Institution: University of West London

Unit of Assessment: 12 - Engineering

1. Unit context and structure, research and impact strategy

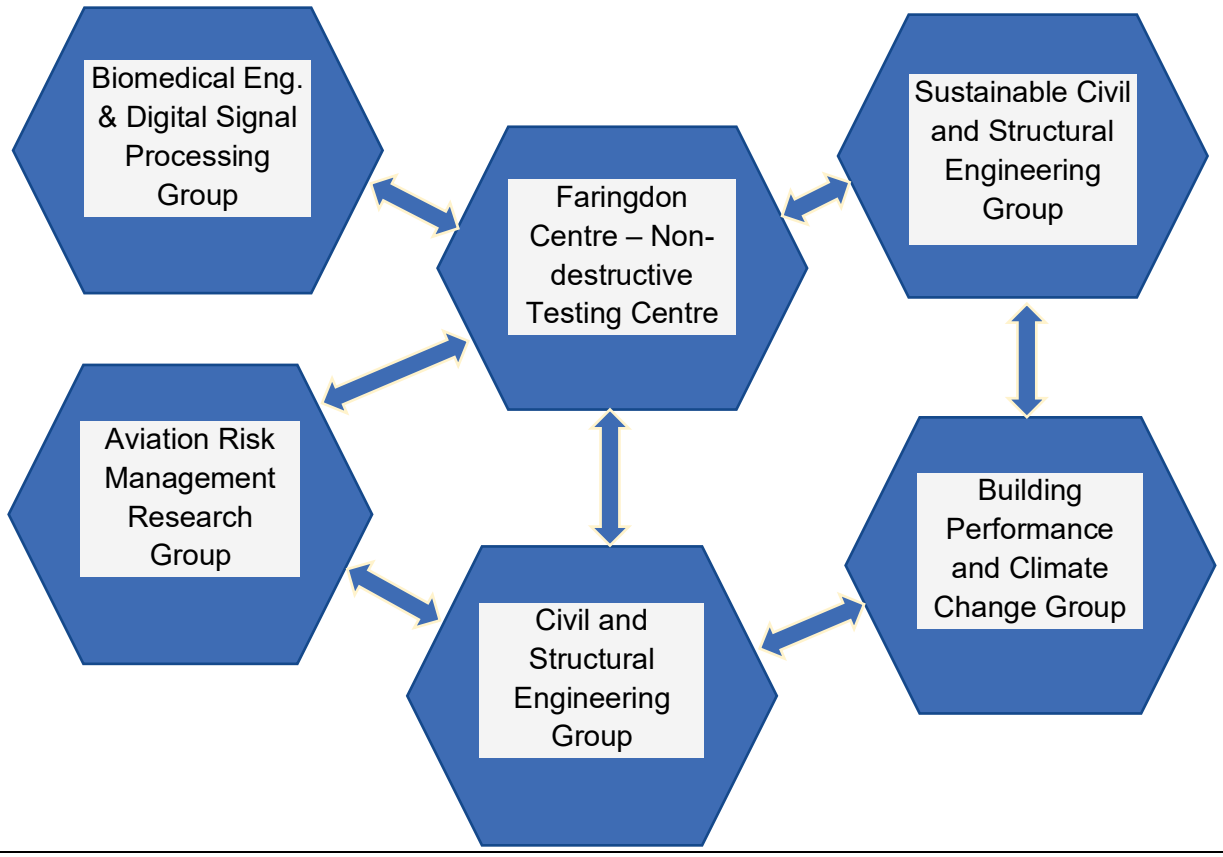
1.1 Context

The University of West London (UWL) offers a broad range of courses; structurally it is divided into six Schools and three Colleges, each led by a Dean or Head of School. This unit encompasses research from six distinct subject areas within the School of Computing and Engineering at UWL. This is a multi-disciplinary setup which provides a conducive and dynamic environment for research and development work to prosper. The School provides ample opportunities for collaborative research between the engineering and the computing subject areas within the School, and beyond.

1.2 Structure

At its core, the research carried out uses numerical methods and principles of engineering, geophysics and sustainability to find solutions for real-life problems presented by industry and communities. The main distinctive features of our research can be defined as the integration of theoretical developments, laboratory investigations, field applications and the development of procedures and methodologies in various areas of activities in engineering. Much of what distinguishes our research approach lies in its theory-informed practice, outward-looking character, and innovative knowledge exchange with external organisations and end-users. The figure below illustrates the position of the Research Centre with regards to the groups associated with this submission, as well as the structure of research activities:

Figure 1, UoA 12 Research Structure



Areas of research covered by the fourteen members of the UoA:

Faringdon Centre research team – Alani, Tosti, Naveed, Nikolic, Zou

- Advanced signal and data processing and numerical modelling for non-destructive testing methods
- Assessing the condition of railway ballast using ground penetrating radar: experimental and numerical developments
- Monitoring the health of ancient and mature trees and identifying early decay and defects in tree trunks
- Investigating tree root-soil interactions and the tree root architecture
- Monitoring the health of bridges and civil and engineering structures

Building Performance and Climate Change Group – Bahadori-Jahromi

- Minimum Energy Efficiency Standard (MEES) requirements and their impact on hotel buildings
- Design and evaluation of Nearly Zero Energy buildings and their viability under current and future UK climate conditions

Biomedical Engineering and Digital Signal Processing Group – Nikolic, Georgakis, Chousidis

- Modelling of biological systems
- Design and development of neural stimulators and recording amplifiers
- Design and development of recording techniques for ENG and EMG signals
- Rehabilitation of SCI patients.

Sustainable Civil and Structural Engineering Group – Rizzuto, Behzadian, Fu, Shaaban

- Computational modelling and structural design
- Structural simulation and blast analysis
- Structural strengthening and rehabilitation, strengthening method
- Building information modelling and civil engineering
- Energy efficiency and building performance
- Application of computational modelling for civil engineering

Civil and Structural Engineering Group – Naveed, Shaaban, Tosti

- Structural behaviour of honeycomb domes composed of reciprocally supported elements
- Advances in measuring mechanical properties of soils in relation to soil health
- Permanent and temporary support to excavated slopes using soil nails
- Roads deteriorate in the form of potholes: how can an effective design and innovative materials stop this?
- Bioengineering of slopes: How root length density, root branching, and root strength contribute to soil slope reinforcement
- Soil stabilisation using biopolymers

Aviation Risk Management Research Group – Padhra and Sikora

- Impact on the environment and climate change of aircraft operations, particularly at airports
- Development of aircraft performance models using input data from industry sources with models calibrated against aircraft manufacturer data.
- Operational aspects of aviation involving including, but not limited to, safety, human factors, drones, and risk management.

1.3 Research and Impact Strategy

1.3.1 Post-REF14 Plans

The University is submitting to this UoA for the first time. This submission results from the expansion and growth strategy pursued by the University over the lifespan of the past two strategic plans, which outlined new strategic research areas, and a programme of investment of human and physical resources to support them, (see institutional statement, section 2). Engineering was one of the subject areas that benefitted from this. With the appointment of an Executive Dean in late 2014 (Professor Amir Alani), and under his direction, the UoA has grown strategically to occupy a strong position in several niche research fields. Two researchers in aviation located it the London Geller College of Hospitality and Tourism are also included in this UoA. Considering that there was no previous organised and structured research culture within this subject area, four major goals were set in 2015:

1) Create and expand a culture of interdisciplinary research with translational impact within the subject area.
2) Build and consolidate such expertise within the subject that will support and harness a long-term and stable research community and culture within the School of Computing and Engineering.
3) Increase research funding to enable the development of our profile in terms of our national and international reach and recognition.
4) Identify and develop impact communities, and impact monitoring mechanisms.

To realise these, the following objectives were set and acted upon:

1) Identify existing areas of expertise and make research active appointments when vacancies arise.
2) Invest in facilities and infrastructure compatible with advanced research and consultancy in relevant areas.
3) Develop courses at postgraduate level to encourage and support a stable research culture.
4) Invest in PhD students and post-doctoral research fellows to support and engage with research and sustain a vibrant research environment.
5) Support and encourage collaborative research with external bodies and groups, nationally and internationally.
6) Invest in niche and emerging areas of research and create centres of excellence for long-term sustained engagement with industry and external research communities.

We identified as our main communities for impact the following partners and organisations:

- At regional level – local authorities and statutory organisations, industry and enterprises, philanthropic organisations, hospitals, schools, and colleges
- At national level – industry and enterprises, higher education and research organisations, professional bodies, philanthropic and public organisations
- At international level – industry and global enterprise and organisations, higher education and research institutions and organisations, professional bodies

1.3.2. Achievements

This area of research has grown significantly over the REF period, with 14 FTEs in this UoA. The following points depict the appointments, and/or promotion of research-active academic staff within the UoA12 since 2014:

- Four professors
- Five associate professors

- Five senior lecturers
- Two research fellows.

In terms of research income, our external research funding complemented by the University's investments centrally, have supported the expansion and scope of high-quality collaborative research – with scholars in the UK and abroad and with a range of non-academic organisations including philanthropic organisations and trusts, businesses, public sector, and specialist research establishments (see section 4).

Objectives 2, 4, 5, 6: the creation of the Faringdon Centre (2017) from income of just under £0.5m from philanthropic sources, specialising in non-destructive testing methods, laboratories equipped with the latest machinery and apparatus (see section 3.2), and the creation of research groups, together with building on staff expertise and knowledge across the board, have helped this UoA immensely to establish a culture that fosters collaborative activities with international partners and projects (see section 4), and to support a thriving postgraduate research environment.

Objective 3: four postgraduate courses have been developed since 2017 to support and foster a conducive and healthy research environment within the field of engineering and associated subject areas. This has enabled and empowered our students to pursue their postgraduate studies in a forward-looking and dynamic environment. The development of these courses, in turn, provided us with ample opportunity to attract research and development collaborations with industry, professional bodies and enterprises (see section 4).

1.3.3 The next five years

The overarching plan for the unit's research, and links to the University's overarching strategy as outlined in the institutional statement, section 2. We are planning to:

1) Continue building critical mass in the Faringdon Research Centre, and the existing research groups in the Building Performance and Climate Change research group and Sustainability in Civil and Structural Engineering group. This will be achieved through sustained, and where appropriate, increased research grant income, postdoc recruitment, and continued collaboration across the board to generate new directions for research.
2) Further secure industry-based collaborations to benefit doctoral students, and develop the doctoral programme across the subject area, whilst supporting early career researchers into academic careers.
3) Secure further sponsorships, commissions, and collaborative partnerships from commercial and non-commercial sources
4) Engage further with identified research users, identify new ones, and deploy strategic mechanisms to monitor and collect evidence.

1.3.4 Impact

Our two submitted impact cases demonstrate the range of activity and relationships with research users. One focuses on the application of non-destructive technologies by the Faringdon Centre, who have worked with leading companies, infrastructure operators and local authorities to introduce novel and enhanced applications in different real-life settings. The second shows the benefits of a collaboration with the Chartered Institution of Building Services Engineers and with a global hotel chain on how best to improve the energy efficiency of existing buildings through application to actual examples.

1.4 Support for standards and ethics

1.4.1 Academic research infrastructure to support standards

The University Research, Scholarship and Enterprise Committee (URSEC) chaired by the Deputy Vice-Chancellor, receives reports on matters of University-wide interest, including regular updates and annual reports from schools on research, scholarship, and knowledge transfer activities.

URSEC also advises on research governance within the individual Schools. It oversees key performance indicators and their fitness for purpose in the context of the University's Strategic Plan. A University Research Degrees Sub-Committee scrutinises progression by postgraduate research students to registration to MPhil status, and onward to doctoral (PhD) completion.

1.4.2 Ethics

The University Research Ethics Committee (UREC) – also a subcommittee of The University Research, Scholarship and Enterprise Committee (URSEC) - has overall responsibility for ethics approval, and it scrutinises all staff and students' approval applications. This UoA's approvals are scrutinised by the School's Research Ethics Panel (SCREP) panel, chaired by Abdelnour-Nocera. SCREP reviews and approves student and staff applications for ethics and reports regularly to UREC. UREC subgroups are convened where 'high risk' applications are identified by any School/College SCREP.

In UoA12, all research activities are also assessed rigorously for the health and safety under the University's established directives and protocols. The equipment being used for research purposes is regularly inspected and tested to ensure it meets the technical and safety requirements.

1.5 Interdisciplinary Research

The Faringdon Centre – our Engineering non-destructive research centre - and our five very active research groups are committed to world-leading interdisciplinary research in various branches of civil engineering, electrical and electronics engineering, bioengineering, and the aviation industry. The nature of the research carried out within this UoA is interdisciplinary and the internal structure of the School of the Computing and Engineering has contributed to make it flourish. Problems studied within these disciplines have always been quite diverse, including fundamental research (theoretical development), numerical simulations, development of methodologies, instrumentation, and application research. The regular monthly research seminars at School level, and separate fortnightly informative research meetings, contribute specifically to support multidisciplinary collaborations.

Our proactive approach in interdisciplinary research is evidenced by the type of projects we are currently engaged in. The School is submitting under two separate units of assessment (computing and engineering) in REF2021. There is very close collaboration between the two units in terms utilising existing expertise, and knowledge creation and translation to solve real problems faced by our communities and society as a whole.

1.6 Open Research Environment

It is important to emphasise that we fully observe the principles of open research. We value inclusivity, diversity, integrity and accessibility in the research process. We share all aspects of our research cycle and make it accessible to all, where possible. The dissemination of our research outputs, our apparatus and research methodologies are all available on our web pages and in our University repository.

Our open research practice has enabled us to attract a wide range of audiences to our activities and engage with many other research-active communities. This has translated into gaining the trust and confidence of a number of organisations, professional bodies communities (regional, national, and international) and developing collaborations and partnerships with them. We work closely with the London Borough of Ealing, and partner with national umbrella organisations such as Tree Council UK, and international and multi-dimensional organisations and enterprises including Hilton Worldwide, Heathrow Airport, Saga, Amazon and the Italian Space Agency

2. People

2.1 Staffing Strategy

In 2015, the University introduced a new employment framework for the management, development and support of academic staff, the Academic Employment Framework (AEF) (see institutional statement, section 3.1). In this framework academic staff can focus (in addition to teaching) on research, scholarship and/ or knowledge exchange activities, and this forms part of targets agreed during the annual appraisals. This framework provides a 5-day annual allowance for CPD and development, and opportunities for attending conferences, applying for sabbaticals, further qualifications, and other staff development programmes. Two members of this UoA were supported with sabbatical arrangements to concentrate on their research and development work over the last three academic years.

The AEF has helped us achieve our strategic objective to recruit, develop and retain established and where possible, world-leading researchers. Over the REF period, the focus has been on increasing visibility, strengthening established areas of research excellence, and investing in emerging areas. Appointments were made based on excellent research track-records and future potential. Since January 2015 high profile research academics and leaders have been appointed including, Alani, Rizzuto, Naveed, Nikolic, Tosti. From this position of strength, we have also identified the next generation of researchers who are being supported to grow their research potential (see section 2.2.1).

2.2 Staff development

2.2.1. Staff development and support

There is a strong staff development provision, both at University level and at School level (see institutional statement, section 3.2); several services contribute to research-based staff development. Research and Enterprise Operations (REOps) offer training on knowledge exchange; impact; collaborative projects; commercialisation; managing research budgets; industry and user engagement; they also support applications for research funding. This UoA has greatly benefited from this training and support. REOps have provided invaluable service to the members of this UoA to support funding applications submitted in the last five academic years. Some junior staff have submitted joint bids with their mentors.

HR trains researchers on managing stress, appraisals, preparing for promotion, working with external collaborators, and leadership. They also hold funds for internal and external courses, conferences, and for staff to study for externally provided qualifications, including PhDs. The staff of this UoA are supported with a dedicated budget for training and attending international conferences. Academic staff with the aspiration of pursuing their PhD are supported both financially, through workload reduction, and by a dedicated internal mentor. Currently three academics and one technician are registered for a PhD.

The Library has trained all members of this UoA on how to use appropriately the University Repository, and to understand compliance rules. The Graduate School has trained all our supervisors on good supervision management, regulations, how to use the VITAE framework and the various stages and milestones for research students. It also runs an annual doctoral conference across all subjects. The annual doctoral conference is always very well attended by members of this UoA who play significant role in supporting the event, and students presenting (e.g. Enrique Sanchez Torres, Runner-up in 2015; Livia Lantini, Runner-up in 2019; Reza Keihani, Best Poster in 2020. Also Livia Lantini, Best Paper Award of the 2020 43rd International Conference on Telecommunications and Signal Processing (TSP) (IEEE Conference Record #49548).

The University has provided training on impact; outputs planning; REF guidance; and the REF Code of Practice. The annual University Research Conference led by the PVC (Academic) provides opportunities to disseminate research findings, and network with potential new research partners. This UoA has played a strong role in the conference, with regular attendance and presentations. Members of the UoA have attended sessions on impact, public engagement, interdisciplinary research, mentoring, and support for new career researchers. Alani has provided several presentations in these activities mentioned above in the last six years.

At School level, all newcomers are allocated a mentor; junior academics are encouraged to meet with their mentors at least twice a year to discuss plans and progress. This is on a one-to-one basis, and it includes informal discussions as well as monthly research meetings where peer-review of work is involved. Staff research concerns and performance are addressed systematically through annual appraisals. A transparent university-wide workload allocation operates throughout the School. In addition to University annual allocations, all research and academic staff are equally entitled to the School staff travel and research funds. All PhD students are encouraged to attend and present international conference papers (at least once a year); there is a centrally allocated budget for this and all PhD students associated with this UoA have benefited from this arrangement regularly.

To ensure a rich culture, we run monthly research seminars that are attended by PhD students, research and academic staff, supervisors, and external invited guests. The activities are publicised within the University and amongst the relevant external parties (industry, research institutions and local communities).

2.2.2. Research students

Expanding doctoral education has been a key priority for this UoA, based on the University's own strategy (see institutional objectives in the institutional statement, section 2.1). The numbers have grown from 1 in 2014 to 16 in 2020. In parallel, supervisory capacity has increased (from 3 to 20). All research groups have attracted students studying for doctoral degrees.

All our doctoral students benefit from a formal centrally-run research training programme based on the *VITAE Researcher Development Framework* and delivered by the Graduate School, with contributions from senior academics from across the institution. On this programme, PGRs complete a series of Research Development Units (RDU) throughout the entire period of their registration, with embedded Epigeum interactive online activities. They are supervised by a team of a minimum of two supervisors, with the main supervisor having the previous experience of at least two PhD completions.

Doctoral students are an integral part of our research community. They attend and contribute to the School's monthly research seminars and the School research committee. As per the University policy, they facilitate some sessions and/or teach based on their increasing level of experience (a maximum of 6hrs a week, including preparation). They also present their work during their studies at milestone events, and at the University's annual doctoral conference. Our students are encouraged, and supported, to publish in discipline-specific journals and in the University press publication, *New Vistas.*

This UoA currently has 16 PhD students engaged with their studies. Six were fully supported by a Vice-Chancellor's PhD Scholarship (see institutional statement, section 3.2); three by externally secured funding; and four partially supported by industry partners. Three more PhD students will be joining their supervisors as soon as the pandemic allows them to travel. This UoA had six successful PhD completions for the period under assessment. An emergency support plan was put in place in 2020 (under the conditions imposed by COVID-19) to support students who needed additional time, support or resources.

Attendance at the School's monthly research seminars is mandatory for doctoral students and post-doctoral assistants. They are also required to present their research at least twice throughout their PhD journey. Once during their first year of studies as they are formalising their research plans, and can best benefit from feedback/comments and practice their presentation skills. And a second time, when they are closer to completion, as they present their final research findings and receive feedback from experienced colleagues, in preparation for their viva. They also present at events organised by the Graduate School. These activities are considered as required milestones for progression and are monitored via termly progress reports.

Twice-yearly, the School runs a full-day event (The Research Showcase) where doctoral students showcase their research to the wider University and invited guests from industry/media/charities (e.g., speakers/guests from Royal Academy of Engineering in January 2020). Showcase exhibits include research posters and oral presentations. About 10 prizes are awarded (through visitor and staff votes) each year for the best exhibit in different categories. Prizes are in the region of £100 (in the form of Amazon vouchers or Students' Union goods such as quality clothing items). All postgraduate and level 6 students are invited to these very popular events every year.

2.3 Equality and Diversity

2.3.1 Training

The HR department delivers a mandatory programme of face-to-face and online training on all aspects of equality and diversity which has been attended by all members of the UoA. Supervisors also had training on this through the compulsory programme of training run by the Graduate School.

2.3.2 Research development

The research development opportunities available to staff - research funding, sabbaticals, conference funding, etc. - always state the conditions and criteria that are applied. There is a transparent process for these applications. Academic staff are actively encouraged to attend briefing sessions on research funding opportunities; academic staff in this UoA have all attended sessions where relevant advice is given with a clear written description of the protocol to submit external bid and internal funding applications. The University regular lunchtime seminars and its 3 annual research events are open to all UWL staff. Applications for conference attendance support, sabbaticals and "seed grants" follow established procedures and are open to all staff meeting the relevant criteria.

2.3.3 Recruitment and progression of research students

The recruitment of doctoral students is based on recruitment policies that specify entry requirements, and their application is supported by a written statement. They are interviewed by a panel including supervisors and a Graduate School Director of Studies to ensure fairness and consistency. The student journey normally leads to completion within 3 to 3.5 years and the University has systems in place to support all students in achieving this (see institutional statement, section 3.2). Progression is monitored by the Graduate School through a set of staggered milestones, and final registration to PhD status (transfer) is overseen by the University Research Degrees Sub-Committee. We subscribe to the Postgraduate Research Experience Survey (PRES) which shows our students' appreciation of these structures; UWL is ranked 7th out of 103 institutions on progression in PRES 2020.

2.3.4 REF

As a UoA we have received training on recruitment, promotion and appraisals, and the UoA leads and reviewers have received specific training on equality and diversity, and unconscious bias to support them in their role.

As a School we are striving to address the known gender imbalance in this subject. We ensure there is a balance of male and female staff on University-wide committees; we are also actively engaged in the Women in Engineering and STEP projects. We developed a dedicated group and activities (Women in STEM) in our School which is managed and led by female members of staff (10 academic staff and eight PhD students). This group is proactively involved with women in Engineering and STEM groups and organisations in the UK and internationally. We provide a safe and flexible environment for working to all our staff. We pride ourselves in being an ethnically diverse School, and the UoA submission includes colleagues who come from nine different nationalities worldwide (in terms of ethnic origin).

3. Income, infrastructure and facilities

3.1 Income

The strategy in the unit is to support applications to both external income (Research Councils, industry, government agencies, consultancy, etc.) and internal investments. The internal funding is used to support active researchers with travel and equipment, and to provide funding for Scholarships for PhD students.

The research-related income generated by the Engineering UoA has increased significantly during the last four academic years, bearing in mind this UoA did not exist prior to 2015. The following bullet points show the details of the external funding obtained by the Faringdon Centre and the Building Performance and Climate Change research group in the last four years.

Faringdon Centre - £435,750, with the following sources of funding:

- Lord Faringdon Charitable Trust
- The Schroder Foundation
- Cazenove Charitable Trust
- Ernest Cook Trust
- Sir Henry Keswick
- Ian Bond
- P. F. Charitable Trust
- Prospect Investment Management Limited
- The Adrian Swire Charitable Trust
- The John Swire 1989 Charitable Trust
- The Sackler Trust
- The Tanlaw Foundation
- The Wyfold Charitable Trust

The Faringdon Centre research group has played a leading role in the development of novel field methodologies, data processing techniques, new application areas and design of new instruments in non-destructive testing methods and techniques in the last four years. The Faringdon Centre, according to visitors and experts within the field, is most probably amongst the most advanced Ground Penetrating Radar centres in Europe and beyond.

The facilities and equipment acquired as part of establishing the Faringdon Centre have created a conducive environment to engage with pioneering research. This environment has also encouraged collaborative research with international industry and academic partners. The following highlight examples of world-leading research carried out by the Centre since its inception:

- Health monitoring and assessment of ancient and mature trees; identifying early decay and defects in tree trunks
- Investigating the integrity of tree roots, mapping tree root architecture, and investigating root-soil interactions using ground penetrating radar (GPR)

- Assessing the integrity and the mechanical properties of road pavements, airfield runways and taxiways using GPR and light weight falling deflectometer
- Investigating the integrity of railway structures and foundations (ballast fouling and rail track deformations) using ground GPR and InSAR Interferometric Satellite Imaging technology
- Health monitoring and assessment of bridges and civil engineering structures using GPR, InSAR Interferometric Satellite Imaging technology, and a 3D laser scanner
- Advanced signal/data processing and numerical modelling for various non-destructive testing methods
- The development of aircraft performance models; and aviation safety and risk management

The creation of the Faringdon Centre's research was externally funded as a result of sustained engagement with philanthropic organisations and trusts. The amount of funding reported above, has sustained the Centre's operation in the past and will continue to support it over the next two years.

The University of West London has contributed in excess of £300,000 towards developing the required infrastructure, including the acquisition of some of the advanced equipment for the UoA.

The Building Performance and Climate Change research group:

- Lidl GB (£43200)
- T3 system 2019 (£8400) for evaluating the structural performance of light aluminium frames
- Concrete Centre 2019 (£3600) for reviewing Eurocode 2- lap design
- Concrete Centre 2018 (£15000) for reviewing UK low-to-medium-rise reinforced concrete frames
- Hilton Worldwide 2018 (£24000) for investigating the effect of minimum energy standards for hotel buildings
- Chartered Institution of Building Services Engineers 2017 (£48000) for the design and evaluation of nearly zero energy buildings
- Hilton Worldwide 2016 (£5000) for investigating impact of various technology on energy efficiency and thermal performance of buildings
- The Chartered Institution of Building Services Engineers 2015 (£51000) for investigating the resilience of buildings in extreme weather
- The Concrete Centre 2014 (£5000) for investigating the deflection of concrete slabs

The Aviation Risk Management Research group

A recent investment of the University in a flight simulator equipped with Boeing 737 original instrumentation, is used for experimental interdisciplinary research, including flight risk and safety. It has been used by members of this UoA for feasibility studies to support aviation risk management research; with future plans for aircraft emission noise, and flight handling capabilities. The simulator has a 220-degree cylindrical display system with triple projection and photorealistic scenarios (landing strips, taxiways, stands) with configurable weather, Categories I, II and III, NPA, missed approaches, windshear, winter conditions, etc. It has CANBUS electronic control of all systems, and is linked with a global database with all airports and their updated approaches (ILS, LOC, GLS, VOR, NDB, RNAV, Radar, etc).

The momentum created within the UoA has paved the path for further external funding in the future, as we continue to engage with potential sponsors. The investment made by the School and the University in terms of facilities and infrastructure development in this area has been substantial in the last three years. The close to £1m investment has provided this UoA with a platform from

which we can sustain further engagement with international partners, and attract further investments from industry.

Academic staff who have joined the University in recent years came to UWL with a successful track record of securing external funding as PI and Co-PI in other institutions (including from ERC, BBSRC, EPSRC, and Wellcome Trust). This wealth of experience has been invaluable in supporting the bids that are currently under review from external funding which will equally support future bids.

3.2 Infrastructure and facilities

In addition to a significant investment programme on campus that has created social and open learning spaces, advanced simulation spaces for research, a library without boundaries, and a large flexible performance auditorium, the University has built a Sports Centre and a postgraduate building for doctoral students. This centre, The Rami Ranger House (RRH), was built as a learning and social space. It offers to the UoA's PGRs spaces for collaborative working, socialising, supervision and mentoring on the ground floor. The first floor offers individual workspaces with teaching and collaborative space on the second floor. RRH is host to regular skills workshops, as well as research and cultural events.

UWL has also built several laboratories and specialist facilities. This UoA has extended laboratory facilities with advanced settings in areas such as concrete technology, soil mechanics and geotechnics, electrical and electronics, sound engineering, fluid mechanics and hydraulics, and the flight simulator mentioned above. Each subject area benefits from dedicated laboratories with state-of-the-art equipment, facilities, and software.

The equipment and infrastructure within some of our laboratories (Concrete Technology and Structures Lab, Soil Mechanics Lab, Hydraulics and Water Engineering Lab, Architecture and 3D printing Studio, two Electrical and Electronics Labs and two Sound Engineering Studios) are unique and of the highest quality in terms of performance and equipment. This has provided ample opportunity for our research students and staff to engage with the world leading research and collaborate with other prestigious research institutions in the world. The availability of such infrastructures has also paved the path for collaboration with world-leading companies and enterprises, as mentioned at the start of this section.

The pictures below showcase the most advanced equipment in the world- in terms of capabilities and manufacture - in the field of remote sensing and non-destructive testing methods (GPR). To the best of our knowledge there is no similar centre (within any academic settings) nationally and internationally in terms of facilities and capabilities.

Figure 2, The Faringdon Centre – Non-destructive Testing Research Centre

Apart from seven different GPR antenna systems with different frequencies and applications, the facilities include:

- Dynamic Vision Sensor – DVS128, a special neuromorphic camera, a 128x128 pixel temporal contrast CMOS sensor that generates asynchronous data. Manufacturer: INI Labs, Zurich, Switzerland (two cameras)
- SpiNNaker (SpiN-3, two boards), a massively parallel computing platform inspired by biological neural tissue for simulating spiking neural networks (SNNs). Manufacturer: University of Manchester (Prof Furber, Computing)
- IBIS-Airborne Radar system, manufactured by the IDS Limited, Italy – state-of-the-art equipment used for bridge and tunnel structural monitoring and slope stability and ground movement (1/10 mm accuracy)
- 3D Leica Laser Scanner P20 – highest resolution and accuracy
- Light Weight Deflectometer (LWD) Dynatest 3031
- Rhode & Schwarz ZNLE6 Vector Network Analyser 2 ports, 1MHz to 6GHz
- dScope Series III analogue and digital audio analysers – a comprehensive electroacoustic measurement analogue and digital audio system
- Fully digitised advanced soil mechanics and geotechnics equipment including drained and undrained tri-axial testing apparatus, advanced shear box and Odometer, state-of-the-art and full-size seepage and pipe distribution apparatus.

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

4.1 Academic collaborations

We endeavour to find solutions to complex environmental and engineering challenges in partnership with other research communities and industry. Our approach to foster research collaborations is based on respect, clear division of responsibilities based on expertise and hard work, and collaborative planning. We have sustained collaborative links with the following research institutions on projects concerning railway foundations, highways infrastructures and tree health monitoring and assessment.

- Delft University of Technology, The Netherlands
- National Technical University of Athens, Greece
- Roma Tre University, Rome, Italy
- University of Illinois Urbana-Champaign, USA
- The National Institute of Advanced Industrial Science and Technology, Japan
- The National Research Council of Italy, Institute for Electromagnetic Sensing of the Environmental (GPR Division.)

Aviation collaborations include Eurocontrol (Research and Development Centre in Paris); the University of Reading, Cranfield University; and the Democritus University of Thrace in Greece for research on emissions modelling tools.

Our national and international engagement activities also include conference attendance, international scholars and visiting researchers' schemes, running conferences and workshops at UWL, taking part is specific exchange schemes, and obtaining exchange grants.

4.2 Networks

Our key research partners in industry reflect our areas of expertise and established research and development background. We work closely with the following industrial partners on projects related to railway foundations, highways and road structures, archaeology, satellite imaging, and tree health monitoring and assessment:

- Ferrovie del Gargano s.r.l., Italy

- Network Rail, UK
- Rete Ferroviaria Italiana, Italy
- The Rochester Bridge Trust, UK
- Umbria Aerospace Systems S.p.A., Italy
- Zetica Rail, UK
- EUROCONSULT SA, Spain
- Geoservice, Greece
- IDS Georadar, Hexagon, Pisa, Italy
- National Research Council of Italy, Institute for Electromagnetic Sensing of the Environmental (SAR Division)
- Utsi Electronics, Cambridge, UK
- The Tree Council, UK
- Ealing Council, London
- Whiteland Woods, Hants, UK

Our recent collaborations with the European Space Agency, the Italian National Space Agency, and the Astronomical Observatories, and the Chinese Academy of Sciences, will provide us with opportunities to access research programmes focused on Interferometric Synthetic Aperture Radar and GPR applications; and advanced signal and image processing and modelling.

Research carried out by the Building Performance and Climate Change research group on the nearly zero energy buildings (nZEB) project, retrofitted to meet the standards governed by the Chartered Institution of Building Services Engineers (CIBSE) outlines a method for applying the nZEB standard to existing UK commercial and residential buildings. We have worked closely with CIBSE over the REF period to demonstrate the potential benefits and risks associated with achieving high energy-efficiency standards within the built environment – this collaboration is described in one of our Impact Case Studies for UoA 12.

4.3 Wider activities and contributions to the research base, economy and society

The research academics within this UoA have produced nearly 400 peer-reviewed journal and international conference papers since 2015 (mainly journal publications).

4.3.1 Editorships and membership of editorial boards

Professor Amir Alani

Guest Editor of the following Special Issues:

- “Advances in Signal Processing Techniques for Ground Penetrating Radar Applications”, *Remote Sensing* (MDPI) – July 2021
- "Advances in Sensing Systems for Assessment and Health Monitoring of Transport Infrastructures and Construction Materials", *Sensors* (MDPI) – March 2021
- “Data Fusion, Integration and Advances of Non-destructive Testing Methods in Engineering and Geosciences*”, Remote Sensing* (MDPI) – April 2021
- “Recent Advances in Non-destructive Testing Methods for Geophysical Surveys”, *Surveys in Geophysics.* Vol.41(3), May 2020
- “Ground-Penetrating Radar and Complementary Non-Destructive Testing Techniques in Civil Engineering”, *Construction and Building Materials*, 2018.

Professor Konstantin Nikolic

- Associate Editor for Neuromorphic Engineering section of *Frontiers in Neuroscience*
- Associate Editor for *IEEE Transaction on Biomedical Circuits and Systems* (TBioCAS)
- Editorial Board member for MDPI journal: *Applied System Innovation* (since 2020)

Dr Fabio Tosti

Guest Editor of the following Special Issues:

- "Research and Developments in Pavements", *Infrastructures* (MDPI) – March 2021
- (Managing) "Advances in Signal Processing Techniques for Ground Penetrating Radar Applications", *Remote Sensing* (MDPI) – July/2021
- "Advances in Sensing Systems for Assessment and Health Monitoring of Transport Infrastructures and Construction Materials", *Sensors* (MDPI) – March/2021
- "T.I.: Geosphere-Anthroposphere Interlinked Dynamics", *Environmental Earth Sciences* – March 2021.
- "Data Fusion, Integration and Advances of Non-destructive Testing Methods in Engineering and Geosciences", *Remote Sensing* (MDPI) – April/2021
- (Managing) "Data Fusion, Integration and Advances of Non-Destructive Testing Methods in Civil and Environmental Engineering", *NDT&E International*, Vol.115, October/2020
- (Managing) "Recent Advances in Non-destructive Testing Methods for Geophysical Surveys", *Surveys in Geophysics*, Vol.41(3), May 2020
- (Managing) "GPR and Complementary NDT Techniques in Civil Engineering", *Construction and Building Materials*, 2018
- (Managing) "Civil and Environmental Engineering Applications of Ground Penetrating Radar", *Near Surface Geophysics*. Vol.14(2), 2016
- "Wireless Sensor Networks for Road Safety and Simulation", *International Journal of Mobile Network Design and Innovation*, Vol.5(4), 2014
- "Road Safety and Simulation", *Advances in Transportation Studies*, Vol.1, 2014

Associate Editor of the following International Peer-Reviewed Journals:

- *International Journal of Pavement Engineering*, ISSN:1029-8436
- *Remote Sensing* (MDPI), ISSN:2072-4292 – Section: Engineering Remote Sensing
- *Geoscientific Instrumentation, Methods and Data Systems*, ISSN:2193-0856
- *Journal of Railway Engineering*, ISSN:2149-1607
- *Frontiers in Remote Sensing*, ISSN:2673-6187 (Review Editor: Microwave Remote Sensing)

Professor Ali Bahadori-Jahromi

- Editorial Board for *Sustainability Journal*, Section of Energy Sustainability, since 2016
- Guest editor for special *Journal of Sustainability* (2016)

Dr Kourosh Behzadian

- Member of Editorial Panel, *Proceedings of the Institution of Civil Engineers - Municipal Engineer*, ICE Publishing (2019-22)
- Champion (Guest editor), themed issue of *Municipal Engineer*, ICE Publishing (call for papers: Infrastructure resilience in cities January-June 2021)
- Associate Editor, *Journal of Cogent Environmental Science.* Taylor & Francis Group (2016-present)

Dr Ibrahim Shaaban

- Member of editorial board of the *Journal of Materials and Engineering Structures*

Dr Changfeng (Charlie) Fu

- Editorial panel member of the *Journal of Construction Research.*

4.3.2 Convenors of conferences and Programme Chairs

Professor Amir Alani

Scientific Committee Member of the following Technical Conferences, Workshops and Sessions:

- 11th International Conference on the Bearing Capacity of Roads Railways and Airfields, Trondheim, Norway, June/29-July/1, 2021.
- 11th International Workshop on Advanced GPR, Valletta, Malta, July/4-7, 2021.
- 9th International Workshop on Advanced Ground Penetrating Radar, Edinburgh, June 28-30, 2017.

Organisation of the following Technical Conferences, Workshops and Sessions:

- Session "Data fusion, integration, correlation and advances of non-destructive testing methods and numerical developments for engineering and geosciences applications", European Geosciences Union (2018–present).
- Seminar "London Tree Officers Association (LTOA)", University of West London, London, UK, July/11, 2019.
- "COST Action TU1208 Training School on Ground Penetrating Radar for road pavement assessment and detection of buried utilities", University of West London, London, UK, October/12-14, 2015.
- General Chair in Technical Conferences, Workshops and Sessions:
- General Co-Chair of the 2nd International Workshop on "Signal Processing Techniques for Ground Penetrating Radar Applications" - IEEE International Conference on Telecommunications and Signal Processing, Milan, Italy, July 7-9, 2020.
- Session Chair in Technical Conferences, Workshops and Sessions:
- "New research trends in the application of non-destructive testing methods" – GI2.3 Oral Session, EGU 2019 GA, Vienna, Austria, April/10, 2019.

Professor Konstantin Nikolic

- IEEE BioCAS conference review committee member for Medical Information Systems and Bioinformatics.
- IEEE BioCAS conferences Session Chair (for Biosensors & Interfacing, Biosignal Processing and Biomedical Circuits)

Dr Fabio Tosti

Scientific Committee Member of the following Technical Conferences, Workshops and Sessions:

- 11th International Conference on the Bearing Capacity of Roads Railways and Airfields, Trondheim, Norway, June/29-July/1, 2021.
- GISTAM International Conference on Geographical Information Systems Theory, Applications and Management (2020-present)
- "Road Safety and Simulation" International Conference, Iowa City, Iowa, USA, October 14-17, 2019
- International Airfield and Highway Pavements Conference, Chicago (IL), USA, July 21-24, 2019
- International Conference on Information Societies and Smart Cities, Fitzwilliam College, University of Cambridge, UK, June/27-28, 2018
- 10th International Conference on the Bearing Capacity of Roads Railways and Airfields, Athens, Greece, June/28-30, 2017.

Organisation of the following Technical Conferences, Workshops and Sessions:

- Session "Data fusion, integration, correlation and advances of non-destructive testing methods and numerical developments for engineering and geosciences applications", European Geosciences Union (2018–present)
- Special Session "Geosphere-anthroposphere interlinked dynamics: geocomputing and new technologies" – TerraenVision 2019, Barcelona, September/3-6, 2019

- Seminar “London Tree Officers Association”, University of West London, London, UK, July/11, 2019.
- Special Session on “Signal Processing Techniques for Ground Penetrating Radar Applications” - IEEE International Conference on Telecommunications and Signal Processing, Athens, July/4-6, 2018
- Session GI3.1 “Civil Engineering Applications of Ground Penetrating Radar”, European Geosciences Union – 2014-2017
- “COST Action TU1208 Training School on Ground Penetrating Radar for road pavement assessment and detection of buried utilities”, School of Computing and Technology, University of West London, London, UK, October/2-14, 2015.
- COST Action TU1208 Training School on Applications of Ground Penetrating Radar in Urban Areas: the Sensitive Case of Historical Cities”, Cracow University of Technology, Cracow, Poland, May/5-7, 2015.
- COST Action TU1208 3rd General Meeting”, School of Computing and Technology, University of West London, London, UK, March/4-6, 2015.
- COST Action TU1208 2nd General Meeting”, Vienna, Austria, May/1-2, 2014.

General Chair in Technical Conferences, Workshops and Sessions:

- 2nd International Workshop on “Signal Processing Techniques for Ground Penetrating Radar Applications” - IEEE International Conference on Telecommunications and Signal Processing, Milan, Italy, July/7-9, 2020.

Session Chair in Technical Conferences, Workshops and Sessions:

- EGU GA Conferences in Vienna, Austria, sessions:
  - “Data fusion, integration, correlation and advances of non-destructive testing methods and numerical developments for engineering and geosciences applications”, GI2.5 Oral Session, May/07, 2020, and GI2.3 Poster Session, EGU 2019 GA, Vienna, Austria, April/10, 2019.
  - “Advances in complex numerical developments and NDT methods” – GI1.5 Oral Session, April/11, 2018.
  - “Novel Ground-Penetrating Radar instrumentation” - GI3.1 Oral Session, April/24, 2017.
  - “Electromagnetic modelling and signal-processing techniques for the interpretation of
  - Ground-Penetrating Radar data” - GI3.1 Oral Session, April/24, 2017.
  - “Ground-Penetrating Radar applications in cultural-heritage management” - GI3.1 Oral Session, April/24, 2017
  - “GI3.1 - Civil Engineering Applications of Ground Penetrating Radar - Applications of Ground-Penetrating Radar in civil engineering”, - GI3.1 Poster Session, April//20, 2016
  - “GI3.1 - Civil Engineering Applications of Ground Penetrating Radar - Meeting the Needs of Transport Infrastructure”, GI3.1 Oral Session, April/14, 2015
- “Poster Session II” - 10th International Conference on Bearing Capacity of Roads, Railways and Airfields, Athens, Greece, June/30, 2017
- “Civil Engineering applications: Method validation”, International Conference of GPR, Hong Kong, June/16, 2016.
- “Guidelines for the inspection of flexible road pavement – review and discussion of the draft (WG2 activity)”, 2016 COST Action TU1208 WG Progress Meeting, Rome, Italy, April 27-29, 2016.
- “Working Group 2 Meeting”, COST Action TU1208 4th General Meeting, National technical University of Athens, Athens, Greece, October/19-20, 2015.

- "Challenges and guidelines – The point of view of manufacturers and private end-users", Oral Session, COST Action TU1208 3rd General Meeting, University of West London, London, UK, March/4-6, 2015.
- "COST Actions TU1208 and TU1206 and Novel GPR Instrumentation for Civil Engineering Applications (Working Group 1)", COST Action TU1208 2nd General Meeting, Vienna, Austria, April/30, 2014.

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4.3.3 Leadership of advisory boards, industry, commerce, research councils, learned societies or professional bodies

Professor Amir Alani

- COST Action TU1208 "Civil Engineering Applications of Ground Penetrating Radar", April 4, 2013 – April 3, 2017
- International panel member for large research proposals – Civil Engineering, The Fundação para a Ciência e a Tecnologia, I. P. (FCT) - the Portuguese public funding agency for R&D - 2014 and 2017
- The Portuguese Ministry of Science, Technology and Higher Education (Fundação para a Ciência e a Tecnologia), Programa Aga-Khan FCT Cooperation, May/2016.

Dr Fabio Tosti

- COST Action TU1208 "Civil Engineering Applications of GPR", April 4, 2013 – April 3, 2017. Project leader: Project 2.5 "Determination, by using GPR, of the volumetric water content in structures, sub-structures, foundations and soil".

Professor Ali Bahadori-Jahromi

- EPSRC National Research Facilities Statement of Need Panel, December/2018

4.3.4 Invited keynotes

Professor Amir Alani

- International COST Action TU1208 Training School on "Ground Penetrating Radar for road pavement assessment and detection of buried utilities". University of West London, London, UK, October/2015
- International COST Action TU1208 Training School on "Civil Engineering Applications of GPR". University of Pisa, Pisa, Italy. September/2014

Dr Fabio Tosti

- International COST Action TU1208 "Roadshow" Technical Meeting:
  - "Introduction to Ground Penetrating Radar and its applications in civil engineering and archaeology – Greece". Akadimias of Athens, September/2016
  - "Dissemination event about the use of Ground Penetrating Radar in Italy", Roma Tre University, Italy, April/2016
- International COST Action TU1208 Training School on "Ground Penetrating Radar for road pavement assessment and detection of buried utilities". University of West London, London, October/2015.

4.3.5 Review activities

Professor Konstantin Nikolic

- EPSRC Peer Review College (10/09/2020, 27/11/2018, 30/01/2018, 14/12/2016, 28/06/2016)

Dr Kourosh Behzadian

- Newtown Fund including STREAM Institutional Links, British Council, NERC (2016-present)
- Innovation and Technology Commission (ITC), a funding agency for applied research of the Government of the Hong Kong (2020)

Dr Changfeng (Charlie) Fu

- EPSRC Peer Reviewers College since 2016 in built environment, BIM and sustainable urban planning and development.
- Invited member of the EPSRC Engineering Prioritisation Panel – 3-4 December 2019.

Dr Muhammad Naveed

- German Research Foundation: Proposal ZA 1127/1-1 (eBer-20-900),
- European Research Council proposal on soil pollution and health (2017).

4.3.6 Members of learned societies or industry boards

Professor Amir Alani

- Fellow member of the Chartered Institution of Mechanical Engineers (FIMechE)
- Board Member of the European Ground Penetration Radar Association – (EuroGPR) since 2007
- Member of the Chartered Institution of Highways and Transportation
- Fellow member of the National Academy of Building and Construction of Ukraine, since November 2013
- Member of the CIHT review and membership panel for Chartered and Incorporated Engineers (professional route) since 2010.

Dr Fabio Tosti

- Fellow member of the Chartered Institution of Highways & Transportation (FCIHT) awarded on September 26, 2019.
- IEEE Senior Member (2019\0.
- External Board Member - PhD School of Civil Engineering, Roma Tre University, Italy.

Professor Ali Bahadori-Jahromi

- Reviewing the Research Methods Programme, Oxford University Press, 2020-Present
- Member of the Joint Board of Moderators (JBM), 2017-Present
- Professional reviewer for Institution of Civil Engineering, 2012- Present

Dr Changfeng (Charlie) Fu

- Chartered member of Royal Town Planning Institute (RTPI) and Chartered Institute of Architectural Technologists (CIAT).
- Member of the membership assessors' panel for the CIAT

Dr Anil Padhra

- Expert Advisor to the UN World Meteorological Organisation, Geneva (Term: 2020- 2024)

4.3.7 Awards, prizes, distinctions

Professor Amir Alani

- Best Paper Award of the 2020 43rd International Conference on Telecommunications and Signal Processing (with F. Tosti) (IEEE Conference Record #49548)
- Paper shortlisted for the "Best Student Paper Award" - International Workshop on Advanced Ground Penetrating Radar - 28-30/June, 2017, Edinburgh, UK.

Dr Fabio Tosti

- EGU "GI Division Outstanding Early Career Scientists Award 2017", EGU 2017 General Assembly, Vienna, Austria, April/23-28, 2017

- Elected as Early Career Scientists (ECS) Scientists' EGU Representative of the "Geosciences Instrumentation & Data Systems" Division, April 2015 – present.

Professor Ali Bahadori-Jahromi

- Best conference paper award, Sustainable Development of Medium Strength Concrete Using Polypropylene as Aggregate Replacement,: International Conference on Concrete Engineering and Technology, Paris, France 2019.

4.3.8 Visiting professorships

Professor Konstantin Nikolic

- Visiting Professor at Imperial College London, Department of Electrical and Electronic Engineering (currently).

Dr Ibrahim Shaaban

- Visiting Professor at University of Liverpool, School of Engineering, from October 2015 to October 2017.

Dr Anil Padhra

- Visiting Associate Professor at the Kazimieras Simonavičius University, Lithuania.

Our approach to developing a rich environment within the UoA and the School is to provide individuals and groups with opportunities to develop and pursue their own research, engage with colleagues across the institution, and collaborate with outside partners, regionally and internationally. This outward looking approach forms the basis on which we aim to continue to develop and grow this UoA towards the next REF.