5) in collaboration with key stakeholder and industry partners. It is funded by Research England, the eight MI universities and several collaborating organisations. Hainsworth leads on the initiative for Aston as part of the TALENT Management Board.
- To highlight the importance of research in our strategy, EPS introduced protected weeks within the annual timetable when staff can focus 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 provide an opportunity for PDRs and ECRs to meet potential collaborators and friends from across the University and develop a mutually supportive network; this includes the Annual ECR Interdisciplinary Conference.

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 (ILES 3.9).

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.

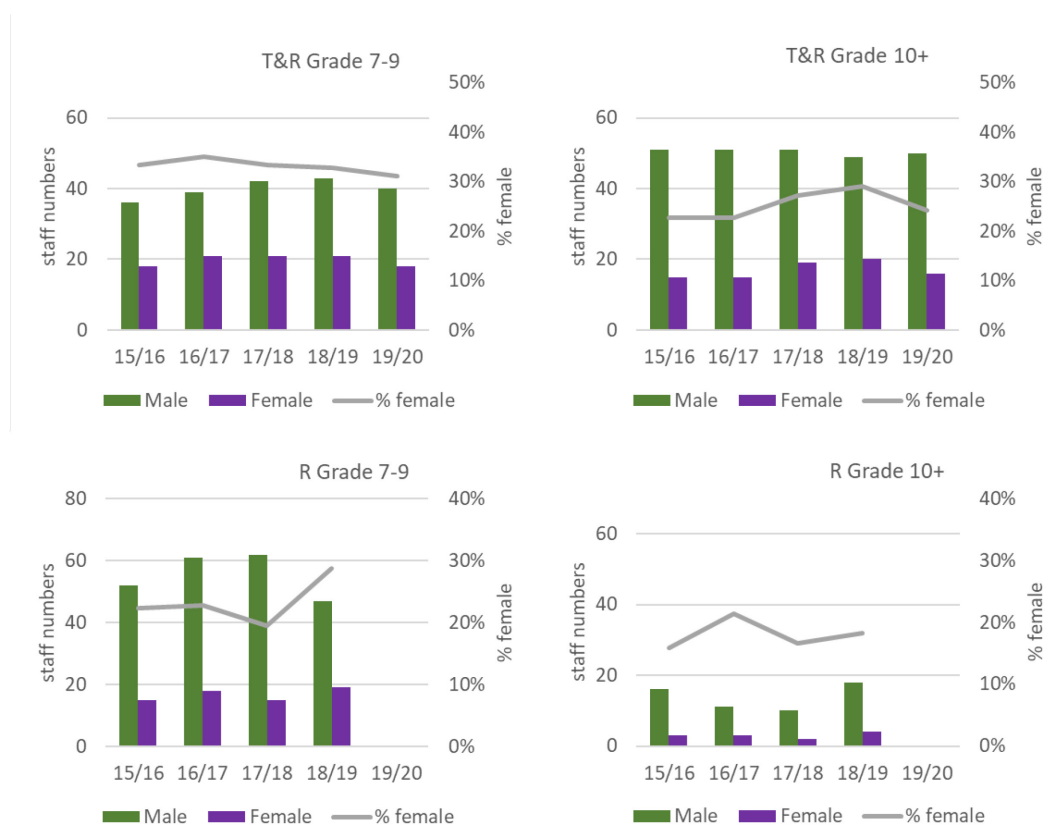
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Table 1: EPS Staff Training Provision

Training for PhD students and PDRs	Alongside the extensive Aston 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 - *compulsory

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 for EPS**

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 (grade 7 to 9 promotions) 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 staff and 83.3% for white staff. Overall, there is no significant statistical difference in success rates between the protected groups observed.

Unit-level environment template (REF5b)

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 reviewing and 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 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 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).

UoA12 proposed 767 outputs in total, of which 229 are attributed against an FTE of 104 Category A staff against an attribution target 260. The UoA12 selection displays a consistent percentage of attributions (mean 36%) across all protected characteristics where small sample sizes explain any differences. Figure 4 below highlights approximate alignment between the percentage of FTE and attributions across the categories.

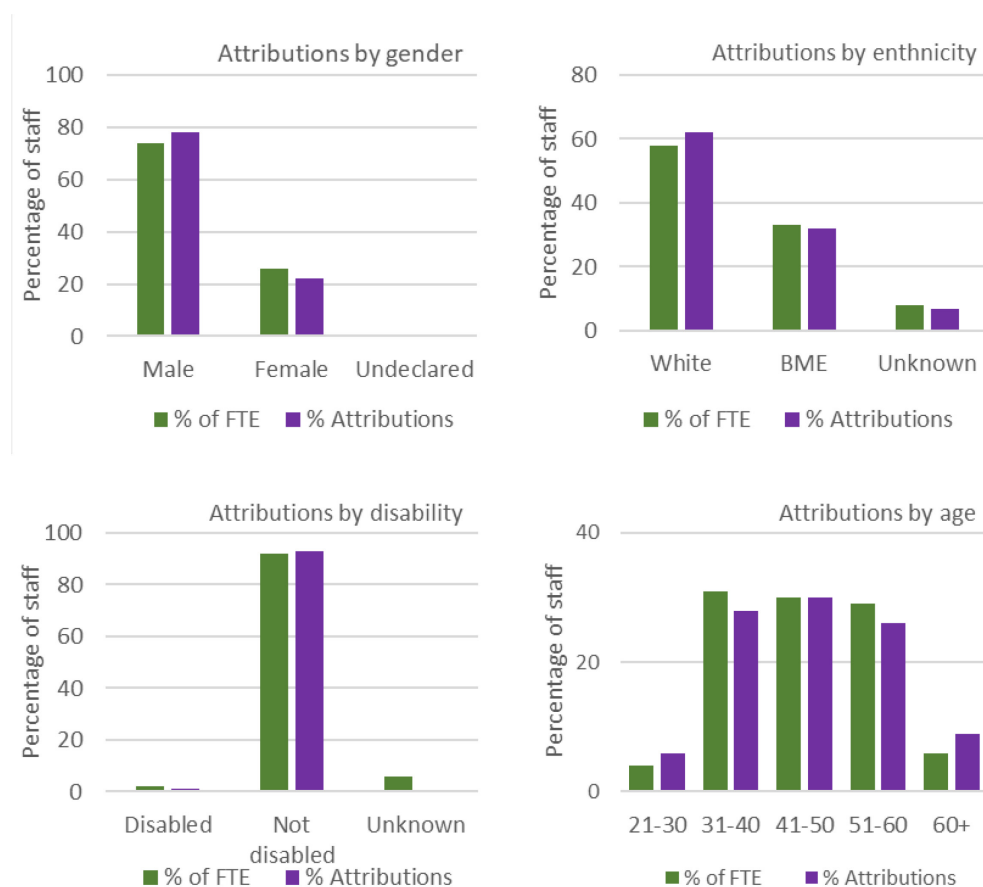


Figure 4: Percentage FTE and output attributions by protected characteristics

Unit-level environment template (REF5b)

2.5 Strategy for Training and Supervision of PGR Students

Aston's Graduate School 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 that provides a strong local research environment, where PhD students are supported in their development towards becoming independent researchers. In this REF period, 138.78 PhD degrees were awarded from UoA12 (compared to 82 from UoA13 and UoA15 combined in REF2014).

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. Stringent checks are placed on the language competence of international students, with English Language training 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, either within the College, or externally via ITNs, 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 a focus 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 undergoes a training needs analysis to identify the development needed to support both their PhD work and their future career goals.

During the PhD – Aston Graduate School 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 EPS 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 Aston Graduate School 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 Aston Graduate School, which now also facilitates University-wide weekly events such as the Interdisciplinary Seminar Series (ILES2.10).

Student networks – Our PGR students are integrated into the research community and relevant networks to provide peer support. Our office spaces have been redeveloped to ensure that

Unit-level environment template (REF5b)

students sit within their academic groups and share communal spaces. They are supported in forming special interest groups, e.g., the SPIE/Optical Society of America student chapter within AIPT which organises visiting speaker talks and monthly workshops where PGR students and ECRs present on research topics; it has also developed links to six US universities which resulted in 16 online shared seminars last year. The Women in Science and Technology (WEST) group provides networking support across all student groups and regularly hosts visiting speakers from industry. Students also benefit from strong links to the Professional Engineering Institutions at regional and national level. EBRI and ASTUTE hold monthly research seminars for staff to expand their interdisciplinary knowledge, networking capability and impact-related links. Researchers are enabled and supported to take the initiative in organising these, developing management and organisational skills, as well as raising their individual profiles.

Graduate Outcomes – The latest Graduate Outcomes survey available for the assessment period (27 EPS responses) showed that 96% of EPS PGR graduates found graduate-level positions. 30% of EPS PGRs 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 – For UoA12, 61% of our current PGR student population is BAME (40% for home students) and 41% female – this exceeds our objective for 2025 of 40% female PhD students. Our 2020 intake was a very positive 54% female and 57% BAME (home). 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, and (d) interview practices including mixed panels.

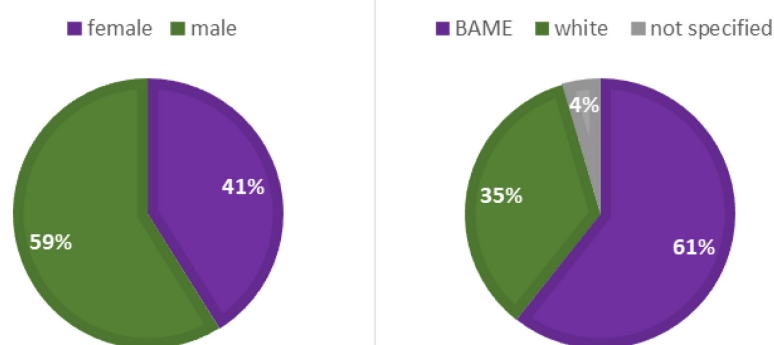


Figure 5: UoA12 diversity data – for PGR students registered in 19/20 (left) all students by gender and (right) for home students by race

3. Income, Infrastructure, and Facilities

Since 2014, the overall aim of EPS 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 URIs, and the increasing focus of our research into related disciplines, allowed us to invest in infrastructure to benefit large groups of individual researchers. This approach has allowed us to bring together research teams to create a more dynamic, interactive and supportive environment. This has included £5.1m investment in new clustered staff offices which co-locate academic staff, researchers and research students from cognate disciplines. 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 use lab space in AIPT, Electronic Engineers working in ASTUTE, and Mechanical Engineers working in EBRI and ASTUTE. The total capital expenditure over the REF period on EPS research was £16.6m.

Unit-level environment template (REF5b)

3.1 Research Income and Awards

The UoA12 income and income in kind for REF2021 is £52,234,768 (£49,871,813 income plus £2,362,955 income in kind) compared to a combined UoA13 and 15 total of £18,554,046 for the previous REF period, demonstrating significant growth. Figure 6 shows research income split by funder.

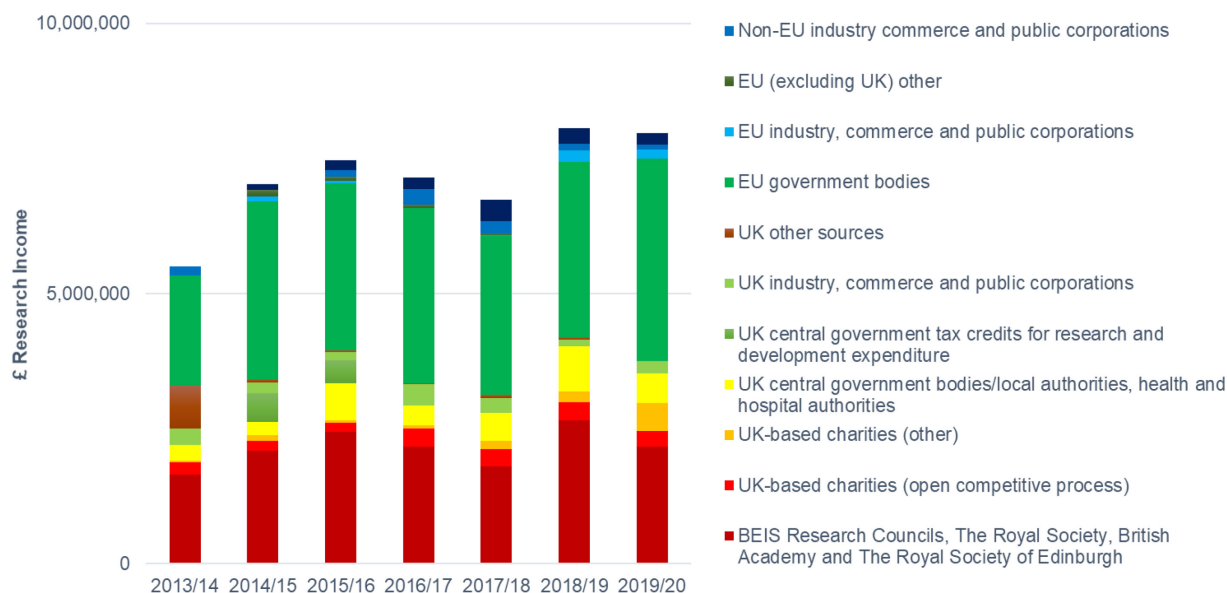


Figure 6: UoA12 Research Income

A particular success has been the significant increase of the amount of EU and international funding in EPS including: 13 EU collaborative research grants, four EU FET, ten EU ITN and 13 EU RISE. In addition, there were also 16 Newton grants, seven GCRF and at least 40 other international funded collaborations (examples are included in section 4.2 on Collaborative Networks).

The in-kind income component is predominantly from access to STFC's Diamond Light Source, the Institut Laue-Langevin (ILL), the European Synchrotron Radiation Facility (ESRF, including the EPSRC's X-ray Materials Science Facility, XMaS) and the ISIS Neutron and Muon Source. For example, this supported Topham's research group in producing superhydrophobic materials from a single, simple commercial polymer by controlling its nanoscale and microscale morphology. This work subsequently led to the creation of the superhydrophobic fabric which was used in collaboration with a research partner for a new wound dressing. Synchrotron access also allowed Topham to collaboratively develop new materials to increase the stability of Organic Solar Cells by developing new triggerable materials that changed their properties on heating. Furthermore, it enabled Martin to carry out diffraction studies of glasses, for which he was awarded the "[Gottardi Prize](#)" in 2016; this prize is awarded annually to young people with outstanding achievements in the field of glass in research and development, teaching, writing, management or commerce.

UoA12 has grown its annual research awards substantially from £7.8m in 2013/14 to an average of £13.2m/year in the last three years of this REF period, see Figure 7. The 2019/20 data was somewhat affected by Brexit uncertainties and Covid, where some contracts were delayed. This underpinning research award growth will drive an increase in research income in the next REF period. The number of successful research award applicants has increased from 29 in 2013/14 to 49 in 2018/19 and 40 in 2019/20 indicating that work to increase research activity across the College is having an impact.

Unit-level environment template (REF5b)

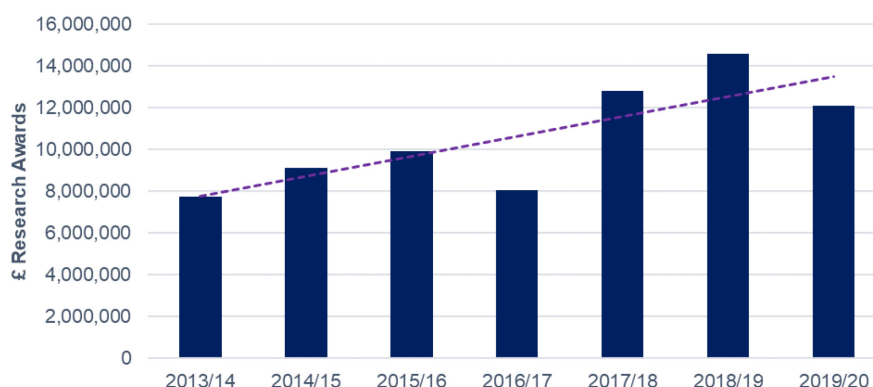


Figure 7: UoA12 Research Awards

3.2 Infrastructure and Facilities Pertaining to Research and Impact

Our investment in infrastructure and facilities has underpinned the growth in income and awards and these will be discussed in this section. It is important to note that these activities take place within a larger support framework. 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 EPS's strong position in KTP grants where we are a sector leader and have substantial EU research funding. 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 funding from the University. The facilities and infrastructure for each of the Research Institutes is summarised below.

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. Facilities in these laboratories include:

- An extensive optical communication laboratory equipped with multiple high speed electronic waveform synthesis and test equipment systems (up to 256Gb/s), optical test equipment, WDM laser sources (covering S, C and L bands), a wide variety of optical transmission fibres (SMF-28, LEAF, Truwave transmission fibres) and a 512Gb/s optical recirculating loop test bed.
- The Wolfson Centre for Photonics for Food and Agri-Tech (co-funded with £500k by the Wolfson Foundation) focusing on spectrometry and hyperspectral imaging for various food safety and agri-tech applications, including: food packaging; mid-IR /near-IR fibre optical sensors for measuring nutrients within foods; optical fibre sensors with coated nanomaterials capable of measuring glucose concentrations; and developing new technologies to monitor the concentration of micro and nano plastics in water.
- The SNAP laboratory, where researchers are working on the design and fabrication of novel ultralow-loss optical microdevices, having potential applications in optical communications; quantum technology; and ultraprecise sensing.
- Five state-of-the-art fibre laser laboratories using UV and femtosecond lasers for materials processing, micromachining, inscription and the development of fibre lasers.

Unit-level environment template (REF5b)

- A free-space photonics lab working on the detection and manipulation of laser beams for defence applications.
- Industrial research laboratories dedicated to bringing industry and AIPT researchers together.
- A nanophotonics lab for research on carbon nanotubes, graphene and 2D materials, nano-diamond and zinc oxide, synthetic fluorescence and laser dyes, natural pigments and polymer composites.
- A bio- and medical-photonics laboratory focused on improving diagnostic and sensing technologies in healthcare, plus a shared biophotonics laboratory that accommodates colleagues from AIPT and the College of Health and Life Sciences, to support interdisciplinary research in this area.

All laboratories are used for research, collaborations with industry in international, national and regional projects, and the training of UG students (through internships and final year projects) and PG students (through projects). The range and capability of the lab spaces and equipment makes AIPT a partner of choice for many businesses and universities giving AIPT an impressive reach. This includes a portfolio of industrial and international collaborations (section 4), 60 patents, and five spinout 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 Planck institute for the Science of Light. Through the [Agri-tech Growth and Resources for Innovation \(AGRI\) project](#) (with regional partner Harper Adams University and ASTUTE), AIPT assists Marches-LEP based SMEs to innovate and develop new products and services in order to exploit growing market opportunities; particularly in agri-tech, food and drink manufacture and specialist food and drink logistics. Having met its initial output targets the AGRI project has been successfully extended and will now be completed in 10/2022, supporting 173 SMEs in the region over five years. The extension support from 03/2020 covers the Shropshire, Telford and Wrekin transitional area of the Marches-LEP region, and to date, has worked with 102 companies, helping 32 of them to introduce new products or services. Additionally, the project has delivered seven specialist workshops: covering areas such as precision agriculture, logistics, innovation in food and drink production and measuring and sensing in food processing using photonics.

The AIPT team includes: Professors (Turitsyn (Head of Institute, *FOSA*), Doran (*FIET*, *FOSA*), Ellis (*FOSA*), Forsyia, Meglinski, Rafailov (*FOSA*), Sugden, Sumetsky (*FOSA*), Webb; Zhang (Emeritus, *FOSA*)) and further six academic staff: Harper, Lutsyk, Rozhin, Turitsyna, Williams (*FIET*), Yurkevich. AIPT also includes 12 independent researchers (Benton, Chinnambedu Murugesan, da Silva, Hill, Perego (ECR), Prilepsky (ECR), Sergeev (ECR), Sokolovski, Sorokina, Sygletos, Zhou), 65 Research Associates and PhD students, and 13 Professional Services staff.

* *FOSA: Fellow of the Optical Society of America, FIET: Fellow of the Institution of Engineering and Technology*

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. These include:

- Outstanding experimental, analytic facilities for biomass and biofuel elemental analysis, and thermochemical characterisation (including Thermogravimetric analysis (TGA)).
- Slow, intermediate and fast pyrolysis reactors for waste and biomass thermal processing with different bio-liquids quenching systems and on-line analysis of gaseous products.

Unit-level environment template (REF5b)

- High-pressure, high-temperature autoclave systems for hydrothermal processing of biomass and catalytic upgrading of bio-liquids towards biofuels and value-added chemicals.
- Differential Scanning Calorimetry (DSC), Pyrolysis-GC-MS (Py-GC-MS), ICP-OES for metal analysis and spectroscopic characterisation (FTIR, UV-VIS).
- Surface morphology and crystallographic characterisation (SEM, EDX, SPX, XRD) and chromatography (Gas Chromatography (GC), Gas Chromatography-Mass Spectrometry (GC-MS) and High-Performance Liquid Chromatography (HPLC)).
- A 1MWth fluidised bed gasification pilot plant connected to a 400kW combined heat and power generator that can provide the heat, electricity, and cooling needs of the EBRI building and other parts of the University campus. This is the only large-scale gasification pilot plant for R&D in the UK, comprising 1000 instruments, 80 pieces of equipment and eight control panels.
- A microgrid demonstrator, incorporating a 10kW smart bi-directional charger, which was the UK's first vehicle-to-grid charger, supporting development of demand-side management approaches to support low-carbon networks.

These facilities allow EBRI researchers to carry out laboratory-scale investigations of the fundamental science around feedstock conversion, facilitating feedstock, intermediate and product characterisation across thermochemical, biological and catalytic conversion pathways. The research-focused laboratories offer high-quality facilities for our cutting-edge research projects as well as attracting international collaborators and visitors, who access our facilities via Marie Curie Fellowships (two confirmed for 2021); schemes such as the transnational access programme BRISK2 (where EBRI is the only UK participant); and research visits from national Supergen collaborators. EBRI is also part of an equipment sharing scheme for researchers and technicians across the Midlands via the Energy Research Accelerator (ERA). The opportunity to access these high-quality facilities is available to our UG students via internships and final year projects, as well as a unique IChemE-accredited training course that allows our students, staff and others to gain experience on a full-scale process plant.

Our analytical and scale-up facilities underpins our work with 387 businesses through *the Low Carbon project* and 211 companies attending EBRI's highly acclaimed (97% rated "Excellent" or "Very Good") two-day 'Value from Waste' Masterclass. In an independent evaluation (*EBRI Interim Evaluation Reports published 06/2015 and 04/2019), 100% of businesses felt that the support received from EBRI had had a positive impact on their company, of which 47% said EBRI improved their competitiveness; 28% increased their investment in Research, Development and Innovation. In accordance with the HM Treasury "Green Book" methodologies, the economic impact of EBRI's support for businesses included:

- Creation of 234 new jobs in the region
- Increase of over £28.9m in Gross Value Added (GVA) through business support
- Increase in RD&I spend of over £1.97m after businesses partnered with EBRI

Success of these programmes is communicated widely through the website and booklets, e.g., the Fusion Guide which has played an important role in supporting regional businesses to develop low-carbon solutions. Andy Street, West Midlands Mayor, said "*With Energy-from-Waste and Bioproduct supply chains expanding rapidly, businesses need to be made aware of the wide variety of specialisms that our region has to offer. The Fusion Guide does a brilliant job of making this process easier for businesses.*"

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

Unit-level environment template (REF5b)

bioenergy systems that support the UK's transition to an affordable, resilient, low-carbon energy future.

The EBRI team from UoA12 includes: Professors Thornley (Head of Institute), Bridgwater (*FIChemE*, *FIE*) and Tighe who work alongside: Blanco Sanchez, Chong, Fratini, Granollers, Griffiths, Hossain, Najdanovic, Nowakowski, Onwudili, Röder (independent researcher, ECR) and ECRs: Amiri, Fernandez-Castane, Yuan and Rezk. A further 16 individuals from UoA12 are members of both EBRI and ASTUTE: Alaswad (ECR), Derry (ECR), Evans, Holderbaum, Jia, Junaid, Li, Mahomed (ECR), Park, Rahman, Swadener, Sweeney (Professor, *FCILT*, *FCMI*, *FInstLM*), Theodosiou, Tota-Maharaj (*FICE*, *FloWater*), van Koningsbruggen and Whitehead. In addition, there are nine Research Associates, 13 PhD students, six knowledge-exchange and eight Professional Services staff including the EBRI Director of Engagement (Miller).

**FIChemE: Fellow of the Institution of Chemical Engineers; FIE Fellow of the Institution of Engineers; FCILT: Fellow of the Chartered Institute of Logistics and Transport; FCMI: Fellow of the Chartered Management Institute; FInstLM: Fellow of the Institute of Leadership and Management; FICE: Fellow of the Institution of Civil Engineers; FloWater: Fellow of the Institute of Water.*

Aston Institute for Urban Technologies and the Environment

ASTUTE provides a range of facilities to support the variety of research activities in the Institute.

- The Aston Laboratory for Immersive Virtual Environments was created in 2015 as a result of a £3.9m investment. It provides motion capture, room-scale virtual reality and EEG recording equipment, enabling research into visual perception, social cognition, and social vision.
- The Aston Interactive Media Lab is dedicated to research into 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 from GBS Institute of Technology has enabled the creation of laboratories dedicated to research in cyber security, rapid prototyping and digital manufacturing.
- Significant research activity in data analytics and AI is supported by a range of computing facilities, including: individual GPU-based workstations; a new shared server (8GPU, 20 core, 512GB, £50k); cloud-based processing (e.g., Amazon Web Services); and the Tier 2 High Performance Computing Plus facility of Midlands Innovation (ILES 1.5).
- Supporting research on future transport, we have a wide range of facilities for testing high-performance electrical machines, power converters and EV batteries to enable bespoke design.

Since the formation of ASTUTE in 2018, the number of KTP projects in the Institute has increased from five to 17. In terms of fundamental research, Aston's two successes in the recent EPSRC New Horizons call were both from ASTUTE members.

ERDF projects continue to deliver measurable benefit to our regional beneficiaries. The [Think Beyond Data](#) project enables 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 of ERDF funding invested. The findings demonstrate that the project represents good value for money and this project has since been extended.

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

Unit-level environment template (REF5b)

Aston University built on research, testing and expertise in materials science. The collaborations with industry have been diverse: from working with a fuel additive manufacturer to verify the performance and efficiency that it brings to an engine, to working with a wind turbine developer to create prototype designs with optimum materials.

The **ASTUTE** team returned under UoA12 includes: Professors Webb (Head of Institute), Al-Malaika, Cao, Hainsworth (*FREng*), Topham (*FRSC*) and Xu working alongside Alexakis, Ankrah, Chattopadhyay, Claussen (ECR), Fratini, Generalis, Geoghegan (ECR), Herzallah, Jabran (ECR), Jones, Kasim (ECR), Laurie, Leslie, Liu, Ma (*FIMechE*), Marinov, Martin, Matopoulos, Mehravar (ECR), Morrison, Nerukh (*FRSC*), Nock, de Souza (independent researcher, ECR), Peters, Price, Prince, Sabri (ECR), Sutherland, Tang, Thomson, Wong, Worrall (ECR), Wu and Zhang. Within UoA12, a further 16 individuals are members of both EBRI and ASTUTE: Alaswad (ECR), Derry (ECR), Evans, Holderbaum, Jia, Junaid, Li, Mahomed (ECR), Park, Rahman, Swadener, Sweeney (Professor), Theodosiou, Tota-Maharaj, van Koningsbruggen and Whitehead. **In UoA11 there are a further 34FTE ASTUTE academic staff including six ECRs.** ASTUTE also hosts 11 professional support staff (project managers, business development managers and administrators).

**FREng: Fellow of the Royal Academy of Engineering; FRSC: Fellow of the Royal Society of Chemistry; FIMechE: Fellow of the Institution of Mechanical Engineers*

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

4.1 Introduction

EPS values collaboration with academic, industry and policy partners. Examples of our leadership internationally include Thornley, who is coordinating the UKRI Supergen Hub's input at COP26, and Turitsyn's COFUND MULTIPLY project. We also have strong involvement in networks such as MSCA-ITNs, which have resulted in the College being well connected internationally. In addition, wide-ranging activities in Knowledge Exchange such as KTP and business-focused ERDF funding have generated strong links to industry – especially in the technical SME community.

4.2 Research Networks

Our Research Institutes collaborate with high-performing institutions and industry partners around the world, allowing regular exchange of people and ideas. This creates a vibrant, high-quality research environment, facilitating the generation of collaborative funding proposals from our international and connected community. Exemplars include:

- **H2020-MSCA-ITNs:** AIPT now coordinates the highest number of MSCA-ITNs in the UK (eight), and the fifth highest in Europe (with only three fewer awards than the French National Centre for Scientific Research (CNRS), which covers all of France). The eight ITN projects we have equate to £19m, with £5.6m going to Aston. These networks, with industrial partners including IBM, Orange Labs, Telecom Italia, Thales, Nokia Bell Labs and other technology leaders, will train 69 ECRs with 12 forming the Aston cohort, illustrating the strength of our industry and academic networks, scientific ideas and excellence in training the next generation of researchers.
- **Erasmus Mundus Joint Masters Programme (EMJMs):** EPS leads one EMJMs and is a partner in three. The total value of these projects is £3m. Combined, the projects fund the training of more than 100 Masters students from across the world to undertake split-stay Masters programmes focused on optical communications technology for smart cities, electronics and micro-engineering. Each programme brings together leading academic groups in Europe with international leaders in industrial research, such as Airbus, Thales, STMicroelectronics, Ericsson and BT.
- **H2020-MSCA Research and Innovation Staff Exchange (RISE):** Since 2014, EPS has received funding for 18 RISE projects, as lead and partner, equal to £9m to support

Unit-level environment template (REF5b)

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, ranging from extending theories on plastic deformation through harnessing techniques in fluid turbulence, to novel wound dressings from natural compounds.

- **H2020-Future Emerging Technology (EU-FET) programme:** Aston is in the top ten UK recipients for the highly competitive FET programme. The projects that Aston leads are excellent examples of multi-disciplinary research, generated by an Aston team from AIPT and the Aston Institute of Health and Neurodevelopment (IHN), bringing together biophotonics experts and neuroscience researchers:
 - **Custom architecturally defined 3D stem cell derived functional human neural networks for transformative progress in neuroscience and medicine (MESO_BRAIN).** Prof Rafailov (AIPT), Dr Parri (IHN), €3.5m (€1m to Aston), Partners: Axol Bioscience (UK), Laser Centrum Hannover (Germany), Institute for Photonics Science (Italy) and University of Barcelona (Spain)
 - **Non-invasive dynamic neural control by laser-based technology (NEUROPA).** Prof Rafailov (AIPT), Dr Parri (IHN), €4m (€1m to Aston). Partners: Sorbonne University (France), Bayreuth University (Germany), University of Barcelona (Spain), Oulu University (Finland) and Pharmacoidea (Hungary)
- **Partner Institutions:** The Aston-Novosibirsk State University International Centre for Photonics, established in 2013, led to more than 90 publications in the leading international journals (including Nature Photonics, Nature Communications and Physical Review Letters).
- **Overseas Development Assistance (ODA) funding:** Aston has a diverse portfolio of research and knowledge exchange projects with ODA recipient countries, attracting funding for six GCRF and 16 Newton projects to tackle UN Sustainable Development Goals aligned economic development and social welfare challenges, such as plastic waste (Turkey); renewable, naturally-derived wound healing (Vietnam); and reducing post-harvest loss (Sub-Saharan Africa).

4.3 Academic Outputs

Our networking strategy has produced a significant impact on international and corporate collaborative outputs. From the Category A staff submitted in UoA12, there were 3168 published outputs, 59.9% were the result of international collaboration and 9.2% were the result of academic corporate collaboration (SciVal report based on Category A staff submitted). Of the collaborative papers, 45% of the authors were from partners within Europe, 24% from Asia Pacific, 18% from North America, 6% Middle East and 3% from Africa. Within the UK, the most significant collaborators for Engineering were the University of Birmingham, University College London, University of Warwick and University of Manchester. Outside of the UK the largest collaborators in each region are:

- Western Europe: CNRS (The French National Centre for Scientific Research), CSIC – Institute of Optics Daza de Valdés (Spain), University of Oulu (Finland), Technical University of Denmark
- Australia: Royal Melbourne Institute of Technology, University of New South Wales
- USA: Harvard
- Eastern Europe: Novosibirsk State University (Russia), RAS – Federal Research Centre for Information and Computational Technologies, Siberian Branch
- China: Huazhong University of Science and Technology and the Chinese Academy of Science

Unit-level environment template (REF5b)

Our top corporate collaborators are dominated by the large global telecommunications companies such as Lucent, Orange Labs and Huawei Technologies, but stretched to 149 in total from global companies (e.g., GlaxoSmithKline, BELECTRIC Solar & Battery GmbH, Airbus) to SMEs (Optimec, Arden Photonics).

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:** Editor in Chief (2019-present) of Biomass and Bioenergy (Thornley); Editorial Board (2019-present) for Science of the Total Environment (Alaswad); Guest Editor (2020) for special issue of the Journal of Materials Research, on The Science and Technology of Vapor Phase Processing and Modification of Surfaces (Hainsworth); Associate Editor (2009-2015) of Optics Express (Ellis); Associate Editor (2019-2022) of Urban Rail Transit URRT (Marinov); Chief Editor (2018-present) of the International Journal for the History of Engineering & Technology (Price); Editorial Board (2014-present) of Optics Letters (OSA) (Sumetsky); Editorial Board (2019-present) Optica (OSA), (Sumetsky); Editorial Board (2017-present) Journal of Chemical Technology and Biotechnology (Theodosiou); Associate Editor (2015-2016) RSC Advances Royal Society of Chemistry Journal (Topham); Associate Editor (2019-present) of the IEEE Journal of Lightwave Technology (Turitsyn), Co-Editor (2016-present) Journal of the European Optical Society (Turitsyn), Editorial Board (2015-present) Nature Publishing Group Scientific Reports (Turitsyn); Guest Editor (2020-present) Applied Sciences (Worrall).
- Contribution to conference organisation:** Chair of Technical Programme Committee of the European Conference on Optical Communications (ECOC 2019, Dublin, Ellis); OFC D4 Subcommittee Chair (San Francisco 2019, previously Committee Member 2016-18, Forsyia); Organiser and Chair of the Royal Society International Scientific Seminar on Orbital Angular Momentum in Optical Fibre Communications (Chicheley Hall, 2016, Forsyia); Chair (2014) and Co-Chair (2015-2016) of the Committee for Optical Micro/Nano Resonators and Devices (IEEE Photonics Conference, Sumetsky); Co-organiser of the Royal Society meeting on Communication Networks Beyond the Capacity Crunch (London, 2015, Ellis, Saad & Payne (Southampton)); Organiser and Chair of the symposium Advances on Biofuels: Materials, Characterisation, Processing and Testing at the XVI International Materials Research Congress (IMRC) (Mexico, 2017, Sodre); Fuel Cell Session Chair and Conference Committee for Sustainable Energy and Environmental Protection (UAE 2109, Alaswad); Committee Member for the 11th International Conference on Environmental Engineering (2020, Toto-Maharaj); Member-at-Large, CDIO International Council, (2018-2022, Junaid); Program Section Co-Chair (2017) and Chair (2018), American Academy of Forensic Sciences (Hainsworth).
- Conference and technical meetings at Aston:** We have also encouraged staff to host conferences and international meetings on campus to expand our network. This has included: IoP Photon 2018, ~400 attendees (Forsyia); 14th International Conference on Materials Chemistry MC14 (2019), 600 attendees (Topham); POF 2016: 25th International Conference on Plastic Optical Fibres (Webb); UK and Ireland / European Annual Meeting of the CDIO initiative 2020 (Junaid); Watef Network Conference 2020 – Moving towards water resilient communities (Toto-Maharaj); 6th international conference on Material Science and Smart Materials (2019, Martin); New Frontiers in Raman-assisted fibre technologies (2017, Sergejev); Non-linear Fourier Transform NFT-Workshop (2020, Doering-Saad).

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:

Unit-level environment template (REF5b)

- European Regional Development Funding (ERDF)** – This allows each Research Institute a platform for regional knowledge exchange, with six projects running in 2020 (AgriTech, Smarterials, UK Centric Supply Chains, Think Beyond Data (UoA11), Low Carbon SMEs and ETICC). In 2020 alone, 200 enterprises were supported by EPS by 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.
- 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 is currently the most successful University regionally with the eighth largest portfolio in the UK and the portfolio is dominated by EPS projects. There have been 32 KTP projects over the REF period, with EPS as either PI or CI totalling £6,374,896 in funding (13 of these in UoA12 since 2018). 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 Knowledge Exchange opportunities. Recent KTP success includes the 2019 [“Future Innovators Award”](#) for KTP associate Gallo working with Sarissa Biomedical.
- Industry Clubs (ICs)** – EPS has developed a model of ICs that has generated significant benefit to both students and researchers. The first IC was launched in Computer Science (CS) 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 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 and curriculum. It helped establish 15 KTP projects and secure joint funding for three PhD studentships (Geospatial Insight, Beazley and Arcadis) and a £586.5k EPSRC project (EP/T017627/1). Innovate UK recognised Aston’s success in this area at their national [“Best of the Best” KTP Awards 2020](#). The IC model is being rolled out across the College. For example, the Chemical Engineering IC currently has six subscribing companies and has already resulted in 50% sponsorship of a PhD studentship, and there is a KTP application in preparation.
- Collaborative Research Grants** – A natural progression from ERDF is collaborative Innovate UK research projects, e.g., a Photonics ERDF project awarded in 2013 created a link to Gas Data Ltd who then went on to collaborate further with AIPT on a project to develop a range of gas monitoring solutions, utilising optical fibre technologies, for difficult-to-detect gases that would function in challenging and hazardous environments. In addition to its Impact Case Study, Energy Harvest, EBRI has won three Energy Catalyst grant awards from Innovate UK during the period in Ethiopia (Onwudili, ECR) and the Philippines (Röder, Independent Researcher, ECR), supporting UK companies in developing sustainable energy solutions for communities in developing countries and underpinning our leading international impact. This is in addition to industrial collaborations with innovative companies such as Nova Pangaea (biofuels/products), Future Energy (biochar) and SHV (low-carbon propane).
- Informing government policy** – In areas such as energy it is important to be working at a governmental level to generate impact. Through SuperGen, Aston staff had 55 meetings in 2020 with representatives from seven relevant governmental departments and agencies (e.g., BEIS, DfT and OfGEM). These meetings help government employees to fill knowledge gaps and inform policy development and deployment. EBRI staff are representatives on several energy policy committees including the Birmingham City Council Route to Zero Taskforce, ERA Energy for Waste Policy Commission and NFU Scientific Advisory Panel on Net Zero. They (Thornley, Röder and Chong) also contributed to the Renewable Energy Association’s biomass strategy (see ICS Bioenergy Policy). Ellis

Unit-level environment template (REF5b)

has engaged with policy makers influencing the transition to full-fibre networks through workshops (2015 and 2017), Parliamentary engagement (2013 to 2016) and generating extensive media coverage.

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; these activities drive our student diversity and our strong links to business and the region. Outreach is explicitly written into many of our grant applications. Examples of our higher-profile events, where a strong link between science and the arts boosts accessibility include:

- **Lightfest** (2015) was a flagship UK initiative for the [UNESCO International Year of Light celebrations](#). This day-long event took place at the newly opened Library of Birmingham. It was funded as a European Commission Researchers Night activity and attracted 12,500 visitors. 100 researchers and 33 additional Aston volunteers participated. It included lectures about light science and technology including Professor Andrew Ellis (AIPT) who explained how optical fibres connect us all together and Dr Maggie Aderin-Pocock, from BBC's the Sky at Night programme, who showcased photographs taken by the Hubble Space Telescope. Alongside there were educational workshops, technology demonstrations and art installations all commissioned for the event. After the event, various exhibits travelled to Manchester's Light Festival 2016 in the Museum of Science and Industry, and the IET's EngTech 2017 and 2019.
- 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 Aston stand concentrated on smart cities and how technology, data and logistics linked together. The event was featured in [China Daily Hong Kong](#).
- Thornley addressed [Climate Assembly UK](#) on bioenergy's role in the UK 2050 climate targets in 2020 and EBRI staff have made regular appearances on radio programmes nationally and internationally to explain climate change and energy-related issues
- Aston staff constituted four of the eleven contributors to the [Supergen Bioenergy comic](#), a successful engagement and research dissemination tool for younger audiences. 3000 copies were distributed globally at the request of research and education agencies worldwide.
- EPS has been an active contributor to The Big Bang Fair, e.g., our STEM Superhero stand in 2019 involved 67 staff and student volunteers explaining seven different research-related activities. We engaged with over 3,500 young people who spent an average of 20 minutes at the stand and generated 15,900 social media impressions. Colleagues have also regularly contributed to activities such as Pint of Science and Café Scientifique, e.g., "Contemporary logistics and supply chain management - the key to economic and societal well-being" (Sweeney).

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. Articles include: The design tricks that made the Nokia 3310 world-beating ([Mallaband](#), 2017); A full fibre network is the only way to future-proof Britain's digital economy ([Ellis & Turitsyn](#), 2015); What is needed to tackle the climate emergency, and who is responsible? ([Thornley](#), 2020); How to fix India's burning issue: turn unwanted straw into bio-energy pellets ([Berry](#), 2017); No-deal Brexit scenario would create serious traffic congestion and supply chain chaos ([Sweeney](#), 2019); Rice growing produces tonnes of excess straw – can we turn it into 'bioenergy'? ([Röder](#), 2019).

Media training and marketing support has also been offered as part of our public engagement strategy. Recent examples include:

- In 2019, Hainsworth was featured on Channel 4's World's Most Extreme series and was interviewed by BBC WM on her research into forensics and knife crime. Sweeney was

Unit-level environment template (REF5b)

featured in [The Telegraph](#) talking about the future of Blockchain. Martin was widely covered talking about stained antimicrobial glasses and how they can protect against hospital superbugs (Midlands Today, [BBC News](#), Reuters, MedicalNewsToday.com, [The Daily Mail](#), [Nursing Times](#)). EBRI gained coverage ([RenewablesNow](#), [Electronicsweekly](#), [Raconteur](#), [E&T](#)) for their Vehicle-to-Grid/Building (V2G/V2B) systems and distribution networks collaboration with ByteSnap Design, Grid Edge and Nortech Management. Whitehead was featured by [Bioscience Today](#) about how we can add value to waste plastic bottles and how these can be turned into essential products for the developing world. This story was also covered by BBC Midlands Today, ITV News Central and BBC West Midlands.

- In 2020 Sweeney featured on BBC Radio WM, ITV News Central and 20+ BBC local radio stations, talking about the logistical rollout of the Covid-19 vaccines. Prince's SNAP device, designed to stop Covid-19 spread during routine throat cancer tests featured in [BBC News](#) and [BBC Midlands Today](#) and widely in related clinical press. Thornley's work on bioenergy featured on [BBC Radio 4's Farming Today](#) and a [BBC World Service – World Business Report](#) on Turning Waste into Energy. A project from the Think Beyond Data ERDF project on route optimisation for transport was picked up by 25 websites including The Engineer. Chattopadhyay's Nature Communications proposal for a new way to use machine learning to define what poverty really means in different contexts was featured in [ZME Science](#).

Looking to the future – Aston's College of EPS 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 and the advancement of science and engineering.