Institution: University of East London

Unit of Assessment: 12 Engineering

1. Unit context and structure, research and impact strategy

Unit Context and Structure

University of East London (UEL) is privileged to be placed at the heart of communities in East London and has been pioneering futures since 1898. This provides us the unique opportunity to widen access for research in order to *nurture local talent* who have limited resources especially from socioeconomic disadvantaged backgrounds. Accordingly, research in engineering at UEL aims to show new ways of seeing the world, to broaden new horizons and networks; and to encourage our students to realise their ambitions. The emphasis is on providing them with *connectivity for collaborating and participation* in world-leading research. This vision for research is *'Inclusive and Connected Engineering'*.

Research and impact strategy

The engineering research is undertaken and administered at the Department of Engineering and Construction within School of Architecture, Computing and Engineering (ACE). Our research strategy is based on taking the REF 2014 performance as the baseline and to improve upon the metrics. This has been achieved by investing in our staff, encouraging and enabling them to access wider opportunities to maximise their research potential. This has been realised through the following aims:

1. Reorganise/develop new research groups to build upon our areas of strength and foster synergy among groups within the School, and to strengthen external collaborations, both nationally and internationally.
2. Building upon our strength by investing in emerging multi-disciplinary areas such as Mechatronics, robotics and embedded systems and our established research areas of Engineering for staff and infrastructure that will help to position us as a recognised centre of excellence for engineering research and application in the Industry 4.0 era.
3. Undertaking outreach programmes in local East London communities, encouraging academics to build networks for collaborative research, supporting open science and open access.
4. Foster an intellectually challenging, supportive and welcoming research culture and environment by offering a clear road map for career progression to newly appointed staff in accordance with the UEL Race Equality Charter and encouraging women researchers to join STEM groups.
5. Encourage researchers to tap into existing and new resources, support mechanisms available at UEL and at outside, to maximise their research potential such as sabbatical and collaboration funding, attending professional workshops aimed at specific bids and funding applications.
   The school is currently significantly upgrading and expanding our laboratory and other experimental infrastructure, to clearly position ourselves with internationally unique and leading capabilities. The school is investing more ~GBP900k this year in its STEM facilities and infrastructure. The investment will be bringing cutting-edge innovation into engineering by adopting modern AI (Artificial Intelligence), cloud computing and visualisation (VR and AR) technologies. The department of engineering and construction offers research informed and business focussed that are delivering Industry 4.0 and Internet of Things focused accredited programmes. Our students from very diverse backgrounds (>70% BAME) have won several

national level awards which is showcasing our commitment towards inspiring and accelerating careers. Many of our academics are collaborating via international research forums/ projects (e.g., on natural disaster management) and knowledge transfer partnerships that are already influencing government policies and shaping future economies and social impact. Our research informed degree apprenticeships programmes developed in partnership with major industrial players like Barclays, Accenture, Costain Skanska, Crossrail etc. Apart from apprenticeships, our commitment towards employability and industry related courses is also reflected in variety of student base we have.

As a knowledge partner in east London, UEL has developed partnerships with key stakeholders in the London Boroughs including the Chambers of Commerce, Businesses, Local Authority Education Departments, Schools and Colleges to enthuse the local community in developing the skills to pursue various research informed degree programmes producing tangible impacts. Since 2014, we have recruited 11 additional research-active staff (in a team of 25 academics). Our research strategy is primarily focussed on upskilling mid-career researchers and mentoring early career academics. We are focussing on professional development for all our research staff, recognising and valuing equality and diversity, to maintain healthy work life balance, and helping staff to develop either academic or industry careers. The school has demonstrated significant commitment towards ensuring that our research delivers maximum impact through both academic and non-academic channels. Research and knowledge exchange is supported via generous workload time allocations (e.g., 0.25 additional FTE allocation for research and knowledge exchange activities).

Implementation of the strategy has led to significant improvements in various areas for the unit since REF 2014 including research outputs, PhD completions and income generation. This was due to substantial increase in number of staff availing the resources and opportunities available both from internal and external sources. These improvements are detailed in sections 2 and 3. Research is undertaken as per four research groups to build upon our areas of strength, maximise research potential of researchers and foster synergy among groups as indicated in Fig.1 with the group activities and leads indicated.
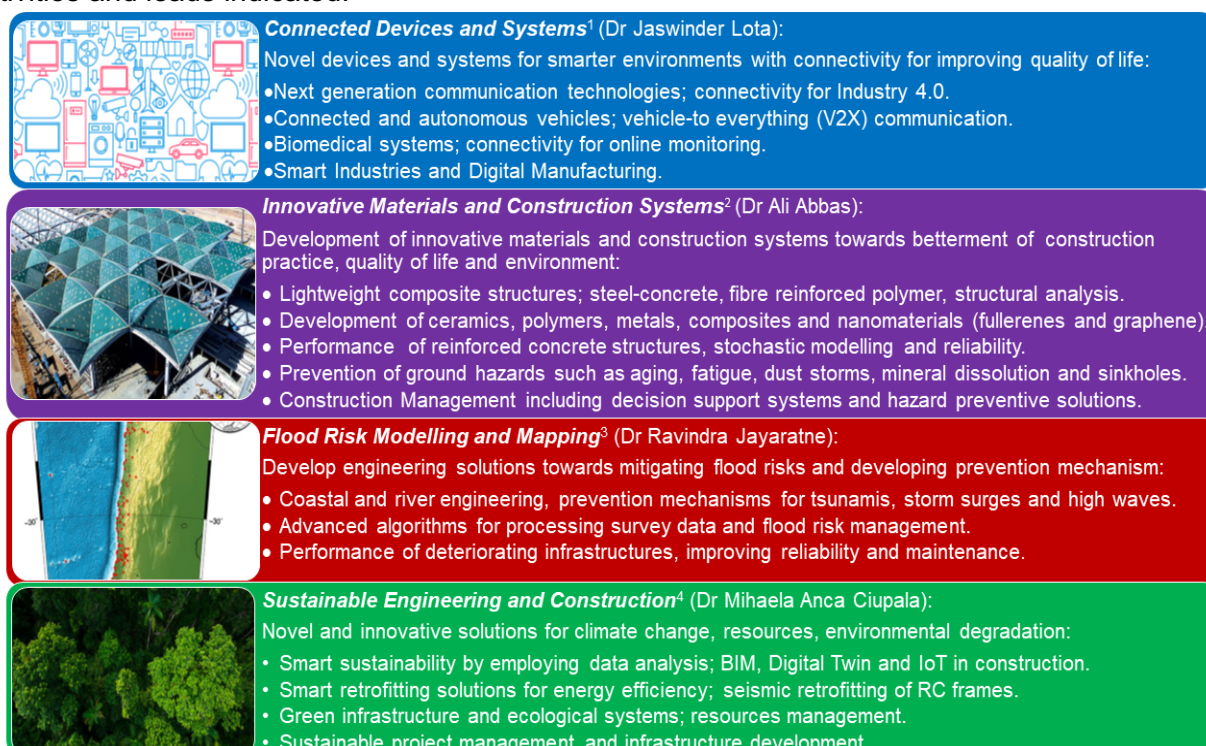

Connected Devices and Systems[1] (Dr Jaswinder Lota):
Novel devices and systems for smarter environments with connectivity for improving quality of life:
- Next generation communication technologies; connectivity for Industry 4.0.
- Connected and autonomous vehicles; vehicle-to everything (V2X) communication.
- Biomedical systems; connectivity for online monitoring.
- Smart Industries and Digital Manufacturing.

Innovative Materials and Construction Systems[2] (Dr Ali Abbas):
Development of innovative materials and construction systems towards betterment of construction practice, quality of life and environment:
- Lightweight composite structures; steel-concrete, fibre reinforced polymer, structural analysis.
- Development of ceramics, polymers, metals, composites and nanomaterials (fullerenes and graphene).
- Performance of reinforced concrete structures, stochastic modelling and reliability.
- Prevention of ground hazards such as aging, fatigue, dust storms, mineral dissolution and sinkholes.
- Construction Management including decision support systems and hazard preventive solutions.

Flood Risk Modelling and Mapping[3] (Dr Ravindra Jayaratne):
Develop engineering solutions towards mitigating flood risks and developing prevention mechanism:
- Coastal and river engineering, prevention mechanisms for tsunamis, storm surges and high waves.
- Advanced algorithms for processing survey data and flood risk management.
- Performance of deteriorating infrastructures, improving reliability and maintenance.

Sustainable Engineering and Construction[4] (Dr Mihaela Anca Ciupala):
Novel and innovative solutions for climate change, resources, environmental degradation:
- Smart sustainability by employing data analysis; BIM, Digital Twin and IoT in construction.
- Smart retrofitting solutions for energy efficiency; seismic retrofitting of RC frames.
- Green infrastructure and ecological systems; resources management.
- Sustainable project management and infrastructure development.

Figure 1 Engineering research groups and leaders

2. People

Recruitment and Retention

In accordance with our research strategy, we have followed a policy of recruiting, retaining and rewarding high-quality research active staff. With an aim of increasing women researchers in the UoA.

JAYA NEPAL joined our unit as a lecturer in Civil Engineering in 2014. JAWED QURESHI who joined us in 2013 as a Lecturer in Civil Engineering became a Senior Lecturer in 2014; JASWINDER LOTA who was a Senior Lecturer in REF2014, is now a Reader in Engineering. He is the lead UoA coordinator for this REF submission. ARYA ASSADI LANGROUDI joined UEL in 2015 as a Lecturer in Geotechnical Engineering and became a Senior Lecturer in 2016. In addition, as per our aims we had ALEX APEAGYEI joining UEL in 2017 as Senior Lecturer in Highways and Transportation Engineering. RAVINDRA JAYARATNE was promoted to Reader in May 2019. JULIUS AKOTIA joined the School in 2017 and was promoted to Senior Lecturer in 2018. For investing in emerging multi-disciplinary areas, FAWAD INAM, who is a Professor in Mechanical Engineering (Materials & Products) joined us in September 2018. SAMIR MORAD joined the School as a Lecturer in Mechanical Engineering (Biomedical) in Sept 2019. BAHAR KHAYAMIAN-ESFAHANI and LUANA PARISI joined as Lecturers in Engineering in 2019 and 2020 respectively.

Career Development and Early Career Researchers (ECR)

All new staff members are trained to supervise PhD students. Every ECR and research staff member is assigned to a research group whose leader acts as mentor, providing support for career development. This includes formulation of publication and networking strategies and help in preparing research funding applications. ECRs and research staff are encouraged to gain experience of organising conferences and workshops, supported by their mentor where appropriate. ECRs and research staff are supported in grant application development by senior staff who provide feedback on proposals prior to submission. LANGROUDI was successful in obtaining the Department of Science and Technology (DST)-National Research Foundation (NRF) South Africa Fellowship for Early Career Researchers in 2018 (Self-healing calcium Abstraction Fixation Engineering: NFPF170627245562, GBP 20,000).

Staff Support

There is a variety of internal investment schemes and support mechanisms to support career development. This includes applying grant bids for Sabbaticals, Early-Career, Mid-Career researchers' grant, International Collaboration grants and UEL research studentship schemes. In our unit, LOTA was awarded the International Collaboration grant for development of large-scale international projects (GBP2,500) in 2016 and a sabbatical (GBP1,200) in 2017. This resulted in increasing collaboration across Europe by putting together a H2020 bid for IoT services in Smart Cities consisting of partners from Spain, Portugal, France and Greece. JAYARATNE and QURESHI were awarded sabbaticals (GBP3,387 each) in 2018 which has increased their research outputs both in terms of quantity and quality. In addition, there are support funds, which staff can bid for such as UEL Impact Awards, which were awarded, to MIHAELA ANCA CIUPALA (GBP3,860) and JAYARATNE (GBP3,720) in 2016. JAYARATNE's award has led to developing a full impact case study that is submitted for this REF submission. JAYARATNE was also awarded the UEL Research Studentship from 2015-18 (GBP68,880) (to recruit a PhD student), the mid-career research grant

2016-17 (GBP4,995) and the International Collaboration grant in 2014 (GBP2,860). The in-place support measures enabled researchers to obtain following external grants:

- JAYRATNE was successful in obtaining a funding of GBP103,948, from the National Environment Research Council (NERC) in 2018 for his research on 'Compound flooding from tropical cyclone-induced sea surge and precipitation in Sri Lanka.
- APEAGYEI obtained funding for US GBP248.38 K to work on study titled 'Soils Stabilization and Full Depth Reclamation Expert' for soil stabilization in Nepal, in 2019; funded by the Millennium Challenge Corporation, USA and the Government of Nepal. (MCA-N/RMP/ICS/021, Millennium Challenge Account (MCA)-Nepal).

   Support is also available to enable research staff to attend international conferences such as the International Joint Conference Composite Structures and Mechanics of Composites ICCS 23, Spain in 2020 (QURESHI GBP 250), CIRP Design Conference in May 2020 and the 12th International Conference on Applied Human Factors and Ergonomics, USA scheduled in Jul 21 (ESFAHANI GBP581, GBP625).

Equality and Diversity

All appointments adhere to UEL's Equality and Diversity Policy. In accordance with the UEL Race Equality Charter, the Unit has a very diverse and wide representation across various sections that includes women staff and a significant number from BAME background. The staff bring their rich diverse experience from across countries such as Sri Lanka, India, Pakistan, Nigeria, Bulgaria, Sudan and Iran. Training on equality and diversity is strongly encouraged for all staff, and additional equalities training is embedded within management training.

In 2015, the university was awarded an Athena SWAN Bronze Award. Building on this success, in 2020 Athena SWAN Bronze Award was awarded to the School of ACE. Development, mentoring, career development and ensuring a fair REF process with support by formalising the mentoring systems, increasing ACE participation in the central Athena SWAN mentoring programme and Aurora / Diversifying Leadership programmes are key objectives as per ACE's Athena SWAN Action Plan for 2019-20. UEL holds the Level Two Disability Confidence award recognising the commitment to equality of opportunity for people with disabilities. UEL is also a Stonewall Diversity Champion in recognition of the continuing efforts in creating an inclusive and accepting environment for our LGBT colleagues.

In accordance with our strategic aim to encourage career progression of women researchers CIUPALA from the UoA was appointed as the post graduate lead (PGR) lead for the School of ACE; and subsequently the school saw significant improvements in terms of PhD completions and student experience as indicated in the following section.

PGR Students

In addition, the university has taken significant steps to improve the experience of our research students as our contribution to developing the next generation of researchers. All new PGR students are supported to interact with the Graduate School, which has ownership and overview of the research learning environment and manages all applications and recruitment, monitors progress, and contributes to, and organises, university-wide training programmes. All new students are expected to develop a full training needs analysis with their supervisors. The students are required to undertake formal training provided through the university Researcher Development Framework within the Graduate School: all new PhD students are required to demonstrate learning from core units on research methods. All PGR students have at least two supervisors and an annual review panel to monitor progress. All supervisors undergo dedicated training before being allowed to

supervise PhD students. All progress meetings with the supervisors and students are recorded through and on-line system for efficient monitoring and recording the progress made. To improve the PGR student experience the following actions were initiated post REF 2014 by the School:

1. Forging the definition and implementation of a clear PGR student review process in the School / including Engineering.
2. Developing an Action Plan on PGR experience/completion.
3. Building up the PGR student community by supporting the development of PGR student events, such as the 3 Minute Thesis Competition (May 2017); facilitating the development of an autonomous PGR Student Network in the School, which empowers students to create an inclusive, welcoming and exciting research environment both professionally and socially; facilitating the creation of fora for discussions, student engagement with the PGR provisions.

   As a result, excellent results obtained by the School of ACE in PRES 2018 when compared with those obtained during PRES 2015 indicating an increase is performance in all 8 compulsory scoring categories from 15 % (Progression) and 24 % (Resources). The School obtained the highest increase in the percentage of positive responses across the university for five out of the eight categories (Progression, Research Culture, Supervision, Responsibilities and Professional Development). For the "Overall Experience" category, the percentage of positive responses for PRES 2018 is 83.33 %, compared with 67.06 % for PRES 2015; this shows an increase in the positive responses of 16.27%, which is by far the highest increase across the university.

   In the UoA, a total of 22 students completed their PhD in this REF cycle, in addition there were seven PhD completions which were co-supervised with academics from other UoAs (architecture and computing).

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3. Income, infrastructure and facilities

Income

The staff in the UoA have been successful in obtaining various research grants/funds.
This is indicative of the success of the REF strategy to encourage researchers to tap into the existing and new resources, support mechanisms such as sabbaticals, bidding for other internal incomes to support research, and attending professional workshops aimed at specific bids and funding applications. Total income was GBP 1.0 M (2014-2020).

The grants obtained are shown in Fig. 2 (with detailed figures in Appendix) are broken down as Royal Academy of Engineering (RAE), Natural Environment Research Council (NERC), industry and income for 'global collaborations' includes Newton Fund (Global Challenges Research Fund, UK Newton Institution Link), Early Career Researcher Fellowship and Royal Society UK. This being the largest share is in line with intent of grant capture in the UoA, which is to enhance student research experience with a global perspective to solve problems.
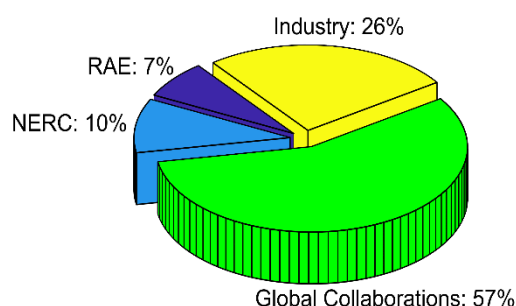

Figure 2 Income breakdown

Infrastructure and facilities

Our laboratory facilities are located adjacent to our library in our Knowledge Dock building where the industrial, enterprise and start up units are located. Teaching staff from the School are all located on

one floor in one of our teaching buildings providing direct access to teaching facilities such as lecture theatres and offering the opportunity for co-operative working both within and beyond the School. Our engineering laboratories provide a 21st Century working environment for our research.

Engineering Resources

Since REF 2014, new resources have been introduced to ensure a vibrant research environment among the various research groups. All PGR students are encouraged to make use of these facilities for their research work. These include:

Advanced Manufacturing Lab This facility provides an additive manufacturing capability to the department. It is equipped with a state-of-the-art ABB IRB robot for 3D production, a variety of versatile 3D printers (polymer and powder-based systems), large scale printing facilities, laser replicators for rapid prototyping, some of which are shown in Fig. 3. The Connected Devices and Systems research group members utilise the state-of-art facilities to undertake the experimental work along with the ones mentioned in the Design and Construction Lab.

ABB Robotic Arm
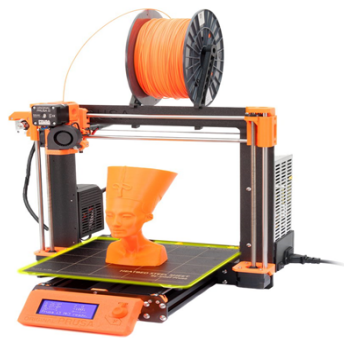
Original Prusa I3 MK3

WASP 40100 3D Printer

Figure 3 Selection of facilities from the Advanced Manufacturing lab

Design and Construction Lab This provides a central service for the design, manufacture and fabrication of equipment for teaching, research and project work. A range of machine tools are available as shown in Fig. 4 including advanced CNC machine tools and a CNC plasma profile cutter. Welding, model making, and casting (foundry) units are also available for students' projects.
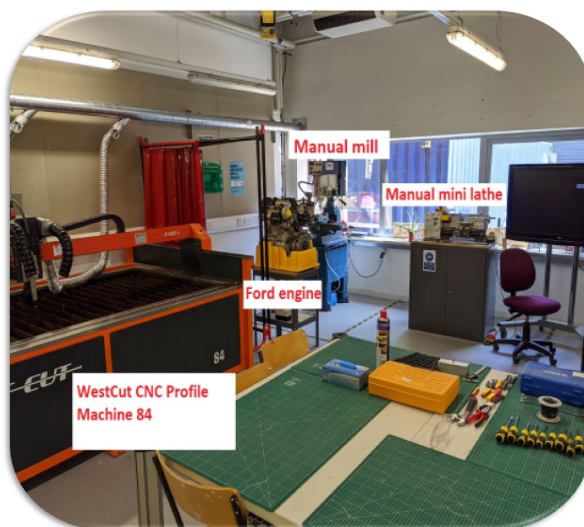
Figure 4 Facilities from the Design and Construction lab

REF2021

Structures Concrete and Materials Lab Large scale facilities are available in this area to study the behaviour of structures and the structural components of steel and reinforced concrete as shown in Fig. 5. During 2017/18, the School upgraded the universal testing machine by investing over GBP35,000 in a digital data logging system. The reinforced concrete strong floor, together with the computer controlled hydraulic testing equipment, provides the means to test large scale structural elements under static and dynamic loading. The laboratory is also equipped with a variety of strain measurement devices and data logging facilities. A new universal testing machine has been purchased. In addition, the equipment is utilised for the characterisation of concrete as influenced by proportioning, mixing and curing processes. The laboratory also contains an environmental chamber and equipment for the testing of challenging materials such as steel. This facilitates are made to good use for the research activities undertaken by members of the Innovative Materials and Construction Systems and the Sustainable Engineering and Construction research group members.

Mixers, Moulds, Vibrating Tables, Curing Tank and 3000kN Compression Machine

Two 500kN loadcells with universal frame

Figure 5 Structures, Concrete and Materials lab

Soil Mechanics and Engineering Geology Lab This is show in Fig. 6 wherein the lab is equipped to sample and prepare soils, in accordance with the latest codes and standards, to determine their engineering properties, to analyse the chemical properties of solid and pore fluids and to undertake model structure interaction. The equipment includes sieves, Casagrande limit apparatus, standard cone apparatus, soil density measuring devices, compaction and shrinkage apparatus. The equipment used for determining the strength of soils include vane, shear box consolidation and swelling apparatus. Tri-axial and unconfined compression tests are performed using 1 and 5 tonne compression machines and constant pressure systems. This laboratory is also equipped with a pneumatically controlled, large scale, cyclic loading triaxle rig that can be used for soil specimens up to 100mm in diameter. All of the equipment

Figure 6 Soil Mechanics and Engineering Geology lab

in this laboratory is computer controlled with all readings being recorded by data logger software. The lab is furnished with point load index apparatus and a 25tonne compression-testing machine for determining the strength of rock. PUNDIT apparatus is used to determine density comparison and isotropic characteristics of rock and the influence of discontinuities on insitu P wave velocities. Slake durability apparatus is available to be used to determine weathering index values. This facilitates the experimental work undertaken by the Innovative Materials and Construction Systems research group.

Hydraulic Engineering Lab This facility is made available in the same floor space as above facilities. This lab is equipped with two long open channels with discharge meters and tilting facility, a mobile bed sedimentation tank, venturi flume and a rainfall simulator with electrical pumps and sumps. Small-scale model hydraulic and coastal defences structures can be tested for hydrodynamics properties and overtopping volumes using two long open channels under various flow depths and dam-breaking type tsunami wave conditions respectively. In addition to that, sluice gates, broad crested weirs, bridge piers, model flood levees, miniature pressure sensors, propeller type current meters, digital video cameras, mechanically operated point gauges are available for research and teaching purposes. The mobile bed sediment tank is connected to a soil protrusion apparatus, where the combined equipment is used to carry out sediment transport research studies. A data acquisition software, the LabView, is installed in one of the computers in the lab for capturing experimental test data with a wide range of frequencies. A high-performance research PC placed in the lab runs a number of numerical modelling suites such as Weather Research Forecasting (WRF), Delft3D and HEC-RAS models. This lab facilitates research activities undertaken by members of the Flood Risk Modelling & Mapping research group.

Figure 7 Hydraulic Engineering lab

Surveying workshop and laboratory This area houses our surveying equipment, which includes an extensive range of (Circa 40) total stations, a 3D laser scanner, geodetic grade GPS receivers, digital and optical levels, including precise levels, electronic and optical theodolites, Unmanned Aerial Vehicles (drones), and all supporting ancillary survey equipment. There is external access for issue of field equipment. There is also a workshop facility with pillar drill, lathe and milling machine

for development and repair of equipment. The laboratory of networked PCs with specialised software including ArcGIS, ERDAS remote sensing and Leica Photogrammetric Suite software, Leica Geomatics Office for GPS processing, Move3 for network design and adjustment, LSS for land surveys and terrain modelling, Cyclone, Pointools and Faro Scene for processing laser scanning data. The laboratory also contains measurement pillars, a laser interferometer, analytical photogrammetric plotter, examples of aerial cameras and a large format (A0) plotter. The facilities are utilised by members of the Flood Risk Modelling and Mapping research group.

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

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Collaboration activities of various research groups

A snapshot of various collaboration activities for research groups is given is Fig. 8 for which the details are summarised in this section.
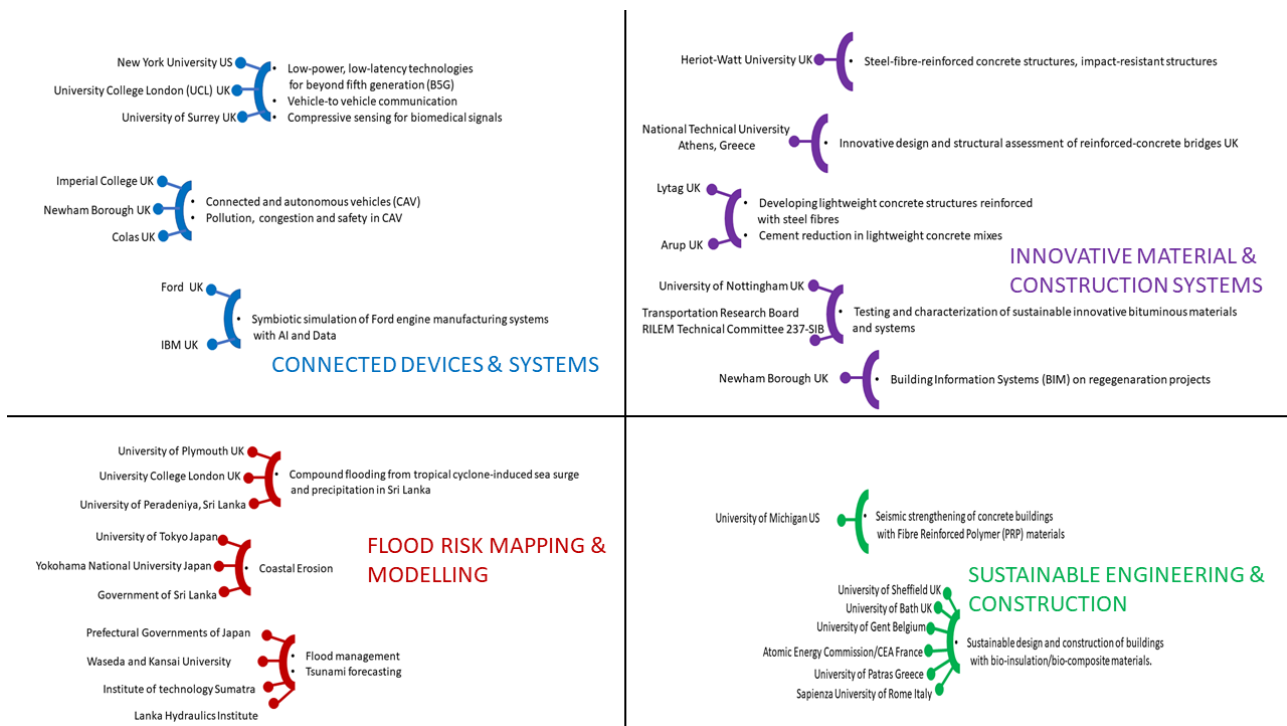
Figure 8 Collaborative activities

Connected Devices and Systems The group collaborates with Prof. Andreas Demosthenous (Sensors, Systems and Circuits Research Group at UCL) for communication technologies and signal processing applicable to wireless and biomedical signals. The collaboration includes Prof. T Rappaport (a leading pioneer in wireless communication) at New York University (NYU) for developing millimetre-wave (mmWave) technology in 5th Generation (5G) mobile communications such as design of low-power, low-latency, hybrid beamforming and multiple-input multiple output (MIMO) systems. Specifically, developing devices and systems for mmWave V2V, V2X to overcome the limitations of low data-rate in current state-of-the-art communication protocols, i.e., the Release 14/15 Cellular (C) V2V and Dedicated Short-Range Communication (DSRC). Other partners include 5G Innovation Centre (5GIC) at the University of Surrey.

The group has carried out research in collaboration with Imperial College, Newham Borough and Colas (a major highway contractor) for CAV and the opportunities to shape the road infrastructure around them to address issues such as pollution, congestion and safety, which are of vital concern to policy makers in London and the UK as a whole. The group collaborates with Ford UK and IBM to

improvise future manufacturing practices which will be required for Industry 4.0 such as Symbiotic Simulation of Ford Engine Manufacturing Systems, and undertaking Symbiotic Simulation using Artificial Intelligence (AI) and Data.

Innovative Materials and Construction Systems The group is carrying out a collaborative research project with Heriot-Watt University for examining the responses of steel-fibre-reinforced concrete structures under impact loading. This includes both experimental and numerical analyses, with the aim of developing simplified design guidelines for impact-resistant structures in locations like Malaysia.

The group also collaborates with Lytag, the main manufacturer of recycled lightweight aggregate concrete in UK and one of the main global producers of this type of aggregate, looking at the structural responses of lightweight concrete structures reinforced with steel fibres in order to enhance its ductility and load-carrying capacity. Recently, the research work with Lytag has been augmented with a collaborative project with Arup, a leading global engineering consulting firm, looking at reducing the amount of cement used in lightweight concrete mixes.

The group has also maintained collaborative research links with Professor Kotsovos from the National Technical University of Athens in Greece, an internationally renowned expert on reinforced-concrete structures. Their current work examines the use of innovative design and assessment techniques (namely the compressive-force-path method) to the structural assessment of reinforced-concrete bridges in the UK.

In addition, the group activities include undertaking research with Newham Borough looking into the potential impact of using Building Information Modelling (BIM) on regeneration projects. The group members have collaborated with colleagues in University of Nottingham, Europe and USA (RILEM Technical Committee 237-SIB: Testing and characterization of sustainable innovative bituminous materials and systems, Transportation Research Board) on cutting-edge research.

These collaborations resulted in co-authorships of three technical reports, four peer-reviewed journal articles and three book chapters in the past couple of years. The group was part of large consortium of major universities and organisations led by the University of Nottingham that submitted GBP15m bid to the RCUK's "Interdisciplinary Research Hubs to Address Intractable Challenges Faced by Developing Countries" call in 2018.

Flood Risk Modelling and Mapping The group has been actively undertaking post-disaster field surveys to gather necessary engineering parameters to develop predictive tools (e.g., mathematical and numerical models), management strategies and stakeholder (community) consultation work for mitigation of natural disasters such as coastal erosion (due to extreme waves), storm surges and tsunamis in Asia and beyond. The field studies include the 2004 Indian Ocean Tsunami, the 2013-14 Winter storms in the South West of England, and the 2011 Great East Japan Earthquake and Tsunami. It has set-up strong research partnerships with University of Plymouth, University College London and overseas universities in Japan (Waseda University, University of Tokyo, Yokohama National University, Kansai University), Sri Lanka (University of Peradeniya), Canada (University of Ottawa), Indonesia (Institute of Technology Sumatra, Bandung Institute of Technology), and Vietnam (Ho Chi Minh City University of Technology).

Other collaborators include the UK and overseas government departments include Environment Agency, Coast Conservation & Coastal Resource Management Department (CC&CRMD), Climate Change Secretariat, Department of Meteorology, Sri Lanka and Prefectural Governments (Kanagawa and Wakayama) of Japan. Engineering consultancies include HR Wallingford, Black & Veatch, WS Atkins and Lanka Hydraulic Institute.

One of the outstanding successes of these collaborations was winning the Natural Environment Research Council's (NERC) Catalyst SHEAR (Science for Humanitarian Emergencies and Resilience) bid for the project titled "Compound flooding from tropical cyclone-induced sea surge and precipitation in Sri Lanka (C-FLOOD)" in 2018 - https://gtr.ukri.org/projects?ref=NE%2FS005838%2F1.

The group has been awarded the Daiwa Anglo-Japanese Foundation's award for a disaster risk reduction (DRR) project "Different scales of natural hazards and community education" with UCL and Kansai University in 2018 focusing on disaster-prone communities in Essex, Devon (England) and Wakayama, Oita (Japan), https://www.uel.ac.uk/news/2018/10/uk-japan-disaster-reduction.

The group has collaborated with several international universities on various disaster resilience projects. This includes a coastal erosion project in Sri Lanka with CC&CRMD, University of Tokyo and Yokohama National University;and a tsunami forecast model for Karakatau in Lampung, Indonesia with Institute of Technology Sumatra, Bandung Institute of Technology and Waseda University.

The group organised the" Emerging Ideas in Water Emergency Management Conference 2019" with the Chartered Institution of Water & Environmental Management (CIWEM) and a RAE Visiting Professor to UEL, in December 2019. This event, designed to generate new partnerships with prominent water-related industries with UEL, not only brings together specialists from the UK, and overseas, and includes contributions from the School staff and postgraduate students.

The group is involved in outreach activities with secondary school students, seeking to inspire the next generation of engineers such as for sixth formers to consider technology-based careers (e.g., Royal Society funded project with Frederick Bremer School, Walthamstow).

Sustainable Engineering and Construction The group has collaborated with UK and oversees universities such as University of Michigan USA on cutting-edge research relating to the seismic strengthening of concrete buildings with Fibre Reinforced Polymer (PRP) materials. The collaboration also includes and sustainable design and construction of buildings such as bio-insulation/bio-composite materials. The UK collaborators are University of Sheffield and University of Bath. European collaborators include University of Gent, Belgium; Atomic Energy Commission/CEA, Saclay, France; University of Patras, Greece and Sapienza University of Rome, Italy. These collaborations resulted in the co-authorship of nine peer-reviewed journal papers and one book chapter from 2013-2017, as well in 6 PhDs completions (2013-2018).

UN Sustainable Development Goals (Goal 11: Sustainable Cities and Communities)

- Joint collaboration by the *Innovative Materials and Construction Systems* and *Sustainable Urban Built Environment groups* is towards realising the UN Goal 11: Sustainable Cities and Communities. For this APEAGEI and CIUPALA working together have resulted in creating wider impact for development and utilisation of industrial by-products for sustainable construction. This case study has been submitted by the UoA as one of the two for REF 2021. Other collaborators include the Sustainability Research Institute (SRI) UEL, and UK industrial partners such as Arup, Aggregate Industries, CRH group, Augean PLC, Thames Water, Tate & Lyle, and OCL Regeneration. The underpinning research has led development and use of artificial construction materials from industrial by-products, plant-based bituminous binders and recycled materials for highway pavement; thereby leading to significant reduction in virgin construction materials, greenhouse gas emissions. The impact provides incentives to drive waste management companies to implement this approach because of the high cost of hazardous waste landfill (GBP130 - GBP150 per tonne) in the UK and increasing demand for lightweight and thermally insulating concrete together with use highway recycled technology resulting in cost-savings of at least 50%.

The collaboration entailed the development of the required design methodology and technical specifications, training of Nepal government officials in Cement Stabilization Design, laboratory testing and full-depth reclamation (FDR) design methods to optimize lifecycle costs in Nepal. Development of standard specifications and training materials on recycling technologies is contributing to more sustainable and cost-effective ways of repairing failed roadways around the world.

- Underpinning research undertaken by the *Flood Risk Modelling and Mapping Group* has impacted on ensuring safety for coastal communities by developing disaster prevention mechanisms against tsunamis, extreme waves and floods. It is also being submitted as one of the two UoA impact case studies for REF 2021. The study has been instrumental for assisting practitioners and professional services involved in coastal disaster management and managing environmental risks for various stakeholders such as fisheries and policy makers e.g., for the Sri Lanka's Coast Conservation and Coastal Resource Management Department and Japan's the Kanagawa Prefectural Government. The study has increased awareness, attitudes and preparedness for tsunamis, storm surges, extreme waves and floods of disaster-prone communities in Marawila, Hita, Inami, Lampung, Sturmer and Slapton.

Wider contribution to research base and society

Majority of staff are active in leadership activities at a national level on a regular and ongoing basis. Many staff are active internationally, setting research agendas and defining the grand challenges of the future. An online event organised by LANGROUDI for 'Nature Inspired Solutions for the Built Environment' a working party formed in 2021, for its first annual meeting in Feb 2021. Total of 37 speakers from England, Scotland, Ireland, USA, Canada, Australia, Italy, France, Taiwan, Malaysia, Mexico, South Africa and Ukraine discussed their perspectives of nature-inspired Models, Materials and Methods in ground engineering. Speakers were from a broad spectrum of disciplines, including environmental philosophy, geotechnical engineering, robotics, materials, bioscience, biotechnology, social sciences, asset management, geology and planetary sciences. The working party will collaborate towards a radical re-thinking of engineering ground, and the impacts, as discussed in the meeting, will be visible in future structures both on earth and on mars.

The following sections provide summary figures and key examples, indicating the breadth and depth of our leadership activities:

A. *Leadership roles in advisory boards, industry, commerce, research councils, learned societies or professional bodies.*

APEAGYEI serves on various expert panels including the Transportation Research Board of the National Academies, USA where he is a member of the National Cooperative Highway Research Program (NCHRP) Project Panel on Guide Construction Specifications for Cold In-place Recycling (CIR) and Cold Central Plant Recycling (CCPR) (2019-2021). APEAGYEI is registered in the EC Expert Database in the area of polymer-modified bitumen, asphalt concrete and by-products and recently served as expert for the Latvian government. APEAGYEI also serves on the Steering Committee of the Nottingham Asphalt Research Consortium.

LOTA is a member of the UK5G Innovation Network that enhances links between academia and industry. This includes the UK Government's 5G Testbeds and Trials Programme. LOTA is a member of the UK Spectrum Policy Forum 5G Working Group under the Future Technologies Network (TechUK) Network. His contributions include identifying key technical challenges faced by

UK companies for development of key facets of 5G technology; applications, roll out and exploitation of 5G networks; findings of which are published in the White Paper "5G Innovation Opportunities A Discussion paper", Future Technologies Network Aug 2015.

CIUPALA's research on seismic design of buildings and energy efficiency in buildings has resulted in participation, as a PI/ investigator, in two EU research projects. She was a member of "COST Action TU1207" European research network, contributing to the development of the "Next Generation Design Guidelines for Composites in Construction" (2015 –2017). She has served as an Expert Evaluator and Rapporteur for EU research proposals (2012-to date); Expert Monitor for EU research projects (2016-to date) and Expert Evaluator for UK/EPSRC research proposals 2017.

B. International Conference organisation committee members and programme chairs:

- LOTA was Chair for Special Session on Security of Complex and Nonlinear Networked Systems: Analysis Control and Optimisation, at the IEEE International Symposium on Circuits and Systems (ISCAS 2020) Seville Spain, the premier flagship international conference on circuits and systems.
- JAYARATNE has been a member of following organising committees:
  - Emerging Ideas in Water Emergency Management Conference 2019 with the Chartered Institution of Water & Environmental Management (CIWEM) at UEL in December 2019.
  - Special Session on Hydraulic Structures at the 6th International Conference on Structural Engineering & Construction Management, at University of Peradeniya, Kandy, Sri Lanka in December 2015.
- INAM has been programme chair for following:
  - 6th International Conference on Environmental Engineering and Sustainable Development (CEESD 2021), 2-5 December 2021, Singapore.
  - 5th International Conference on Environmental Engineering and Sustainable Development (CEESD 2020), 3-6 December 2020, Xishuangbanna, China.
  - 4th International Conference on Aerospace Science and Engineering (ICASE-2015), 2-4 September 2015, Islamabad, Pakistan. Conference funded by IEEE.
  C. Invited keynote lectures and presentations.
- LOTA was invited speaker at the *First Workshop on Advancements in Circuits and Imaging*, organised by the European Doctorate in Image Sensors and Optical Nanotechnology (EDISON) University of Oxford, held in September 2015 for lecture on 'Compressive sensing & delta-sigma modulators'.
- JAYARATNE has delivered guest lectures on tsunamis, extreme waves and sediment transport modelling at Waseda University (2011-2017), National Autonomous University of Mexico (2014), Lanka Hydraulics Institute (2015-17), University of Peradeniya (2015), Dubai Municipality (2016), National Aquatic Resources Research & Development Agency (2016), University of Ottawa (2017), Yokohama National University (2018) and Institute of Technology Sumatra (2019).
- INAM has delivered following keynote presentations:
  - Next generation fullerenes – Carbyne based nanocomposites for aerospace applications, 1st International Congress on Engineering Technologies (*EngiTek 2020*), 16-18 June 2020, Irbid, Jordan.
  - Carbyne filled carbon nanotubes – polymer nanocomposites, Invited Guest Speaker, 24 April 2020, Cambridge Graphene Centre, University of Cambridge.

- Utilisation of carbon nanotubes in oil/ gas applications, *3rd International Conference on Advanced Materials and Process Engineering (NEDAMPE-2019)*, 11-12 December 2019, Karachi, Pakistan. Funded by Engro Corp.
- Graphene for Smart Materials Engineering, 3rd *Brazilian Conference on Composites Materials (BCCM3)*, 28-31 August 2016, Gramado, Brazil. Conference funded by IoM3, Du Pont, JEC group, netcomposites, Toho Tenax, SAMPE and Composites UK.
- Utilisation of carbon nanotubes in oil/ gas applications, *2nd International Conference on Advanced Materials and Process Engineering (NEDAMPE-2017)*, 12-13 December 2017, Karachi, Pakistan. Funded by Engro Corp.
- Structural Health Assessing Capabilities in Polymer and Ceramic Nanocomposites filled with carbon nanofillers, *International Conference on Structural Nano Composites (NANOSTRUC 2014)*, May 2014, Madrid, Spain. Funded by FP7 and KTN Nanotechnology.
- Processing fullerenes for next generation HPHT thermoplastic umbilical systems, *4th International Conference on Polymer Processing and Characterization (ICPPC-2016)*, 9-11 December 2016, Kerala, India.
- Fullerenes for Airbus A350' wings, *4th International Conference on Aerospace Science and Engineering (ICASE-2015)*, 2-4 September 2015, Islamabad, Pakistan. Conference funded by IEEE.
- Carbon nanotubes for next generation aircraft materials, 3*rd International Conference on Polymer Processing and Characterization (ICPPC-2014)*, 11-13 October 2014, Kerala, India.
  D. Journal editorships and editorial board membership for given in this section.

- INAM
- Editor (special issue, journal *Crystals, Q2*) since *2020*
  https://www.mdpi.com/journal/crystals/special_issues/Carbon_Fabrication
- (Along with LANGROUDI), Editors (special issue, journal *GeoHazards*) since *2020*
  https://www.mdpi.com/journal/geohazards/special_issues/nature_engineering
- Editorial panel (journal *Graphene*) since *2015 http://www.scirp.org/journal/Graphene/*
- Editor (special issue, journal *AIMS Materials Science*) since *2020*
  https://www.aimspress.com/aimsmates/article/5788/special-articles
- Editor (special issue, journal *Polymers) 2018 – 2020*
  https://www.mdpi.com/journal/polymers/special_issues/graphene_fullerene
  https://www.mdpi.com/journal/polymers/special_issues/fullerene_polymer
- Editor (special issue, journal *Molecules*) *2018 – 2020*
  https://www.mdpi.com/journal/molecules/special_issues/molecules_in_engineering
  https://www.mdpi.com/journal/molecules/special_issues/engineering_applications_materials
- LOTA is Associate Editor/Editorial Board Member for the IEEE Transactions on Circuits & Systems: I (2018-todate).
  and has/is Guest Editor on Special Issues for following top ranking journals:
- IEEE Transactions on Circuits & Systems-I 2021 Special Issue on Enhanced Systems and Circuits for Network 2030 Beyond 5G
- IEEE Transaction on Circuits & Systems I Special Issue 2017 on the CASS Flagship Conferences (APCCAS 2016, ICECS 2016 and ISCAS 2017);
- IEEE Transactions on Circuits & Systems-II Feb 2015 Special Issue on Biomedical and Bioelectronic Circuits for Enhanced Diagnosis and Therapy.
- JAYARATNE is Associate Editor of the Coastal Engineering Journal, Taylor & Francis (2019-todate).
  APPENDIX: INCOME DETAILS
  (Refers to Section 3 Income)

TOTAL INCOME ~GBP 1.0 M (2014-2020)

RAE
o **Towards the Adoption of the 'Fall Cone' as the Standard Method of determining the Index Parameters in South Africa IAPP1R2\100195. Industry Academia Partnership Programme – 17/18 Round 2.**
Commences: 02 Apr 2018. *Duration*: 24 months. Amount: GBP 72,000
Partners: Central University of Technology Free State, South Africa, Letaba Lab, Bloemfontein, South Africa.

NERC
o **C-FLOOD (Compound flooding from tropical cyclone-induced sea surge and precipitation in Sri Lanka), funded by NERC's 'SHEAR' Catalyst Scheme**
01 Nov 2018. *Duration*: 24 months (extended until September 2021 due CoVid-19 pandemic).
Amount: GBP103,948.60, Total grant of GBP252,805
Partners: University of Plymouth (lead), UCL, University of Peradeniya, Sri Lanka and Coast Conservation & Coastal Resource Management Department, Sri Lanka.

GLOBAL COLLABORATIONS

o **Kansai University, Japan Integration of disaster risk reduction and climate change adaptation for Sustainable Development Goals (SDGs)**
Commences: 1st April 2020 – 31st March 2023 (due to CoVid-19 pandemic research agreement was not finalised in 2020. This project is officially started in 2021)
Amount: GBP33,000 (UEL share GBP15,750)
Partners: Kansai University and UCL.

o **Soils Stabilization and Full Depth Reclamation Expert, (MCA-N/RMP/ICS/021), Millennium Challenge Account (MCA) – Nepal.**
Amount: US $ 300,467.00.
Consultancy to Nepal for stabilizing soils and reclaiming pavements with cement.
Funders: Millennium Challenge Corporation, USA and the Government of Nepal.

o **Great Britain Sasakawa Foundation (GBSF) Relationship between beach profile evolution and sediment mixing depth: Laboratory and mathematical modelling**
Commences: 1st June 2019 - 30th November 2020
Amount: GBP3,200 (Awarded to UEL and its share GBP1,600)
Partners: Yokohama National University, Japan

o **Daiwa Anglo-Japanese Foundation Community engagement in preparing for natural water disasters of different time and magnitude scales – A comparative study between UK and Japan**
Commences: 1st July 2018 – 30th June 2019
Amount: GBP7,000 (UEL share GBP2,955)
Partners: UCL and Kansai University, Japan

- **Research England – Global Challenges Research Fund (GCRF) Awareness and preparedness of local communities in Vietnam and Indonesia under climate-driven and geophysical hazards**
  Commences: 15th Nov. 2018-31st July 2019
  Amount GBP5,610
  Partners: Ho Chi Minh City University of Technology, Vietnam; Bandung Institute of Technology, Indonesia

- **Research England – Global Challenges Research Fund (GCRF) Understanding coastal erosion issues with a focus on the alleviation of natural hazards and risk analysis-A case study in Sri Lanka**
  15th Nov. 2018-31st July 2019
  Amount GBP2,045
  Partners: Coast Conservation & Coastal Resource Management Department, Sri Lanka; University of Tokyo; Yokohama National University, Japan

- **UK Newton Fund Energy Efficiency in Buildings**
     (Newton Institutional Links Fund)
  GBP 2,85,000 Grant number 2015EGY.

- **Newton Fund Understanding coastal and river sediment transport processes with a focus on the alleviation of natural hazards and risk analysis**
  1st Dec 2016- 31st Aug 2017
  Amount: GBP1,360
  Partners: Coast Conservation & Coastal Resource Management Department, Sri Lanka; University of Tokyo, Yokohama National University, Japan

- **Newton Fund Modelling natural hazards with community behaviour**
  20th-25th March 2017
  Amount: GBP1,000
  Partners: Ho Chi Minh City University of Technology, Vietnam

- **SAFE2 (Self-healing calcium Abstraction Fixation Engineering 2) DST – NRF Fellowships for Early Career Researchers from the UK. NFPF170627245562.**
  Commences: 01 June 2018. *Duration*: 06 months.
  Amount: GBP 20,000
  Partners: Central University of Technology Free State, South Africa

- **Great Britain Sasakawa Foundation (GBSF) Understanding coastal erosion processes with a focus on mitigating natural hazards and risk analysis.**
  Commences: 1st April - 31st Dec 2017
  Amount: GBP1,600
  Partners: Waseda University, Japan

- **Great Britain Sasakawa Foundation (GBSF) Hard engineering solutions to mitigate natural disasters: Tsunamis and storm surges**

Commences: 1st December 2014 – 30th September 2015
Amount: GBP2,000
Partners: Waseda University, Japan

o **Great Britain Sasakawa Foundation (GBSF) Mitigating future tsunami and storm surge disasters**
Commences: 1st April 2013 – 31st March 2014
Amount: GBP3,200
Partners: Waseda University, Japan

INDUSTRY

o **Industry funded project: Symbiotic Simulation using Artificial Intelligence and Data Management**
Commences: 2017. *Duration*: 12 months
Amount: GBP260,000 Grant & GBP395,000 Industry Contribution)
Partners: Ford Motor Company Limited (Lead), HSSMI Limited.