Aston University BIRMINGHAM UK | College of Engineering and Physical Sciences

# Call for Engineering and Physical Sciences DTP PhD Applicants – Academic Year 2021-22

**Deadline for applications: 3rd January 2021**

## List of 2021-22 Projects

**2020/21-001 - Sensors-based deterioration monitoring of ageing railway bridges**

**Supervisor:** Dr Haris Alexakis (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) / Department of Civil Engineering)
**Assoc Supervisor:** Dr Kaiming Zhou (Engineering and Physical Sciences College, Aston Institute of Photonics Technology (AIPT))

**Areas of Research**
Structural health monitoring; civil/structural engineering; data science; systems engineering; ICT; electronics and photonics.

**Knowledge and skills required in applicant:**
Essential
- BSc in civil/structural engineering, data or computer science, mathematics or statistics, electrical engineering, mechanical engineering, photonics, information and communications technology, or other relevant area
– Experience in coding, data processing
Desirable
– MSc or industry experience on data science or relevant area
– MSc or industry experience on sensing technologies (photonics or electronics)
– Experience in signal processing, pattern recognition techniques, statistics, neural networks, wavelets, cloud programming
– Experience in structural health monitoring or non-destructive testing
Optional
– Experience in structural lab testing and structural analysis

**Project Summary**
Rail infrastructure deteriorates with time due to material fatigue, overloading, ground movement and environmental effects. This might affect the serviceability and structural integrity of rail assets, such as bridges, causing major socio-economic disruptions and occasionally life loss. Ageing masonry bridges comprise around the 50% of the UK and European rail stock and their structural assessment is particularly challenging. Traditional inspection practises and fragmented monitoring appear unable or impractical to ensure adequate maintenance on a national scale. Digitisation of civil infrastructure networks emerges today as an essential next step to address this challenge, offering opportunities to enhance our understanding of the structural deterioration mechanisms involved, and hence supporting decision-making for the maintenance of railway networks.
This PhD research will explore the benefits of combining advanced sensing technologies with data analytics to enable automated civil asset management tools for resilient infrastructure, focusing on ageing railway bridges. The student will work on the processing and interpretation of field monitoring and lab tests data from two ongoing deteriorating bridge monitoring projects. Data science techniques will be applied, combining information from fibre optic strain and temperature sensors, acoustic emission sensors and high-sensitivity accelerometers. The analysis will contribute towards the development of early-warning, sensors-based, deterioration monitoring systems that will integrate machine learning, cloud data management and statistics.

The student will benefit from the close collaboration with researchers from ASTUTE and AiPT at Aston University, the University of Cambridge, the University of California, Berkeley, engineers from Network Rail and industry partners. This PhD research combines elements from civil engineering, data science, systems engineering, ICT, electronics and photonics. Applications from students with background or aspirations in any of these areas and with interest to develop their digital abilities are welcome to apply. Tailored training on Data Analytics and AI shall be provided

**2020/21-002 - High energy orbital oscillations induced in an artificial gravity system**

**Supervisor:** Dr Yu Jia (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)
**Assoc Supervisor:** Dr Xianghong Ma (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)

**Areas of Research**
Nonlinear dynamics, energy harvesting, smart systems and structures
**Knowledge and skills required in applicant:**
Knowledge in vibration and nonlinear dynamics.
Knowledge in signal processing.
Skill in MATLAB and FEA software
Skill in dynamics experimentation
**Project Summary**
This PhD project aims to better understand and control the high energy orbital oscillations from a given resonator placed within a rotational environment that is subjected to high levels of centripetal acceleration manifesting as artificial gravity.
Objectives include: (1) develop analytical and numerical models to describe the dynamical characteristics of artificial gravity induced multi-stability phenomenon, (2) design, prototype and experimentally validate the world's first artificial gravity energy harvester, (3) train a world class PhD researcher in the field of dynamics, (4) leveraging existing research collaborations within the automotive sector to develop an exploitation plan for this research.
The mechanical world is abundant with kinetic energy that can be harnessed to power modern technologies in a decentralised manner. The current state of the art already comprises of a number of successful translatory vibration harvester technologies. Meanwhile, rotational systems remain a relatively untapped environment due to the presence of high g centripetal forces which adversely suppress motion. Wheels in cars, blades of wind turbines and rotors in engines can all experience upward of hundreds of g (where 1-g is 1 earth gravity).
In a previous paper by the PhD supervisor of this proposed project, a new dynamics mechanism was theorised and conceptualised where the artificial gravity within high-g rotational systems can be harnessed, instead of previously being perceived as something to avoid. This PhD project will develop this novel concept, and for the first time, attempt to experimentally validate the theory.
Outcomes of this project has industrial and societal implications by enabling self-powered sensors and smart systems within automotive wheels, wind turbines and any rotational engineering systems in order to improve their operational efficiencies, reduce running costs and cut down carbon footprints. This research aligns with ASTUTE's research vision, serving as a component of the future smart transport and energy systems.

**2020/21-003 - Engineering A Novel Mobile Assistive Technology to Improve Quality of Life, Independence and Medical Condition Management in Individuals with Healthcare-Related Needs**

**Supervisor:** Dr Jo Lumsden (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) /Computer Science)
**Assoc Supervisor:** Dr Lilit Hakobyan (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) /Computer Science)

**Areas of Research**
Human Computer Interaction (HCI), combining the disciplines of engineering & health and human-centred design.
**Knowledge and skills required in applicant:**
At its core, this project is a human computer interaction (HCI) research project. As such, we are looking for a student with a strong HCI academic (or industrial) background who has (commensurate with career level) appreciation of and experience in standard human-centred HCI methods, including participatory design and evaluation methods; alternatively, if a student shows empathy and the correct aptitude, they may be considered on the basis that core methods can be taught. Since this project also has a strong technical component, the student will also require strong programming/software development skills.
**Project Summary**.
Personal mobile technologies (e.g., smartphones, wearable technology, etc.) have significant potential to be used effectively as assistive devices to improve the quality of life for individuals with health-related needs. This can range from self-tracking systems designed to support behaviour change based on information users collect about themselves through to rehabilitative technology designed to support users in regaining independence following a significant health event. This emerging field is still in its infancy, with scope for significant contribution to scientific knowledge yet to be realised in terms of design and evaluation methodological know-how as well as longitudinal evidence of the efficacy of the use of such technologies in practice.
The aim of this project is therefore to design, develop and evaluate a novel mobile assistive technology that has the potential to significantly and positively impact the quality of life, independence and healthcare management capabilities of individuals with special or healthcare-related needs in an area of the candidate's choice (e.g., mental health, physical health, healthy aging, etc.). In so doing, it will contribute to the emerging field of engineering and health as well as to expanding know-how in the field of human-centred design, notably in terms of adaptive methodologies for designing and evaluating with atypical user groups. The key objective of this project is that it will benefit citizens within the chosen community of study (which may represent a marginalised community of use), contributing to an improved quality of life by enhancing their independence and maximising the benefit – in a healthcare context – to the individual of the vast quantities of data that can be collected/generated via the use of pervasive, mobile technologies.

**2020/21-004 - A Novel, Ability-Reactive Health Technology for Older Adults with AMD**

**Supervisor:** Dr Lilit Hakobyan (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) /Computer Science)
**Assoc Supervisor:** Dr Jo Lumsden (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) /Computer Science)

**Areas of Research**
This research sits within Human Computer Interaction (HCI), combining the disciplines of engineering & health and human-centred design.
**Knowledge and skills required in applicant:**
We would be looking for a candidate with a strong HCI academic (or industrial) background who has appreciation of and experience in standard HCI methods. Candidates who show empathy and the correct aptitude may also be considered. Since this project also has a strong technical component, strong programming/software development skills will also be required.
**Project Summary**.
With around 285 million people worldwide and 2 million people in the UK living with sight loss, visual impairment is one of the most serious age-related health concerns among older adults; the most common cause of sight loss in the UK is Age-Related Macular Degeneration (AMD). A healthy lifestyle can mitigate sight loss risk and retard sight degeneration for those at risk of or with AMD. Whilst we are witnessing the emergence of a plethora of self-help monitoring applications, these are not sufficiently accessible to individuals with AMD or visual impairment in

general. As such, a significant percentage of the population is excluded from the use of healthcare technology that has the capacity to greatly enhance their wellbeing.
Our research to date has made novel, initial inroads to providing effective support in this area by designing – via participatory practice with clinicians and patients with AMD – a diet diary and recommendation app: the research has culminated in a preliminary field trial of the app, which revealed that the app encourages positive diet behaviour change and was received positively by AMD patients.
Taking a multidisciplinary approach, the main objectives of this project are therefore to: (1) develop novel algorithms to automatically adapt the app user interface to reflect detected (based on app interaction) changing visual acuity of its user and thus future-proof its use over time; (2) develop methodological best-practice for evaluation of such algorithms and the effectiveness of a mobile healthcare app of this nature in longitudinal trials; and (3) gather longitudinal data which will prove the impact capacity of the app. It is anticipated that the results from this PhD work will be generalisable to other visual impairments and will contribute to an emerging body of research into best practice for healthcare-related technology design and evaluation

**2020/21-005 - New sustainable polymers: a greener future for commercial inkjet printing**

**Supervisor:** **Dr Matthew J Derry** (Engineering and Physical Sciences College / Materials Research, Chemical Eng & Applied Chemistry)
**Assoc Supervisor:** **Prof Paul D Topham** (Engineering and Physical Sciences College /Materials Research, Chemical Eng & Applied Chemistry)

**Areas of Research**
Polymer Science, Materials Science
**Knowledge and skills required in applicant:**

- Good practical skills and ability to work safely in the laboratory.
- Good oral and written presentation skills.
- General understanding of polymer synthesis, including controlled radical polymerisation techniques.
- General understanding of polymer characterisation, including nuclear magnetic resonance (NMR) spectroscopy, gel permeation chromatography (GPC), differential scanning calorimetry (DSC), and UV/vis spectroscopy.
- Appreciation of the role polymer science plays in the current and future challenges for developing sustainable technologies.
- Willingness to learn practical and theoretical principles of X-ray scattering.

**Project Summary**.
This project will contribute to our green, sustainable future ambition by tackling key technical challenges faced within the polymer and materials science communities, particularly focused on the development of new, advanced commercial inkjet printing formulations. Current inkjet printing formulations typically use toxic organic solvents due to their enhanced print quality, image durability and substrate compatibility, which is facilitated by their superior wetting ability and reduced drying times. In order to develop sustainable inkjet printing formulations, we must generate water-based ink formulations using materials derived from renewable resources that offer these key benefits for optimum performance.
Inkjet printing has been utilised for decades, ranging from casual home use to wide-scale industrial processes, such as printing crucial information on food and medical packaging. Considering the vast and wide-reaching uptake of this technology, it is imperative that we develop greener and more sustainable formulations that minimise the environmental impact whilst maintaining the key benefits that have laid the foundations for the technology's success (e.g. low manufacturing costs, high quality printing, fast prototyping, compatibility with many substrates).
In this project, reagents derived from renewable resources will be sourced, produced, and subsequently used to generate polymeric materials for use in aqueous inkjet printing formulations. You will develop protocols for the design and synthesis of a range of suitable sustainable water-based formulations, which will involve advanced

synthesis and characterisation techniques. There is potential for industrial engagement throughout the project, with industry standard testing being conducted on the most promising systems.
Ultimately, this project will develop completely renewable, green technologies for inkjet printing, which will have a significant impact on academic and industrial scientists around the world.

**2020/21-006 - Transfer Learning Solutions for Intelligent Transportation**

**Supervisor:** **Dr Alina Patelli** (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE)/ Computer Science)
**Assoc Supervisor:** **Dr Aniko Ekart** (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE)/ Computer Science)

**Areas of Research**
Artificial Intelligence, Intelligent Transportation, Smart Cities
**Knowledge and skills required in applicant:**
Essential:
- Degree in CS, Mathematics, or relevant Engineering discipline
- Knowledge of computer programming (e.g., Matlab/Python)
- Analytical skills
- Good communication skills

Desirable:
- Traffic modelling familiarity
- Time series modelling familiarity

Foundations of Artificial Intelligence
**Project Summary**.
Traditional urban infrastructure is at a breaking point. Given the rampant pollution, traffic congestion, and rising cost of powering energy-inefficient structures that are commonplace in our cities, switching to a more sustainable technological platform to support urban life is an imperative. Smart cities offer a potential solution, with intelligent transportation spearheading the transition from traditional urban traffic monitoring and control to a greener, more cost-effective approach, seamlessly integrated in the urban ecosystem.
Within this context, our project aims at measurably improving transportation related decision making at every level, from finding the fastest route to work in real time and improving traffic light control, to investing in road infrastructure. The project's stakeholders, i.e., ASTUTE, Birmingham City Council, and the Department for Transport, will be regularly consulted to inform project work and evaluate its results.
The initial modelling of urban traffic will draw from the supervisor's recent work, leveraging several sources of open data:
- UK's Department for Transport – providing country-wide coverage, at regional and local levels: https://roadtraffic.dft.gov.uk/#6/55.254/-16.161/basemap-regions-countpoints (e.g., Birmingham traffic data is available at https://roadtraffic.dft.gov.uk/local-authorities/141);
- Darmstadt Urban Institute: https://darmstadt.ui-traffic.de/faces/TrafficData.xhtml.

The in-depth investigation and comparison of current modelling and prediction techniques, alongside their applications, will lay the groundwork for the original contribution to science, namely new, accurate, robust, scalable, and economical urban traffic prediction algorithms. The PhD researcher will investigate several distinct approaches to modelling and prediction, including time series, deep learning, and evolutionary computation. The algorithms will feature modern transfer learning capabilities, in order to reuse existing knowledge effectively and efficiently.
The specific objectives are:
- Investigate the potential of transfer learning (i.e., efficient reuse of existing knowledge) in large-scale urban road network modelling.
- Build robust, accurate, and reusable computational models of traffic flow through major cities.

Develop a collaboration with local authorities, to integrate our novel tools in their infrastructure policy.

**2020/21-007 - Ellipsometric Optical Frequency Comb LIDAR for Plants Vegetation Monitoring (EOFC-LIDAR)**

**Supervisor:** Dr Sergey Sergeyev (Engineering and Physical Sciences College/ Aston Institute of Photonics Technology)
**Assoc Supervisor:** Dr Mariia Sorokina (Engineering and Physical Sciences College/ Aston Institute of Photonics Technology)

**Areas of Research**
Detection of the plant health condition, especially water stress, based on remote sensing is an essential component of precision agriculture, forest management, and the ecosystem's study. Because a water shortage is a significant constraint of the agricultural yield, improving water use efficiency for crop production requires more accurate remote sensing techniques. Conventional Polarimetric LIDARs measure degree of polarisation (DOP) as an indicator of the plant health condition in terms of the water stress, i.e. it was found that the healthier leaf has a higher DOP vs unhealthy or dying leaf. Though the polarimetric LIDARs' application demonstrated a potential for water stress monitoring, the existing solutions use expensive bulk optic components that requires a special design to stabilise such polarimeter in the case of inflight conditions on board of drone, plane etc.
**Knowledge and skills required in applicant:**
Preferred skill requirements include experience in experimental work, knowledge of scientific programming and computing, photonics, and machine learning. Knowledge in the theory of differential equations, mathematical physics, and numerical analysis is an asset. At a minimum, the successful applicant should have an outstanding BSc or equivalent qualification in physics or engineering. Applicants holding a Master of Science degree (or expected to be awarded one soon) in Physics, Electrical Engineering, Applied Mathematics, or equivalent are especially encouraged to apply.
**Project Summary**.
The project aims to address the challenges by developing and proof of concept demo of a new generation of Polarimetric LIDARs using the Ellipsometric Optical Frequency Comb technique (EOFC).
The proposed EOFC LIDAR provides an additional information about plant health condition by the fast measuring all Stokes parameters instead of DOP only. To harvest the benefits of the EOFC LIDAR technique, the research programme is divided into the following objectives: 1) Design of an EOFC LIDAR by using on mode-locked fibre laser with the temporary evolving state of polarisation; 2) Development of test rig with plants' leaves samples under different water stress conditions and use of the EOFC LIDAR to collect the elipsometric signatures from the samples; 3) Using ellipsometric signatures, design, train and implement machine learning models to recognize plants health conditions. A field test of the novel LIDAR will be conducted in a real-world outdoor environment to demonstrate the advantages of the sensor. Unlike the state-of-the-art solutions, EOFC LIDAR includes all fibre design with a minimum number of bulk components that reduces the cost and weight and enables cost-effective application by using drones. The technique also provides a high lateral resolution, access to the ellipsometric signatures of the object, and decreased measurement time. The project complements the research agenda of Horizon 2020 funded projects coordinated by Aston university - EID MOCCA and ETN MEFISTA - by extending OFC applications' area to environmental monitoring.

**2020/21-008 - Novel silver(II) compounds as enhanced antimicrobial agents for surface disinfection**

**Supervisor:** Dr Petra van Koningsbruggen (Engineering and Physical Sciences College / Chemical Engineering and Applied Chemistry (CEAC), Aston Materials Research)
**Assoc Supervisor:** Professor Corinne M. Spickett (Life & Health Sciences College / Biosciences Research Group)

**Areas of Research**
Metal compounds, redox biochemistry, mechanisms of cell killing
**Knowledge and skills required in applicant:**
This is an interdisciplinary project at the interface of inorganic chemistry, organic chemistry and chemical biology. Candidates are expected to have a solid background in at least one of these areas and a strong interest in being trained as a multidisciplinary researcher.
Applicants should hold or expect a first class or upper second class degree in Chemistry or Chemical Biology.
**Project Summary**.
*Project Aim:* The synthesis and characterisation of more effective antimicrobial cleaning agents and the assessment of their antimicrobial potential.
*Objective 1:* Synthesis of novel silver(II) compounds with improved properties, e.g. solubility, stability, reactivity.
*Objective 2:* Assessing the antimicrobial potential of the novel silver(II) compounds.
*Objective 3:* Detailed study of the mode of antimicrobial action of silver(II) compounds.
*Additional benefits:* Broad training in chemical synthesis, chemical analysis, microbial culturing techniques, high throughput screening assays, which are key skills for a future career in the pharmaceutical/agro-chemical sectors.

## 2020/21-009 - All Optical Signal Processing

**Supervisor:** Prof Andrew Ellis (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT))
**Assoc Supervisors:** Dr Stylianos Sygletos Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT)); **Industrial supervisor from the HOSP project**

**Areas of Research**
The use of All Optical Signal Processing (AOSP) techniques to enhance the performance of optical networks, including wavelength conversion to reduce blocking, phase conjugation to compensate nonlinearity, regeneration to increase reach and optical digital to analogue conversion to increase capacity.
**Knowledge and skills required in applicant:**
Applicants for this position should have: a first class Honours degree in electronic engineering, applied physics or related subject with final year or optional courses relevant to optical communications or nonlinear optics. Alternatively, then should have a Master's degree in optical communications at Distinction level.
They will be able to demonstrate a high level of competence in experimental demonstration, ideally though experimental project work, and an awareness of basic signal analysis techniques, such as sampling and spectral analysis. Understanding of nonlinear optics is desirable, but not essential. Successful applicants will also be also be able to demonstrate the ability to analytically or numerically resolve complex optimisation problems, such as routing algorithms.
**Project Summary**
As network capacities continue to increase, the performance constraints and energy consumption associated with the use of electronics to perform signal processing on optical signals become more apparent. By avoiding opto-electronic conversion and enabling quantum-limited noise performance, all optical signal processing (AOSP) provides a way to alleviate these constraints. Whilst the potential for such devices is well established, compatibility with contemporary optical networks requires innovative materials and designs to enable the simultaneous processing of multiple wavelengths and/or the operation over a significantly broader range of wavelengths (up to 10 times greater wavelength range),and compatibility with high cardinality modulation formats.
This project will develop an AOSP platform offering a substantial increase in operating wavelength range, analysing and selecting appropriate materials systems, working with partners to source devices, and demonstrating basic AOSP functions. By providing wide tunablillity and multi-wavelength operation, this project could enable AOSP to challenge incumbent electronic digital signal processing technologies in the same way that fibre amplifiers were able to displace single wavelength electronic regeneration for the deployment of the transatlantic cable TAT12/13, and initiating the explosion of the internet. To substantiate this potential benefit,

in collaboration with network operators, the project will analyse a number of network use cases with a view to establishing a "break even" specification for the optical signal-processing device.
The project will require a balance of network design skills, ranging from heuristic optimisation to integer linear programming techniques, AOSP subsystem assembly and test, and fundamental materials analysis. The successful candidate will be offered freedom to select the most promising AOSP device to highlight the technical capabilities and use case benefits of this re-emerging technology. The successful candidate will work alongside commercially funded activities developing shorter term AOSP devices, and research projects investigating novel optical signal processing applications such as neuromorphic computing

**2020/21-010 - Coupled Oxidative Ageing and Mechanical Multiphysics Modelling of Asphalt Pavements built with Sustainable Bitumen**

**Supervisor:** Dr Yuqing Zhang (Engineering and Physical Sciences College/ Civil Engineering / Aston Materials Research)
**Assoc Supervisor:** Prof Mujib Rahman (Engineering and Physical Sciences College / Civil Engineering)

**Areas of Research**
Renewable Construction Materials; Durable Road Infrastructure; Advanced Computational Modelling
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree or equivalent qualification in the areas of Civil Engineering, Chemical Engineering or Material Engineering. Preferred skill requirements include knowledge/experience of Bituminous Materials, Pavement Engineering, Numerical Modelling, Bioenergy Engineering, or Material Characterisation.
**Project Summary**.
The UK's highways today are predominantly made up of a composite material called asphalt mixture, more commonly known as Tarmac. It consists of mineral aggregates bound by bitumen obtained by processing crude oil. The crude oil itself has accordingly increased the energy costs in asphalt production. Moreover, asphalt is one of the biggest sources of carbon emissions in road construction. For example, in 2016 the UK produced 26 million tonnes of asphalt, according to the European Asphalt Pavement Association, of which emitted 27kg of carbon dioxide per tonne.
The state-of-the-art researches including those at Aston University have examined alternative and renewable binders from biomass and waste plastics. The produced sustainable bitumen such as bio-bitumen or waste-derived bitumen can potentially improve the economic feasibility and environmental sustainability of the asphalt mixtures.
However, the challenge exists around if the asphalt produced from the sustainable bitumen is durable during the pavement lift time under the field environmental conditions. This is because the sustainable bitumen may have significantly different aging characteristics. Another obstacle is how to couple the aging of the asphalt mixture with its mechanical performance so that the long-term field performance of the asphalt pavements built with the sustainable bitumen can be accurately predicted.
This research project aims to develop a coupled oxidative ageing and mechanical multiphysics model to investigate how the asphalt mixture manufactured from the waste-derived sustainable bitumen ages under the field environmental conditions and how this affects the long-term durability performance of the asphalt pavements. The research objectives include:
1) Data Collection and Field Testing of Highway Road Sections;
2) Material Characterisation of Traditional, Waste-derived and Field Asphalt Mixtures;
3) Aging Multiphysics Modelling and Validation using the Field Road Sections Survey Data;
4) Durability Performance Predictions of Field Road Sections built with the Sustainable Bitumen.

**2020/21-011 - Augmented Reality Mental Health First Aid Agent**

**Supervisor:** Dr Ulysses Bernardet (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) /Computer Science)

**Assoc Supervisor:** Dr Christopher Buckingham (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) /Computer Science)

**Areas of Research**
Artificial Intelligence; Human-Computer Interaction; Virtual Humans; Augmented Reality; Mental Health
**Knowledge and skills required in applicant:**
Background in computer science/engineering with a strong interest in psychological concepts or a background in psychology/biology with a strong technical proficiency.
Skills: VR/AR development (Unity/Unreal); experimental design; data analysis
**Project Summary**.
The aim of the project is to develop an intelligent Augmented Reality Mental Health Support Agent that enables people with mental health issues such as anxiety and depression to better manage their everyday lives. Mental health is a growing public health concern, and mental illness costs the UK economy billions every year. The interventions by the AR agent will be based on the successful approach of using mental health first aiders (MHFA), i.e. laypersons trained to identify people in need and be a first person of contact. The agent will identify an acute crisis, listen to the user, and guide them to resources of further, professional help. The longer-term way people interact with the agent is through regular check-ins by prompting users about their wellbeing based on expert knowledge from the GRiST mental health decision support system (Buckingham et al., 2015). The rendering of the ARA will be done using head-worn Augmented Reality transparent holographic glasses that provide the augmented reality experience to the user and simultaneously captures human actions (gaze, gesture, voice). The agent will show empathic responses -- facial expressions, posture, and non-verbal behaviour (nodding, posture) -- to the affective quality of the user's communication. The project addresses the Research Question of what perceptual capability and non-verbal behaviour an Augmented Reality Agent needs to have to function as an empathic and non-judgemental lister. In human to human interaction, empathic listening plays a key role. While agents in Virtual Reality have been shown to be effective in health interventions, Augmented Reality agents have not been investigated so far.
Augmented Reality is an emerging technology that will become an important part of life in the near future. Agents operating within Augmented Reality are an exciting new research domain that holds enormous potential but is as of yet under-investigation

**2020/21-012 - Development and Characterisation of Multifunctional Bioactive Materials for Bone Tumour Therapy.**

**Supervisor:** Prof Richard Martin (Engineering and Physical Sciences College/ Electrical, Electronic and Power Engineering)
**Assoc Supervisors:** Prof Ivan Wall (Life & Health Sciences College/ Biosciences), Dr Laura Leslie (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design), **Dr Adrian Gardner** (Royal Orthopaedic Hospital), **Professor Lee Jeys** (Royal Orthopaedic Hospital)

**Areas of Research**
Biomaterials, Material science, Interdisciplinary Physical / Chemical and Biological Sciences.
**Knowledge and skills required in applicant:**
This is a highly interdisciplinary research project and the student will be working at the material/ engineering/ life science interface. A good first degree in science such as materials, physics, chemistry, biology, biomedical science, or engineering such as chemical engineering will be appropriate. Students with research experience in subjects above are preferred. The applicant must be prepared to learn new skills and techniques across disciplines. The student will undertake biological experiments within wider research groups at Aston. Full training will be provided.
**Project Summary**.
Applicants are invited to apply for a highly interdisciplinary PhD studentship working across the physical and life sciences. The successful applicant will develop and characterise novel multi-functional bioactive materials to

treat bone tumours. Working in conjunction with the Royal Orthopaedic Hospital in Birmingham, materials will be developed to help repair and regeneration bone lost, or surgically removed, from the tumour site. In addition, the materials will simultaneously release ions to prevent further tumour development. Furthermore, antimicrobial agents will be incorporated into these bioactive materials, which will help prevent surgical site infections.

The project will enhance and further develop bioactive glasses, which are already widely used clinically for bone repair and regeneration. These materials are biodegradable and can be tailored to provide a controlled release of key biological ions such as calcium and phosphorous which then precipitate to form new bone mineral inside the body. Our glasses will be developed specifically to treat bone tumours and provide an anti-tumour agent and antimicrobial effect. Working closely with clinicians, we will ensure the materials is optimised for clinical applications.

The project will benefit from an experienced and multi-disciplinary supervisory team who have expertise and state-of-the-art facilities covering all areas of the project including: bioactive glasses (Prof Richard Martin), tumours, clinical input (Dr Adrian Gardner, Prof Lee Jeys, Royal Orthopaedic Hospital), cell culture (Prof Ivan Wall), Dr Laura Leslie (mechanical engineering).

Aim and Objectives:

The overall aim of this project is to develop bioactive glasses to treat bone tumours. The objectives include:

1. Optimise bioactive glasses to repair and regenerate bone that has been lost or removed from the tumour site.
2. Optimise the release of anti-tumour agents to prevent tumour regrowth.
3. Optimise the release of anti-microbial agents to prevent surgical site infections.
4. Optimise the method of delivery for clinical applications.

**2020/21-013 - Compact and responsive sorption thermal energy storages: material development, experimental characterisation and modelling**

**Supervisor:** Dr Ahmed Rezk (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)
**Assoc Supervisor:** Prof Richard Martin (Engineering and Physical Sciences College/ Electrical, Electronic and Power Engineering)

**Areas of Research**

Thermal energy storage and upgrading

**Knowledge and skills required in applicant:**

The project is open for applicants from Mechanical Engineering, Chemical Engineering, Physical sciences, Material Sciences or Chemistry background. The applicant should show the willingness to gain new skills in relation material formulation and characterisation. The applicant will submit a research proposal to demonstrate their ability to carry out outstanding research and plan efficiently in order to achieve the aim of the project

**Project Summary**.

Thermal energy storages (TES) can be used in a wide range of applications including space heating & cooling and industrial processes. Heat storage provides heat load shifting capability by decoupling the heat supply and demand. It smoothes the peak demand for heating, utilises the intermittency of renewable energy resources (e.g. solar thermal, geothermal and PV driven electric heaters), maintains the operation of smaller heating equipment at peak efficiency conditions (e.g. electric heat pumps and micro combined heat and power systems) and transports surplus thermal energy for later use to promote the concepts of heat sharing networks. Sorption-based TES, a subcategory of thermochemical TES, is the next-generation technology that provides the highest possible storage density compared to the other alternative technologies. However, the poor thermal performance of the existing working substances bottlenecks the development of effective systems. The vision of this project is to progress beyond the state-of-the-art research and filling the knowledge gaps in order to achieve a paradigm shift in the field of sorption heat storing.

The aim of the project is to develop new materials and component designs to overcome the heat and mass transfer limitations, thereby, miniaturise and accelerate the rate of heat charging / discharging in sorption-based

heat storage. The research to be undertaken will require material selection & development, formulation of new composite sorbents by utilising carbon-based hosting structures and ionic liquids, detailed material characterisation, develop a tool to optimise the composites formulation and empirical modelling of the developed materials. A numerical modelling at component level will be carried out and coupled with the experimental results to enable designing effective sorption reactors. The project will focus on low-temperature heat storage (150-50 oC). State-of-the-art laboratory facilities for characterisation of material thermal and sorption properties and rapid prototyping are available to accomplish this work at Aston University.

**2020/21-014 - The Optical ID key**

**Supervisor:** Dr David Benton (Engineering and Physical Sciences College/ Aston Institute of Photonics Technology (AIPT))
**Assoc Supervisor:** Prof Kate Sugden (Engineering and Physical Sciences College/Department of Mechanical Engineering & Design (MBD) / Aston Institute of Photonics Technology (AIPT))

**Areas of Research**
Low power secure optical communication
**Knowledge and skills required in applicant:**
Physics or Electronics
**Project Summary**.
This proposal is to demonstrate the next generation of contactless communication using optical rather that RF communication, demonstrating much stronger security and faster communication rates. Contactless connections – so-called near field communications - are now pervasive in society for ID and payment. They use passive responders that draw energy from a stimulating RF field and rely on close proximity to provide security. But the RF technology is a broadcast technology that has a much longer range than people imagine and the security and privacy weaknesses are not common knowledge. For example car keys have a broadcast range of 10s of metres and can have their codes detected and copied compromising the security. An optical system can offer security due to its line of sight requirements – overcoming the security weakness of broadcasting and can deliver much faster data rates.
This project will develop an all-optical close communications system to enhance security, helping to protect personal information and property. Making use of low power electronics and energy harvesting this project will develop and demonstrate secure optical ID for applications such as financial transactions, access control, the IoT and peer to peer communication.

**2020/21-015 - Techno-economic and socio-economic feasibility of bioenergy systems**

**Supervisor:** Dr Mirjam Röder (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI), Supergen)
**Assoc Supervisor:** Dr Katie Chong (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI), Supergen)

**Areas of Research**
Bioenergy
**Knowledge and skills required in applicant:**
Techno-economics with an understanding of wider economic and socio-economic impacts
Background in climate change and understanding of renewable energy sector (preferably bioenergy)
Understanding of emission trading and carbon price schemes
Strong numerical skills, strong window office skills, in particular excel
Interest and initiative learning new analytical/programming skills, e.g. MatLab, Python
**Project Summary**.
Sustainable bioenergy systems play an important role in the transformation to a low-carbon economy. However, within the context of renewable energy, other technologies such as wind and solar are currently much more cost-effective than bioenergy applications. While this is a valid argument in terms of directly related energy

generation cost and energy distribution, none of the other renewable energy technologies can offer the utilisation opportunities in terms of feedstock and energy vector choices or the wider system benefits such as carbon sequestration, waste management, eco-system services, biomaterial/bioproducts as bioenergy does. This work will directly link to the Supergen Bioenergy Hub research activities and build upon findings from the four different topic groups (resources, pre-treatment/conversion, vectors and systems). The results will provide scientific evidence on the current and future cost and benefits of bioenergy pathways and therefore directly inform UK industry and policymaking.

This PhD project will focus on the techno-economic and socio-economic assessment of a suite of bioenergy case studies that have been identified by the Supergen Bioenergy Hub as part of the UK-s net-zero climate change target. This will allow evaluation of the costs and benefits of the Hubs case studies and their interaction within the wider energy sector and other relevant sectors, such as agriculture, forestry, waste management. Additionally, the PhD will analyse the socio-economic feasibility beyond the "cost of ownership" by including the cost of climate change and energy security, environmental and social cost and benefits and consider the relevance of policy and regulatory frameworks.

**2020/21-016 - Human visual perception with helical wave fronts and various optical states**

**Supervisor:** Dr Greg Swadener (Engineering and Physical Sciences College/ Department of Mechanical, Biomedical and Design)

**Assoc Supervisors:** Prof Igor Meglinski (Engineering and Physical Sciences College/ Department of Mechanical, Biomedical and Design); Professor Stephen Anderson (College of Health & Life Sciences / Centre for Vision and Hearing Research / Optometry & Vision Science Research Group); Professor Gary Misson (South Warwickshire NHS Foundation Trust, College of Health & Life Sciences / Centre for Vision and Hearing Research / Optometry & Vision Science Research Group)

**Areas of Research**

Current clinical imaging/diagnostic modalities are only sensitive to the presence of ocular disease after retinal damage has occurred. Orbital angular momentum (OAM), manifested by a helical wave front of light, has emerged as a new degree of freedom of light, and has a great potential to be used for diagnosis, and in particular for evaluation of macular function, as a new marker of the disease and/or disease progression. Nevertheless, despite multiple recent technological advances in the area, the light with OAM has not been implemented to assess human visual perception. The current project, for the first time to our knowledge, brings the complex light with helical wave front/OAM to visual science.

**Knowledge and skills required in applicant:**

Ophthalmology/Optometry, laser light, polarization, light-matter interaction, basic experimental skills, basic knowledge of Matlab, programming skills

**Project Summary**.

*The ultimate aim of the proposal* is the exploration of the fundamentals of interaction of OAM with both static and dynamic nano-scaled inclusions in tissue-like scattering medium, and the immediate technology transfer to the current clinical practice of functional characterization of macular structure.

*The overall goal of the project* is to investigate human visual perception of structured light with helical wave fronts and explore their applicability for detecting central visual field dysfunctions, including age-related macular degeneration and diabetic retinopathy, in routine clinical practice.

Biomedical applications of complex structured light with helical wave front/OAM have not been explored in any detail so far. Background theoretical and experimental studies on sensitivity of structured light with OAM to the small alterations in biotissues do not exist. Therefore, the project represents a major breakthrough, one that will define new physical phenomena, such as interaction of OAM/helical wave front with biological tissues, to detect small static and dynamic alterations of their optical and structural properties, which serve as the actual markers of certain dysfunctions. The techniques could provide a basis for the rapid, objective and accurate assessment of macular function in health and disease.

The imaging approach developed promises to be highly targeted and may revolutionise clinical diagnosis of visual dysfunction in common and dangerous macular diseases (such as including age-related macular degeneration and diabetic retinopathy), with sensitivity far beyond the standard limitations and resolution currently achievable in clinical practice. The project will be linked with clinicians from South Warwickshire NHS Foundation Trust.

**2020/21-017 - Mid infrared fibre laser and device technologies for biomedical sensing and imaging**

**Supervisor:** Dr Kaiming Zhou (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT) / Department of Electrical and Electronic Engineering)
**Assoc Supervisors:** Dr Laura Leslie (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design); Prof Sergei Turitsyn (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT) / Department of Electrical and Electronic Engineering)

**Areas of Research**
Engineering and health
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree in physics, electronic engineering or an MSc in a subject related to optics, photonics, or other relevant subjects. Preferred skill requirements include knowledge/experience of fibre optics and lasers.
We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to EAS, and we pride ourselves on our vibrant, friendly and supportive working environment and family atmosphere
**Project Summary**.
Emerging Mid Infrared (Mid-IR) microscopy provides rich chemical and structural information about biological samples, including viruses, without staining. Sensing and hyperspectral imaging in Mid-IR also have great prospects for medical analysis like screening of cancer cells. These technologies take advantages of identification of many important biomolecules, such as proteins, lipids, and amides, using their strong fundamental finger print absorptions in the Mid-IR region. A device enabling this variety of practical applications is a Mid-IR laser. However, currently available Mid-IR lasers are either cumbersome or operate in a narrow spectral range limiting the applications only to certain analytes. This PhD student project is to develop a Mid-IR fibre laser that will feature portability, high beam quality, excellent spectral purity and wide wavelength tuneability and to exploit this laser for bio-medical applications.
The student will be educated through three key research objectives:
(i) Development of microfabrication technology for Mid-IR photonic devices such as fibre grating using the ultrafast laser inscription, tackling the inscription challenges in Mid-IR fibres and materials.
(ii) Development of novel Mid-IR fibre laser with long operational wavelength, wide spectral coverage and capability for fast measurement .
(iii) Application of the developed laser for sensing of bio-materials and hyperspectral imaging of bio-samples, with a focus on biomedical applications.
The success of the research project and training will be ensured by:

(i) supportive environment of the two research institutes with the state-of-the-art facilities available for this cutting-edge research (including the ultrafast laser microfabrication system, the Mid-IR characterisation set-up, the Particle Image Velocimetry and many others); (ii) general technical support from the institutes' experienced staff with expertise in laser technology, Mid-IR techniques and biomedical sensing and imaging, and (iii) dedicated support from two co-supervisors and senior mentor with complementary skills, including fabrication of photonic devices, fundamental theoretical modelling and biomedical applications

**2020/21-018 - Developing an implantable infection biosensor for long term implant monitoring**

**Supervisor:** Dr Sarah Junaid (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)
**Assoc Supervisor:** Dr Anisa Mahomed (Engineering and Physical Sciences College / Chemical Engineering & Applied Chemistry)

**Areas of Research**
Healthcare & Biomedical engineering
**Knowledge and skills required in applicant:**
Materials science
Mechanical engineering
**Project Summary**.
Infection is a serious challenge in the field of orthopaedic surgery. These infections not only increase the risk of revision surgery but also lead to an economic burden on patients and risk of antimicrobial resistance (AMR). Currently, the diagnostic techniques that are applied to detect and study implant-associated infection (septic loosening) involve radiographic analysis, pathological assessment, and various blood culture tests. However, the result from these techniques are often not accurate, not timely and are unable to detect the infection at an early stage.
Therefore, in this doctoral study, our aim is to develop an implantable sensor, which can detect early signs of infection around the implant. In a preliminary seedcorn-funded study, a biocompatible material was synthesised that can respond to change in its surrounding and a standard operating procedure (SOP) has been established. This doctoral study will build on this work by refining the biomaterial formulation and embed a sensor that has been previously developed to detect motion without the need for radiographic imaging. The aim is to develop a system that can remotely detect infection development in real time, allowing for immediate and timely intervention without the need for X ray exposure.

**2020/21-019 - Development of a Systems Approach for Freight Interchange Design**

**Supervisor:** Dr Marin Marinov (Engineering and Physical Sciences College/ Engineering, Systems and Supply Chain Management (ESSCM) / Aston Institute of Urban Technology and the Environment (ASTUTE)
**Assoc Supervisor:** Dr Edward Sweeney (Engineering and Physical Sciences College/ Engineering, Systems and Supply Chain Management (ESSCM) / Aston Institute of Urban Technology and the Environment (ASTUTE)

**Areas of Research**
Freight Transport; Logistics; Urban freight; Rail Freight; Rail systems engineering and management; Operations management and systems design; Computing and transport modelling
**Knowledge and skills required in applicant:**
This project will employ "Road Mapping" to develop a multi-disciplinary research encompassing knowledge from transport engineering, logistics, systems design, mathematical modelling, simulation, computing, and evaluation of new technology.
The successful applicant should have a first class or upper second class honours degree or equivalent qualification in [Engineering Management, Transport Management and Systems Engineering Design, Supply Chain Management, Logistics, Computing].
Preferred skill requirements include knowledge/experience of [Transport Systems, Freight Service Design, Modelling, Capacity Management, Logistics and Supply Chain; Industrial Engineering; Urban Freight, Transport Planning, Systems Design; Transport Networks and Intermodal; Engineering Management; Operations Research and Information Management; Mathematics and Computer Science].
**Project Summary**.
Modern logistics has been exploring alternative intermodal concepts to improve the performance of freight networks around the world. At the heart of the freight network lies the freight interchange. A freight interchange

can be defined as a multi-purpose transhipment facility that links different transport modes and makes it possible for goods to be transferred from one transport mode to another.
Freight interchanges are vital for the quality of the entire service. They are complex facilities that include many static and dynamic resources. They process a huge amount of data on a daily basis and handle many clients with different needs. Freight interchanges are seen as a non-revenue component in the freight network. As a result, many have argued that this is unsustainable and impractical, and that they should be removed from the system. However, the criticality of freight interchanges to the functioning of the overall logistics network means that they cannot be easily removed. In this context, a feasible alternative is that they should be redesigned to meet the evolving needs of the freight market.
The scholarly literature on the matter is not mature enough to provide meaningful guidance in this regard. Much of what is available is somewhat dated and does not consider digital applications or artificial intelligence. It focusses primarily on layout reconfigurations without considering thoroughly the dynamic component of the ecosystem.
The overall aim of this project is to develop a better understanding of the factors and design parameters for the next generation freight interchange. The specific objectives of this PhD project are:

- to develop a systems approach for next generation freight interchanges;
- to identify design parameters for the next generation freight interchanges as part of a wider user-centric ecosystem;
- to formulate a thorough methodology that will lead to the elaboration of a sustainable freight service network.

**2020/21-020 - Creating novel testing technologies for patient specific fracture fixation devices**

**Supervisor:** Dr Laura Leslie (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design).
**Assoc Supervisors:** Dr Sarah Junaid (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design); Dr Greg Swadener (Engineering and Physical Sciences College/ Department of Mechanical, Biomedical and Design)

**Areas of Research**
Healthcare and medical engineering, materials science, Biomedical engineering, mechanical engineering
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree in mechanical engineering, materials science, biomedical engineering or a related subject. Preferred skill requirements include knowledge/experience of mechanical testing of biomaterials.
We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to EAS, and we pride ourselves on our vibrant, friendly and supportive working environment.
**Project Summary**.
Osteoporosis affects 1 in 2 women and 1 in 5 men over the age of 50 causing 500,000 fragility fractures per annum with an economic burden of just under £3.5 billion (UK figures). Many of these fractures are fixed using fracture fixation devices i.e. plates and screws, however, re-fracture and reduced healing may occur.
There are new fracture fixation materials such as Carbon Fibre Reinforced Polyetheretherketone (CFR-PEEK) being used. These non-rigid materials can be manufactured to specific requirements e.g. tailored anisotropic strength and stiffness, providing potential for patient specific implants. However, currently only basic test methodologies and standard plate configurations and materials are available, therefore the healthcare system faces the limitation of fixation plates which are unsuitable for osteoporotic patients and no standard biomechanically relevant test methods to develop and compare new materials and designs.
The aim of this project is to deliver a new technology platform to evaluate mechanical integration of patient-specific internal fracture fixation plates comprising novel biomaterials. This will meet an urgent clinical need and advance non-animal technologies for health.
There are three Research Objectives in this project:

1. Establish novel and robust mechanical test methodologies to allow for the effective biomechanical, fatigue and wear analysis of internal fracture fixation devices.
2. Use these novel methodologies to evaluate and validate the process in standard fracture fixation devices.
3. Use these novel methodologies to evaluate the use of new material configurations for bespoke patient specific fracture fixation plates in the treatment of fragility fractures.

This project will run in collaboration with both industrial and clinical partners, providing support and advice, as well as a deeper understanding of the user requirements behind these innovative ideas.

**2020/21-021 - Nuclear biorefinery: Novel routes for the production of fuels and chemicals using wastes**

**Supervisor:** Dr Vesna Najdanovic (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI) )
**Assoc Supervisor:** Prof Patricia Thornley (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI))

**Areas of Research**
Chemical Engineering; Organic Chemistry; Green Chemistry; Sustainable chemical engineering; Radiolysis
**Knowledge and skills required in applicant:**
Applicant should have a degree in Engineering, Chemistry, Materials Science, Physics or a related discipline. The applicant should demonstrate excellent oral and written communication skills with the ability to prepare presentations, reports and journal papers as well as excellent interpersonal skills to work effectively in a multi-disciplinary environment.
**Project Summary**.
This studentship project will develop a novel radiochemical process to convert abundant and low-cost biomass-derived feedstock into high-value chemicals. This novel and green concept of a nuclear biorefinery will couple two otherwise wasted resources: radiation from nuclear plants and waste biomass.
As an exemplar system, the project will be focused on the production of high-value chemicals from glycerol, an emerging waste from biodiesel production. In Europe alone, a surplus of 1.4 million tonnes of glycerol is produced per year which cannot be used by other industries. This is expected to triple by 2030 to achieve the Sustainable Development Scenario. Finding new ways to use glycerol is important to ensure the holistic sustainability of global biodiesel production and to improve the economic competitiveness of nuclear energy production which is a major driver of the UK's nuclear innovation & research strategy.
You will benefit from training in the complementary disciplines of sustainable chemistry and chemical engineering and you will learn how to prepare biomass-derived feedstock and use a combination of nuclear energy sources for their conversion into useful fuels and chemicals. You will also measure the reaction kinetics and selectivity using various analytical methods (FTIR, MS, HPLC, GC) for analysis of the liquid and gaseous products which will allow to reveal reaction mechanisms and optimise process conditions for good yields. In the final stage, the project will focus on data analysis and assessment of sustainability and profitability.
In addition to regular hands-on support by Aston supervisors, you will be supported by external advisers from Lancaster University (UK) and Jožef Stefan Institute (Slovenia). Thus, knowledge exchange and dissemination will be an integral element of this collaboration which will provide opportunities for networking within the other ongoing bioenergy and nuclear engineering related research.

**2020/21-022 - A new way of thinking about bioenergy production from anaerobic digestion**

**Supervisor:** Dr Alfred Fernandez-Castane (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))

**Assoc Supervisors:** Dr Paula Blanco-Sanchez (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC)); Dr Vesna Najdanovic (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI) )
(Engineering and Physical Sciences College /); **Mr Eric Dauleu (**Edenviro Ltd)

**Areas of Research**
Bioenergy, Environmental Biotechnology, Bioprocess Development, Anaerobic Digestion (AD)

**Knowledge and skills required in applicant:**

- The applicants should possess a good honours degree (1st Class or 2:1 minimum) in any of the following disciplines: Environmental Engineering, Chemical Engineering and Biochemical Engineering and should have a strong interest in devising engineering solutions to environmental problems.
- Experience in working in a laboratory environment, intermediate use of Microsoft Office and use of statistical analysis tools.
- Knowledge of aseptic techniques, handling microorganisms and separation techniques.
- Knowledge in AD, fermentation technology or thermal processing is an asset.
- Good communication skills and motivation to work individually and as part of a team.
- The student will be required to work closely with the industrial partner, visit AD sites and potentially spending time for a 3-month secondment.

**Project Summary**.
Anaerobic digestion (AD) is a nature-inspired technology converting organic waste into biogas that can be used as a fuel, and digestate, a source of nutrients that can be used as a fertilisers or as feedstock for the production of added-value products. Therefore, the implementation of AD enables the development of circular economy solutions to valorise widely available organic waste. Recent advances demonstrate that supplementing AD with metallic nanoparticles enhances biogas formation. However, the use of supplements such as iron oxide nanoparticles requires an additional and energy intensive step which limits its implementation at industrial scale. As an alternative, magnetotactic bacteria (MTB) naturally synthesize iron-rich nanoparticles namely, magnetosomes. MTB are also well known for their capacity to accumulate polyhydroxyalkanoates (PHAs), which can be used in bioplastics packaging or as agricultural nutrients. This project aims to explore the feasibility of using MTB in AD to enhance biogas formation and co-produce PHAs, and will be supported by the industrial partner Edenviro Ltd.
The experimental approach will use a powerful combination of microbial cell culture and single-cell technologies to identify the viability of MTB in AD and its effect on biogas production. Magnetosome purification from pure MTB cultures will be followed by optimising their dosage into AD for improved biogas production. Recovery of PHAs and thermal treatment will be undertaken to further valorise the process.
This project will provide the student with a unique opportunity to contribute towards the development of clean energy and an environmentally sustainable bioeconomy.

## 2020/21-023 - Safer functionalised cellulose composites for environmental and medical applications: design and manufacturing

**Supervisor:** Dr Jiawei Wang (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI))
**Assoc Supervisor:** Dr Boris Kysela (College of Health and Life Sciences / Aston Medical School)

**Areas of Research**
Bioproduct, nanomaterial, process engineering

**Knowledge and skills required in applicant:**
Essential:
A first-class or upper second-class honours degree in chemical engineering or chemistry.
Basic chemistry laboratory skills
Desired:
Knowledge on nanomaterial synthesis and characterisation

Lab experience in surface functionalisation of cellulose

**Project Summary**.

The project is aiming to develop safer functionalised cellulose composites for environmental and medical applications, including water purification and antibacterial action, and design an easy scale-up process for manufacture.

Cellulose is the most abundant and sustainable natural polymer on the planet. It is considered as one of the most well-known renewable, environmentally friendly, and biocompatible materials. Metal nanoparticles, including silver (Ag), copper (Cu), gold (Au), titanium dioxide (TiO2) and copper oxide (CuO), have been successfully functionalised onto cellulose in the last decades. However, the dramatic expansion of the applications of nanomaterials also gives rise to the requirement to investigate the potentially toxic effects of nanoparticles towards the human body. In an ideal situation, nanomaterials should have maximum inhibitory power over bacterial growth with minimum cytotoxicity on normal human cells.

Previous research in the group approved that compounds extracted from natural plants can significantly reduce the cytotoxicity of the nanocomposite while the toxicity towards bacteria still maintained at a high level. In this project, the researcher will design functionalised cellulose composites which are safe for human cells and toxic for bacteria and develop a continuous manufacture process for easy scale-up. The cellular and genome toxicity will be assessed by an established battery of tests used for nanotoxicity testing of clinical nanoconstructs.

**2020/21-024 - BIOPOLY – Single BIOmolecule detection via an ELISA sandwich assay through the realisation of novel optical POLYmer biosensors for a low cost rapid field deployable diagnostic instrument**

**Supervisor:** Dr D Hill (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT))
**Assoc Supervisor:** Prof David Webb (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT)

**Areas of Research**

Optical biosensing

**Knowledge and skills required in applicant:**

*Essential*:

-*Education and qualifications*: BEng or BSc in Electrical and Electronic Engineering, Optical Engineering, Photonics, Physics, or equivalent.

-*Experience* – Practical experience in developing and utilising optical setups, General laboratory skills, data taking and analysis. Aptitude and skills - Creative problem solving skills. Excellent English language communication skills to relay work in spoken and written media. Ability to write reports and contribute to deliverables.

*Desirable*:

- *Education and qualifications:* - Master of Science degree in Electrical and Electronic Engineering, Optical Engineering, Photonics, Physics, or equivalent.

-*Experience* – Experience in COMSOL/RSoft/Lumerical, , LabView, photonics, microfabrication.

Experience of initiating and conducting research up to doctoral level. Experience of writing up/contributing to the write up of reserch for high quality publications. Experience of producing papers, posters, reports presenting at seminars, conferences etc. Experience of positive collaboration within and outside of candidate's immediate research team. Supervising other personnel involved in a project. *Aptitude and skills* - Ability to present data in both a clear and concise manner that is visually appealing. Ability to prepare written communications to a high standard. Ability to develop and maintain a research programme and to publish in high quality publications.

**Project Summary**.

It is proposed to use a novel detection scheme that will actually capitalize on the high thermal sensitivity of polymers, which for many applications is problematic, to eliminate for the first time all of their inherent low-frequency (DC) related noise and drift issues in a polymer waveguide based biosensor. So much so that it will result in three beyond state of the art achievements:

(1) Polymer photonic biosensing - in LoD and selectivity.

(2) Photonic biosensing – in rapid, sensitive and selective detection from small sample volumes at low cost.
(3) Point of Care (PoC) Immunodetection – its six unique selling points (USP) will be equal or better than the state of art in PoC immunodetection, where detection of small number of pathogens (bacteria and viruses) normally requires slow incubation processes, providing an alternative to the Gold Standards of immunochemistry or PCR (Polymerase chain reaction).
The project has three principle objectives.
*Prime objective (1):* Develop the first ever polymer waveguide based biosensor with a low limit of detection (LoD), for few, and potentially single small particle (e.g. peptides, proteins, antibodies and hormones) detection, using a highly promising and novel concept.
*Secondary objective (2):* Demonstrate beyond state of art photonic biosensing for the Unique Selling Points of portability/field deployable-ness, cost, sensitivity, selectivity, time to result and multiplexing. These are enabled due to both the sensing mechanism itself and because it enables the use of polymer photonic structures and therefore a low cost visible light reader and low cost/large area Lab on Chip cartridges/chips with a very large effective sensing area and thus single particle detection via a sandwich assay.
*Prime objective (2):* Provide the student with the multidisciplinary technical and complementary skills (managerial, entrepreneurial, communications) she/he requires for a successful scientific career, in academia or industry.

**2020/21-025 - Developing the Liquid Phase Pyrolysis (LPP) process for chemical recycling of waste plastics**

**Supervisor:** Dr Y Yang (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI))
**Assoc Supervisor:** Dr J Wang (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI))

**Areas of Research**
Thermochemical conversion of plastics
**Knowledge and skills required in applicant:**
Chemical engineering; thermochemical conversion; catalysis; waste processing
**Project Summary**.
More than 8.3 billion tonnes of plastics have been produced in the past 65 years worldwide, but only about 12% was ever incinerated and only 9% was recycled. Waste plastics are usually mixed and cannot be fully recycled by conventional mechanical recycling methods. Every year, over 260 million tonnes of unrecycled waste plastics in the world are disposed of by uncontrolled landfill and irresponsible dumping. The mismanaged wastes have resulted in tremendous damage to our ecosystem and polluted every corner of the earth in the form of soil contaminants and marine debris and food chain accumulates through the terrestrial and aquatic environments. While it is urgent to remove the pollutions from the environment, it is equally critical to develop new processing technologies that can effectively convert the unrecyclable plastics back to their monomers for new plastic product synthesis to realise the circular economy around the plastic industry.
This research project aims to develop a step-change Liquid Phase Pyrolysis (LPP) process that can directly convert the waste plastics into hydrogen, ethylene and propylene gases. The target waste plastic feedstock not only covers the typical materials (PE and PP), but also include the very difficult halogen containing plastics (PVC and WEEE), which can generate a range of halogenated persistent organic pollutants (POPs) under thermal processing. The key feature of the LPP process is the application of the molten salts system as a tri-functional processing medium to achieve an effective and complete conversion process.
The research will tackle the fundamental challenges that currently impedes the development of thermal conversion of mixed waste plastics. It will develop new knowledge and an advanced circular approach to promote the sustainable recycling of waste plastics.

**2020/21-026 - Electro-synthesis of metal-organic framework (MOF) based energy storage devices**

**Supervisor:** Dr Stephen Worrall (Engineering and Physical Sciences College / Chemical Eng & Applied Chemistry (CEAC))
**Assoc Supervisor:** Dr Vesna Najdanovic (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI) )

**Areas of Research**
Nanomaterials, energy storage and pollutant capture
**Knowledge and skills required in applicant:**
A good background knowledge in Chemistry/Materials Science, as evidenced by a Bachelor's or Master's degree (at a minimum of Upper Second class honours) in a relevant subject. Knowledge of inorganic materials and electrochemistry particularly desirable. Basic skills in synthetic and analytical chemistry required.
**Project Summary**.
environment. Renewable sources are playing a growing role in electricity generation, with 20% growth predicted in the next three years, however compared to fossil fuels they are intermittent. As times of peak generation do not coincide with peak demand the ability to store this renewably generated energy in a way that can be released on demand is absolutely essential.

Supercapacitors are a type of device that can rapidly release their stored energy, with the amount of energy stored being proportional to the surface area of their electrically conductive active material. Metal-organic frameworks (MOFs) are a type of highly modifiable, porous nanomaterial with incredibly high surface areas that would make attractive active materials; however they are usually electrical insulators. Promising recent research has shown that it is possible to make MOFs that are electrically conductive, but this work is still in its infancy. Additionally, MOFs have shown great promise for the adsorption and degradation of water borne pollutants, meaning that these materials could be a "swiss army knife" in our fight for a cleaner, greener world.
In this project:
1) Novel MOF materials with superior electrical conductivity will be synthesised using electrochemical techniques.
2) Different electrochemical techniques will be investigated to create superior coatings, in terms of chemical and operational stability, for use in devices.
3) Utilising the materials obtained from the first objective and the knowledge gained from the second, devices for charge storage and pollutant capture/degradation will be fabricated.
4) The performance of the devices (e.g. charge storage capacity, operational stability, rate of pollutant capture/degradation) will be assessed and compared to the best performing devices in the literature.

**2020/21-027 - Waste not, want not** – the real cost and environmental impact of UK waste

**Supervisor:** Dr Katie Chong (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI), Supergen)
**Assoc Supervisor:** Prof Patricia Thornley (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI))

**Areas of Research**
Bioenergy, climate change, waste, sustainability
**Knowledge and skills required in applicant:**
Degree in Chemical Engineering - Potential for other disciplines if proof of a strong understanding of above science and interdisciplinary knowledge base is given.
Strong numerical skills, strong Microsoft Office skills, in particular, Excel.
Interest and initiative for learning new analytical/programming skills, e.g. MatLab, Python.

Background in the waste sector and/ or climate change and understanding of renewable energy sector (preferably bioenergy) is preferred but not essential.
Interest in working in an interdisciplinary environment and engagement with stakeholders outside academia.

**Project Summary**.

Waste management is a global issue, which is closely linked to climate change and the circular economy. The current models for waste management, such as the waste minimisation hierarchy, no longer fit the global situation as we push for a sustainable future. Current metrics are inadequate to measure and describe the actual techno-economic- environmental impact of energy, products or disposal of waste.
The project aims to review the UK waste sector and circular economy in order to develop end of life processing options for UK waste streams. The results will provide stakeholders with techno-economic-environmental information about waste processing, as well as recommendations for an updated waste management strategy.
This project will involve developing end-of-life processing options for UK waste streams to guide policymakers, researchers and industry on where intervention may be needed to support the environmentally preferable alternatives. As part of this work, appropriate circular economy and waste management metrics will be defined to update the waste management hierarchy.
Tasks in this project may include:

- Review of the UK waste sector and circular economy with key stakeholders
- Life cycle assessment (LCA) of processing options
- Techno-economic assessment (TEA) of process options
- Combining LCA and TEA to evaluate the whole system against a set of metrics.
- Consider the most appropriate metrics to develop sustainable waste management guidelines and whether this is consistent with circular economy aspirations

## 2020/21-028 - Algae-based biorefinery routes to obtain high-value fuels and chemicals

**Supervisor:** Dr Paula Blanco-Sanchez (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))
**Assoc Supervisor:** Dr Marta Granollers Mesa (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))

**Areas of Research**

Bioenergy, Bioproducts, Biomass, Algae, Biofuels, Biochemicals, Biorefinery

**Knowledge and skills required in applicant:**

The successful applicant should have a first class or upper second class honours degree or equivalent qualification in Chemical Engineering or a closely related area.
Preferred skill requirements include knowledge/hands-on-experience of thermochemical processing of biomass and biomass model compounds, acid hydrolysis, catalytic process design and characterisation, bio-fuels, bio-chemicals, and biorefineries

**Project Summary**.

The increasing demand for fuels and chemicals derived from crude oil has accelerated dangerously the emissions of greenhouse gases (GHG) and increased the dependence on the existing fossil oil reserves. Thus, exploring alternative bio-renewable feedstocks and process routes for current and future demands of fuels and chemicals is crucial. However, the key to switch and transition to a new feedstock is to prove its sustainability.
The algae biorefinery concept represents the transformation of algae, a renewable biomass feedstock, through sustainable processing routes to obtain biofuels and value-added chemical products. Whilst research has demonstrated that algae biorefinery is technically feasible, to optimise the whole algae-based biorefinery concept, it is required the development of environmentally friendly pre-treatments and well-integrated upgrading and product separation processes.
This PhD programme aims at developing a sustainable and optimised route to convert algae feedstock into high-value fuels and chemicals, by combining diverse experimental and analytic techniques.
To achieve this, it will:

- Develop novel and green pre-treatments to improve algae properties from different cultivation approaches
- Identify the potential to obtain high-value fuels and chemicals from thermochemical conversion of algae
- Develop methodologies focused on the upgrading and separation of high-value products
- Identify the most relevant end-user sectors (cosmetics, pharmaceuticals, transportation, energy sector, construction, etc.) based on final product yields and properties.

This project is part of ongoing collaboration with the Scottish Association for Marine Science, Plymouth University (@PlymouthMarine), and the Biology Institute of the Mexican Autonomous University of Mexico (UNAM). The student will have the opportunity to manipulate a wide-range of experimental and analytic techniques, and gain soft-skills by attending to relevant National (UK) and International Conferences. There will be engagement opportunities by joining relevant Hubs such as Supergen Hub, Algae-UK, etc.

**2020/21-029 - Theory and numerical simulation of optical frequency comb generation in nonlinear resonators**

**Supervisor:** Dr. Auro M. Perego (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT))
**Assoc Supervisor:** TBC

**Areas of Research**
Engineering, Photonics
**Knowledge and skills required in applicant:**
The successful applicant should have been awarded, or expect to achieve, a Masters degree in a relevant subject preferably with a 60% or higher weighted average, and/or a First or Upper Second Class Honours degree (or an equivalent qualification from an overseas institution) in Physics or Electronic Engineering (or a subject related to laser physics and fibre optics). Preferred skill requirements include knowledge of fundamentals of laser physics and experience in numerical modelling of lasers/optical fibres/optical resonators.
We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to EPS, and we pride ourselves on our vibrant, friendly and supportive working environment and family atmosphere.
**Project Summary**.
The successful applicant will work under the supervision of Dr. Perego, in the context of his Royal Academy of Engineering (RAEng) Research Fellowship Project "Novel tuneable dissipative optical frequency combs: from visible to mid-infrared". The research topic developed in this project is at the forefront of research in nonlinear photonics and focuses on engineering novel methods for optical frequency comb generation in nonlinear optical resonators.
Optical frequency combs are ultraprecise optical rulers that find applications across a vast spectrum of technologies including high precision metrology, distance ranging, molecular fingerprinting and sensing, and optical communications.
This project, focuses on developing new techniques for achieving tuneability of the comb repetition rate in optical resonators, in order to guarantee a better versatility of the source and increased measurement precision. Developing novel methods for exploitation of dissipative intracavity effects - especially optical filtering - and engineering parametric gain (modulation instability of the pump field) in optical cavities, are among the crucial scientific and technical challenges that will be tackled in this project.
This PhD position will enable the candidate to perform research and getting state-of-the art training in the exciting research field of nonlinear photonics in optical resonators.
The successful candidate will gain expertise in numerical modelling of light propagating in nonlinear fibre- and micro-resonators and will directly collaborate with experimentalists collaborators in guiding experimental setup design and explaining measurements results.

The successful applicant will also have the further opportunity to work under the supervision of Dr. Perego - and in collaboration with other AIPT researchers - on related nonlinear photonics research topics such as parametric amplification, and theory of mode-locking and generation of light pulses in lasers. The successful candidate, where needed, will have the opportunity to participate in broader collaboration with academic and industrial partners both in the UK and in EU.

**2020/21-030 - Polarisation insensitive multiband optical parametric amplifier for opticalcommunications**

**Supervisor:** Prof Nick Doran (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT) )
**Assoc Supervisor:** Dr Vladimir Gordienko (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT) )

**Areas of Research**
Fibre optic parametric amplifiers and related devices for ultra-wide band amplification and optical signal processing of high bitrate WDM signals. Optical amplifiers are the key subsystem enabling the optical communication networks worldwide. The current research in Prof Doran's team puts us as world leaders in a new type of amplifier technology based on fibre optical nonlinearity. This project will address one of the key issues in this technology i.e. polarisation sensitivity and will connect the student with this crucial technology and enable them to make key contributions to the advance of a technology which has the potential to transform communications networks across the globe.
**Knowledge and skills required in applicant:**
A successful applicant will have knowledge of fibre optical communications (e.g. optical wave propagation in fibre, data transmission) and nonlinear fiber optics (e.g. four wave mixing, stimulated scattering). At least basic skills of working in a fibre optical laboratory and using simulation software (e.g. Matlab, Python) are required.
**Project Summary**.
This project will aim to deliver a broadband polarisation-insensitive fibre optic parametric amplifier (FOPA) with the best-to-date signal performance supposedly able to outperform a commercial EDFA in terms of noise figure and an amplified signal bit-error rate. This project will build up on our world-leading polarisation-insensitive FOPA and will focus on eliminating the key source of signal noise: a pump phase modulation required for mitigation of stimulated Brillouin scattering (SBS). A wide range of FOPA configurations, special optical fibres and SBS mitigation approaches will be explored via simulations and experiments to find an optimal solution for a broadband dithering-free FOPA. This development will then be implemented in a polarisation-insensitive configuration to achieve the first-ever dithering-free polarisation-insensitive FOPA. Then, we expect to challenge the unmatched EDFA performance with this world-beating FOPA.

**2020/21-031 - Building Empathy: Designing for International Development**

**Supervisor:** Dr Timothy Whitehead (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)
**Assoc Supervisor: Dr Lyndon Buck** (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)

**Areas of Research**
Design, Design Practice, Design Research
**Knowledge and skills required in applicant:**
We are looking for motivated and engaged individuals who have experience in User centred design, 3D modelling and visualisation, prototyping and model making to work as part of the design team. Applicants should be educated to masters level, or equivalent, in Product Design, Industrial Design, Design Engineering or a similar field.

**Project Summary**.
It is well documented that successful design solutions are a result of a user-centred design process which consists of designers engaging with target markets to elicit novel insights. Typically, this involves established design thinking methods such as; contextualisation, observations and structured interviews which can be translated into in-depth user narratives which designers and engineers can engage with. This process of immersion with user groups is of particular importance when the designer is working in unfamiliar environments.
A growing area of design research is utilising design methods to support international development efforts such as those highlighted within the UN's Sustainable Development Goals. This can include the development of essential products such as water filters, cook stoves or solar lighting, as well as working with local communities to develop new solutions to solve unique problems. During these projects, it is often not possible for all the design and engineering teams to visit the user group and fully engage with users or experience the local context and environment.
However, what hasn't currently been explored, is the wealth of creative and emerging technologies (such as Augmented and Virtual Reality) which could take this process one step further, by helping designers and engineers to understand and empathise with the user and engage with remote ethnography. It could also be used to prepare designers for field work and help them to empathise with the users and understand and contextualise their needs.
Aim: To investigate emerging technology (such as augmented and virtual reality) to support user centred design practice and remote ethnography for the development of products in low income countries.
Objectives:
- Establish current user-centred practice and emerging technologies
- Develop design approaches to remote design ethnography
- Use practice based design research to test and develop the approach
- Validate the use of the technology

**2020/21-032 - Innovative catalysis for the Conversion of alcohols from biomass into aviation fuels**

**Supervisor:** Dr Qingchun Yuan (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))
**Assoc Supervisors:** Prof Tony Bridgwater (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI)); Dr Daniel Jozef Nowakowski (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))

**Areas of Research**
Development of new alternative catalysts from zeolitic imidazolate frameworks (ZIFs) for a new generation catalysis of alcohols (from biomass) to hydrocarbons that can be used as the main body of aviation fuels rather than blending-in components, for sustainable zero-net CO2 emission.
**Knowledge and skills required in applicant:**
1. Good knowledge in organic and structural chemistry, catalysis and reaction engineering
2. Practical skills in effectively designing experiments for synthesis and characterisation of catalysts
3. Confidence in hands-on testing of the catalysts synthesised
4. Logical thinking and writing
5. Good communication skills to effectively communicate with supervisors and colleagues, and for dissemination of results
6. Ability to work independently and as part of a team

**Project Summary**.
This project aims to develop novel catalysts to convert alcohols from biomass by fermentation of synthesis into hydrocarbons that have the desired carbon distributions to meet aviation fuel requirements. The novel catalyst will be developed from ZIFs rather than the well-known ZSM-5 to enable the formation of larger branched and cyclic hydrocarbon molecules which peak at C12 rather than those catalysed by ZSM-5 which peak at C9.

ZIFs are composed of tetrahedrally-coordinated transition metal ions (e.g. Fe, Co, Zn, Mg) and bridged by imidazolates. Their similar structural features to that of zeolites, adjustable pore size, shape and metal site environments make ZIFs chemically and thermally highly stable, suitable and attractive to be developed as catalysts. So far, ZIFs have not been investigated for the catalysis of alcohols to hydrocarbons.
Aviation fuels are rich in branched and cyclic hydrocarbons with carbon numbers in the range of C8-16 for Jet A fuels or C5-15 for Jet B fuels. Conventional jet fuels are derived from crude oil. In recent years bio-aviation fuels have been derived from vegetable oils by hydrotreating and have been successfully blended into conventional Jet fuels to reduce the net CO2 emissions of the aviation industry. Ethanol has been massively produced from agriculture and municipal solid wastes without competing with food production both by biological processing and thermal process with synthesis.
The research work will include
1) selecting suitable ZIFs from more than 105 candidates. The desired ZIFs need to have effective pore sizes and bottlenecks larger than that of ZSM-5.
2) Selection of ZIFs to be synthesised and modified as catalysts.
3) The catalysts will be tested for their performance in ethanol and other alcohols dehydration and shape selective oligomerisation to form branched and cyclic hydrocarbons,
4) Optimisation of the carbon chain growth processes to produce carbon chain lengths most suitable for reining into aviation fuels.
The outcome will be a new class of catalysts specially designed to deliver aviation fuel standard hydrocarbons for direct blending and/or replacement of fossil fuel derived fuels. The results will form the basis of a new proposal to EBSRC for a responsive mode application.

**2020/21-033 - Next Generation Medical Skin Dressings**

**Supervisor:** **Prof Paul D Topham** (Engineering and Physical Sciences College /Materials Research, Chemical Eng & Applied Chemistry)
**Assoc Supervisor:** **Dr Anisa Mahomed** (Engineering and Physical Sciences College / Chemical Engineering & Applied Chemistry)

**Areas of Research**
Biomaterials; Polymers
**Knowledge and skills required in applicant:**
MSc/ MEng preferred; Understanding of polymers and materials; Ability to plan and undertake lab work unsupervised; Quick starter and self-learner;
**Project Summary**.
Chronic wounds are wounds that fail to progress through the healing phases and show no significant progress towards healing in a timely manner. The prevalence of these is growing at a rate of 12% per year in the UK alone and this exerts an increased economic burden on the NHS. A stoma, is an opening in the abdomen that connects to an ostomy bag for collection of body waste in a controlled manner. It has a lot in common with that of a chronic wound.
Both chronic wounds and stomas are managed through the use of medical wound dressings and ostomy adhesives. Wound dressings cover and protect a wound. They also stimulate healing. Ostomy adhesives enable the attachment of an ostomy bag to the stoma. To function as intended, both products must as a minimum be:
i) easily mouldable to the body site whilst remaining securely attached to skin,
ii) absorb wound fluid or effluent without adversely affecting the adhesion to skin and remain intact during wear,
iii) be easily removed and replaced at a relatively frequent interval without leaving residue on skin.
Current medical skin adhesives have improved the quality of a patient's life, however, they can cause unnecessary trauma to the skin that surrounds the wound or stroma. This exciting project will, in particular, use cutting edge polymer science principles to develop and design effective ecological and cost-effective alternative medical skin adhesives that balance strong adhesion with ease of removal.
Key objectives of this project are to:

a) identify suitable ecological polymer adhesive and process handling aids (protective layers) alternatives to develop an ecological adhesive that meet the criteria above,
b) optimise the polymer synthesis process as well as stability during processing,
c) develop suitable lab fabrication processes to inform scale-up to mass manufacture of the medical dressings.

**2020/21-034 - Tractable sparse representation of 3D images**

**Supervisors:** Dr Laura Rebollo-Neira (Engineering and Physical Sciences College / Mathematics Department);
**Assoc Supervisor:** Dr Yordan Raykov (Engineering and Physical Sciences College / Mathematics)

**Areas of Research**
Applied Mathematics
**Knowledge and skills required in applicant:**
Essential: Strong background in Linear Mathematics and Probability. An interest in developing advanced computational and programming skills. Knowledge in machine learning would be an advantage.
**Project Summary**.
At the core of the Artificial Intelligence (AI) revolution, we are currently experiencing, has been the discovered capability to represent huge amounts of complex high dimensional data with simple to analyse features that capture the essence of the objects these data represent. The more efficient lower-dimensional representation of the data space allows us to process vast amount of information and learn knowledge in different levels of abstraction, identify relationships which otherwise we did not anticipate and push the frontiers of science across many domains.
In the area of image processing lower dimensional representations are achieved, at high quality, by means of sparse representation techniques. Sparse representation of 3D arrays, such as medical and hyper-spectral images benefits from 3D approximation due to the correlated nature of the 2D channels [1]. The fundamental challenge in extending these techniques to health-care and consumer applications [2] is to reduce their computational cost. The central aim of the PhD project is to achieve the tractability of sparse 3D representation techniques and make them suitable for 3D image analysis.
The prospective candidate will join an interdisciplinary team and develop scalable algorithms, based on tensor decomposition, to accelerate the training of latent feature models [3] for 3D arrays. He/she will develop advanced mathematical and computational skills and gain expertise in state-of-the-art machine learning and deep leaning methodologies.
[1] Rebollo-Neira L, Whitehouse D., 2019, ``Sparse representation of 3D images for piecewise dimensionality reduction with high-quality reconstruction'', Array, https://doi.org/10.1016/j.array.2019.100001
[2] Schork, N.J., 2015. Personalized medicine: time for one-person trials. Nature, 520(7549), pp.609-611.
[3] Farooq, A., Raykov, Y.P., Raykov, P. and Little, M.A., 2020. Latent feature sharing: an adaptive approach to linear decomposition models. arXiv preprint arXiv:2006.12369.

**2020/21-035 - Optimal capacity modelling of integrated technology, manufacturing and supply chain lifecycles for resilience under conditions of uncertainty.**

**Supervisor:** Dr Brian Price (Engineering and Physical Sciences College / Department of Engineering Systems and Supply Chain management)
**Assoc Supervisor:** Dr Muhammad Azmat (Engineering and Physical Sciences College / Department of Engineering Systems and Supply Chain management)

**Areas of Research**
Optimizing the utilization of resources/investments in an engineering enterprise through robust capacity planning for uncertain future conditions.
**Knowledge and skills required in applicant:**

A Bachelor in engineering/product development at 2.1 or above. A Masters in engineering / production / management at Merit or above. Excellent Quantitative and Qualitative methodology skills, including simulation and modelling. Prior experience of academic research and/or relevant industrial lifecycle analysis desirable. Excellent (IELTS 7 or C1) English Language Skills.

**Project Summary**.

The pace of change in technologies, manufacturing processes and supply chain configurations is increasing, leading to reduced lifecycles. Capital intensive facilities, processes and systems require an extended life to justify their return on investment. These pressures are in direct conflict and can lead to solutions that are mutually exclusive. There is a recognised need to align the investment lifecycles for the three dimensions of bringing technology to market and supporting it through its useful life and eventual disposal (3D Concurrent Engineering - 3DCE).

The capacity of the 3DCE systems, including the capital plant and equipment that supports them, needs to be adaptable to future unknown requirements, with minimal write-off. Development of a robust/resilient capacity strategy under Red Queen conditions will allow optimal return on investment while keeping product/service offering relevant to latest conditions.

Biological models of survival and allometric capacity strategies will be used to develop simulations and models to be used by industry to 'satisfice' 3DCE system definition. This has impacts in the areas of:

- Risk management
- System dynamics
- Sustainability and material/capital use optimization
- Resilience

This study will enable the better utilization of assets and resources, leading to greater efficiency and effectiveness of operations. This will enable sustainability agendas through reducing waste and loss in the enterprise. Improving the agility of organizations to adopt latest technologies by reducing adoption barriers will enhance competitiveness.

## 2020/21-036 - Catalytic transfer hydrogenation of bio-based feedstocks to valuable chemicals and fuels

**Supervisor:** Dr Amin Osatiashtiani (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))

**Assoc Supervisor:** Dr Marta Granollers Mesa (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))

**Areas of Research**

Catalysis, Green Chemistry, Biofuels, Bioproducts

**Knowledge and skills required in applicant:**

The successful applicant should have a first class or upper second class honours degree or equivalent qualification in chemical engineering, chemistry, or related fields. Preferred skills include knowledge/experience of catalyst synthesis, characterisation and testing, and good computer literacy

**Project Summary**.

Hydrogenation is one of the most common and important class of reactions in chemical synthesis to transform biomass-derived compounds into high value chemicals and fuels. Hydrogenation is conventionally conducted in the presence of expensive metal catalysts (e.g. Pt and Pd) and high H2 pressure, which from the economic and safety perspective is undesirable. Alternatively, hydrogenation can be performed using liquid hydrogen donors such as renewable alcohols. This so-called “catalytic transfer hydrogenation” (CTH) process can be catalysed by inexpensive metals (e.g. Zn or Ni), allowing hydrogen transfer from the H-donor to the target molecules.

To optimise CTH reactions, it is crucial to understand the transformation steps occurring, and the catalyst properties that procure high yield and selectivity. In this context, this project aims to develop an efficient catalytic process for biomass-derived feedstocks conversion into valuable platform chemicals, which in turn are

used for production of fuels and high-value chemicals. The target is to design a safe and low-cost process using stable, tailor-made and efficient catalysts, easy to synthesise and recover.
The project objectives include:

- Design, synthesis and testing of efficient and inexpensive heterogeneous catalysts for CTH.
- Understanding the reaction mechanism involved in the conversion under CTH conditions.
- Optimisation of catalyst formulation and reaction conditions for the heterogeneous CTH of bio-based feedstocks.

The successful applicant will join an enthusiastic research team at the Energy and Bioproducts Research Institute (EBRI), at Aston University. Working at the Chemical Engineering-Chemistry interface, the successful applicant will gain hand-on experience in advanced analytical tools, including XPS, XRD, SEM, and have the opportunity to attend national and international conferences during their PhD studies. Equipped with knowledge and skills related to heterogeneous catalysis and green chemistry, the PhD graduate will be able to work in various sectors, from catalyst manufacturing industry, to the rapidly growing bioenergy and nanomaterials.

**2020/21-037 - High performance computer modelling of whole viruses at atomistic resolution**

**Supervisor:** Dr Dmitry Nerukh (Engineering and Physical Sciences College / Mathematics)
**Assoc Supervisor:** Dr Amit Chattopadhyay (Engineering and Physical Sciences College / Mathematics)

**Areas of Research**
HPC modelling, Molecular Dynamics, biomolecular modelling, virus structure and dynamics, hybrid atomistic/continuum approaches.
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree or equivalent qualification in physics, mathematics, theoretical chemistry, or relevant natural sciences. Preferred skill requirements include knowledge/experience of the theory of molecular dynamics and of, high performance MD simulation of biomolecular systems.
**Project Summary**.
Applications are invited for a three year PhD studentship at Mathematics Department, Aston University. Understanding molecular details of virus structure and dynamics is crucial for studying their biological functioning providing the basis for developing treatments of diseases caused by the virus. Research in this field is particularly relevant in light of the COVID-19 outbreak. The project will be devoted to all-atom Molecular Dynamics modelling of a series of small viruses. The model will consist of complete all-atom representation of the whole virus including its protein capsid, genomic DNA/RNA, explicit water, ions and other small molecules from the virus environment. High performance supercomputers will be used, including world-fastest machines such as FUKAGU at RIKEN, Japan. MD-specialised supercomputers, such as MDGRAPE, will also be used. Research will be focused on computer simulations, however, close collaboration with viral molecular biologists (Leicester University) and structural biologists (City College of New York) will be used for setting up the atomistic models for simulations and analysing the results.

**2020/21-038 - Nanomaterials for Biocompatible Field-Effect Transistors and Microelectrode Arrays for Advanced Applications**

**Supervisor:** Dr Petro Lutsyk (College of Engineering and Physical Sciences, Aston Institute of Photonic Technologies (AIPT)/ Department of Electrical and Electronic Engineering)
**Assoc Supervisor:** Dr Alex Rozhin College of Engineering and Physical Sciences, Aston Institute of Photonic Technologies (AIPT)/ Department of Electrical and Electronic Engineering)

**Areas of Research**
Nanoscience, field-effect transistors, microelectrode arrays, biocompatible nanoelectronics,
**Knowledge and skills required in applicant:**
The successful applicant should have a first-class or upper second class honours degree or equivalent qualification in Physics, Engineering, Nanoscience, or similar. Preferred skill requirements include knowledge/experience of nanomaterials processing, experimental characterisation of liquid/solid samples by electrical measurements, and optical spectroscopy techniques.
**Project Summary**.
The proposed studentship focuses on nanoelectronics – the use of nanotechnology in electronics - an exciting & growing avenue due to recent achievements in nanoscience & instrumentation. Nanomaterials are superior candidates for future electronics with low energy consumption, mechanical flexibility, & biocompatibility enabling ground-breaking practical applications, e.g. wearable healthcare devices, smart packaging, biocompatible electronics, etc. However, to translate this knowledge into real-world applications, the performance of such devices must be optimised.
This studentship is aiming to study new experimental procedures for nanomaterials processing, design & fabrication of novel nanoelectronic devices, such as field-effect transistors & microelectrode arrays, targeting advanced neuroscience & other applications.
The first research objective is to establish a novel experimental basis for solution-processing of semiconductor nanomaterials (such as carbon nanotubes and so on) for field-effect transistors, which could be a key to enable real-life application of biocompatible nanocarbon electronics.
The second objective is to develop a protocol of nanofabrication of biocompatible microelectrode arrays for brain studies, which have a disruptive potential to give world-first insights into the pathology of epilepsy and other brain diseases.
The proposed project focused on research and development of these techniques at the interface of nanoscience, electronic engineering, & neuroscience has the potential to lead to high-impact publications and meaningful IP, via the creation of cutting-edge nanomaterial electronics for measuring the electrical activity of brain networks.

**2020/21-039 - Design for Circular Economy: Exploring circular product design strategies in manufacturing industries**

**Supervisor:** Dr Wei Liu (Engineering and Physical Sciences College / Mechanical, Biomedical & Design)Department)
**Assoc Supervisor:** Dr Luciano Batista (Aston Business School); Prof Kate Sugden (Engineering and Physical Sciences College/Department of Mechanical Engineering & Design (MBD) / Aston Institute of Photonics Technology (AIPT))

**Areas of Research**
Product Design, Advanced Manufacturing, Circular Economy, Business Models, Design Strategy and Management
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree or equivalent qualification from Design, Engineering Design, Mechanical Engineering, Manufacturing, or Management subject. Preference may be given to the applicant who owns cross-disciplinary degrees or has research experience in the above areas. Preferred skill requirements include knowledge/experience of Circular Economy, Circular Product Design, Design for Manufacture, Manufacturing technologies, Product Design and Development, Business Management, and basic understanding of qualitative and quantitative research methods
**Project Summary**.
With increasingly limited non-renewable resources and deteriorating environments, there is a growing need to design and manufacture products in a more sustainable way. Circular Economy (CE), with a clear and strong intention to support a new generation of global businesses towards a more efficient and sustainable industrial ecosystem. 'Circular' starts from product design through to consumer use, reuse and/or recycled which requires

to fundamentally rethink the way when designing products, by taking into consideration the systems in which the products flow. Current literature has given focal attention at the product's end-of-life stage, leading to concerns on lengthening the life of the product and reuse of the product materials. Product design serving as an initial stage of a product life cycle makes a huge influence on the overall product development. At the level of the value chain, information regarding product recycling, reuse and remanufacture should be effectively transmitted to product designers so as to achieve effective product design to increase product circularity. However, there is limited research on how we may achieve the above purpose through appropriate design strategies along with feasible business models. Therefore, this research intends to explore progressive product design strategies toward CE in manufacturing industries.
The research outcome would be expected to drive the development of circular design knowledge and accelerate the firm's transition from a linear design to a circular design of products, as well as enable appropriate use of advanced manufacturing technologies to achieve a more positive environmental impact, towards creating a product system that is truly circular by design

**2020/21-040 - ECG signal modelling: from compression to automation of routine tests interpretation**

**Supervisors:** Dr Yordan Raykov (Engineering and Physical Sciences College / Mathematics Department);
**Assoc Supervisor:** Dr Laura Rebollo-Neira (Engineering and Physical Sciences College / Mathematics)

**Areas of Research**
Machine Learning
**Knowledge and skills required in applicant:**
In addition to aspiration to learn, the ideal candidate will have deep interest in probability and statistics, plus will enjoy learning advanced programming concepts. Candidates from Engineering, Computer Science, Mathematics and related fields are welcome.
**Project Summary**.
Electrocardiography (ECG) is the process of recording the electrical activity of the heart. The shape and variation of the ECG record embody information that an expert diagnostician can interpret to assess the physiological state of a patient.
This project will look at the potential of ECD records for use in heart pathology prediction and disease phenotyping, using machine learning. We will extend recently proposed models for sparse representation of ECG signals [1, 2], and dedicate them to tackle the problem of automatic diagnosis of heart anomalies. Parameters of sparse representation contains significant information useful for capturing pathologies of the heart, different phenotypes of heart conditions and stress levels of the patient. The features extracted from those parameters can be employed to build machine learning systems that learn from ECG records risk of patients developing different conditions and indicate high risk individuals. We will achieve this by developing machine learning algorithms which discover shared structure among the sparse ECG representations and learn to predict the ECG patterns that indicate different heart pathologies.
Beyond contributing to this research of societal importance, the prospective candidate will gain expertise in deep generative models and model-based learning, highly sought across sectors beyond healthcare.
[1] Rebollo-Neira, L. & Cerna D. , 2019, Wavelet Based Dictionaries for Dimensionality Reduction of ECG Signals, Biomedical Signal Processing and Control, 54, 101593.
[2] -Chagnon, J. & Rebollo-Neira, L, 2020, Mixed-transform based codec for 2D compression of ECG signals, Biomedical Signal Processing and Control. 62, 10206.

**2020/21-041 - Trustworthy Artificial Intelligence**

**Supervisor**: Dr Peter Lewis (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) / Computer Science)

**Assoc Supervisor:** Dr Aniko Ekárt (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) / Computer Science)

**Areas of Research**
Computer Science, Artificial Intelligence
**Knowledge and skills required in applicant:**
Masters' or at least strong undergraduate degree in Computer Science, Artificial Intelligence, or a related discipline
**Project Summary**.
Artificial intelligence (AI) is transforming society, raising questions around its responsible use and trustworthiness; understanding and enhancing the trustworthiness of AI are pressing needs. In 2019, the EU published its 'Ethics Guidelines for Trustworthy AI', and in its view trustworthy AI will respect the ethical principles and values of the society in which it operates. Similarly, the IEEE's 'Ethically Aligned Design' report argues that it is essential that intelligent systems 'are designed to adopt, learn, and follow the norms and values of the community they serve'.
Being trustworthy includes adaptively behaving in a socially sensitive manner, and being transparent about your ability to do so. As humans, we reflect on our behaviour in its social context to achieve a high level of trustworthiness: we evaluate previous and potential future actions against social norms and the values held by ourselves and the groups of which we are part, and use this to govern our decisions. However, machines without this ability to reflect cannot do this. The project forms part of the broader 'self-aware computing' agenda, aiming to construct equivalent reflective capabilities for machines. This PhD in Trustworthy AI focuses specifically on reflecting on, enhancing, and exposing aspects of trustworthiness related to social norms and values.
The project will therefore contribute towards a new generation of trustworthy AI technologies with reflective capabilities, able to model and reason about their congruence with social norms and values as well as their own trustworthiness. Aligned with the strategic aims of Aston's institute for smart cities research, ASTUTE, and in partnership with Midlands-based companies adopting AI, including through Aston's Think Beyond Data initiative, this PhD will provide foundations for the responsible adoption of trustworthy AI by industry.

**2020/21-042 - Development of collaborative network of Free Trade Zones and Freeports to guarantee a minimum level of international supply chain resilience.**

**Supervisor: Dr Constant Iannacci** (Engineering and Physical Sciences College/ Engineering, Systems and Supply Chain Management (ESSCM) / Aston Institute of Urban Technology and the Environment (ASTUTE)
**Assoc Supervisor:** Dr Edward Sweeney (Engineering and Physical Sciences College/ Engineering, Systems and Supply Chain Management (ESSCM) / Aston Institute of Urban Technology and the Environment (ASTUTE)

**Areas of Research**
International Trade and Logistics operations sustainability.
**Knowledge and skills required in applicant:**
Combination of qualitative and quantitative approaches.
The required skillset ranges from organisational and relationship skills to the ability to apply quantitative techniques to solve a research problem such as defining and assessing spare capacity in a logistics network.
**Project Summary**.
The concept of a Free Trade Zone and the rules surrounding the creation of an FTZ differ from one country to another. According to Venables (2003) an FTZ ultimately would reduce manufacturing production costs and provide additional market opportunities at least at regional level. The obvious direct potential benefits to companies lead to more efficient resource flows and synergies through supply chain clustering.
However, the ongoing uncertainty linked to the current pandemic, the lack of an internationally coordinated approach to a solution and the Brexit implementation in the UK, expose the resilience limitations of international trade supply levels. This increased variability is impacting negatively on capital intensive derived activities such as Shipping or Cargo Handling.

The benefits but also the limits of lean thinking have been discussed for several years (A. Cusumano 1994) and it becomes now necessary to re-consider manufacturing and logistics optimization of operations to favour increased resilience in operations.
Therefore, the aim of the project is to identify the benefit of FTZs, especially Free ports for international supply chain, and propose a collaborative working framework between FTZs in terms of knowledge and logistics capacity sharing in order to respond at minimum total cost to a brutal change in supply and demand forecasts independently from political interferences.
The proposed methodology is expected to be a combination of qualitative and quantitative approaches. The required skillset ranges from organisational and relationship skills to the ability to apply quantitative techniques to solve a research problem such as defining and assessing spare capacity in a logistics network

**2020/21-043 - Development of graph neural networks for protein representation and epitope prediction.**

**Supervisor:** Dr. Felipe Campelo (College of Engineering and Physical Sciences, Aston Institute of Urban Technology and the Environment – ASTUTE, Department of Computer Science.)
**Assoc Supervisor:** Dr. Luis Manso (College of Engineering and Physical Sciences, Aston Institute of Urban Technology and the Environment – ASTUTE, Department of Computer Science.)

**Areas of Research**
Data mining, machine learning, AI, bioinformatics
**Knowledge and skills required in applicant:**
Required skills: the successful applicant should have a first class or upper second-class honours degree or equivalent qualification in Computer Science, Mathematics, Statistics or related areas; or Biology, Chemistry or related areas. The applicant should have demonstrable skills on data mining and machine learning, including good programming skills. We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to our College of Engineering and Physical Sciences, and we pride ourselves on our vibrant, friendly and supportive working environment and family atmosphere
**Project Summary**.
Computational prediction of epitopes, i.e., protein sections capable of being recognised by the immune system, is a core element in the development of vaccines and diagnostic tests against infectious diseases. This project will focus on the development of innovative protein data representations, antigenic properties prediction models, and on optimising models for maximising predictive performance for specific organisms, or for specific objectives (e.g., vaccines or diagnostic tests). The student will develop in-depth understanding of graph-based neural networks, deep learning and other state-of-the-art predictive approaches, hyper-parameter optimisation and model selection strategies, and work towards production-ready models capable of providing highly accurate predictions of potentially interesting peptides based on the specific interests of stakeholders (immunologists and bioinformaticians in both academic and industrial occupations). At the end of this project the student will have developed predictive approaches capable of substantially improving the current state-of-the-art, providing researchers and industries with the required tools to accelerate research and development in the context of neglected and emerging infectious diseases.

**2020/21-044 - Smart laser system for fabrication advanced fibre devices for sensing and telecommunication applications**

**Supervisor:** Dr Elena Turitsyna (Engineering and Physical Sciences College/ Aston Institute of Photonics Technology (AIPT))
**Assoc Supervisor: :** Prof Igor Meglinski (Engineering and Physical Sciences College/ Department of Mechanical, Biomedical and Design); Dr Egor Manuylovich (Engineering and Physical Sciences College/ Aston Institute of Photonics Technology (AIPT))

**Areas of Research**
Fibre devices are in high demand across many areas of research and sectors of economy. The proposed project uniquely combines the following areas of research: laser processing of materials, machine learning, fibre optics, advanced numerical modelling, laser science and technology, applications of sensors, telecommunications, signal processing, light-matter interactions
**Knowledge and skills required in applicant:**
Basic knowledge of machine learning, advanced math, basic electronic or photonic skills
**Project Summary**.
The presented project aims to educate the student in the thriving fields of photonics and machine learning (ML). More specifically, the project aims at using ML methods to enhance optical sensor fabrication and applications. During the project, the student will be involved in the development of a smart system for fibre Bragg grating (FBG) inscription for industrial applications. Applications of fibre gratings include sensing (from civil engineering to medicine and healthcare), telecommunications, laser technology, and many others. Each particular application often requires specific parameters and characteristics of a grating device. However, some key features such as the induced refractive index change, and optical losses depend on many parameters and cannot be fully controlled during the manufacturing process of FBG, leading to deviations from the target characteristics. In this project, we aim to create a "smart" system controlled by machine learning techniques. The main advantage of the developed new system over the currently existing ones will be the real-time measurement of the parameters of an FBG during its fabrication. This will be achieved by using a machine learning algorithm based on neural networks (feed-forward or convolutional neural network) for real-time retrieving of the physical parameters of the FBG being inscribed and real-time adjustment for efficient recording of FBGs. Objectives include the development of a machine learning algorithm for real-time retrieval of the physical parameters of an FBG and developing a closed-loop system for real-time adjustments in the FBG fabrication system. On the stage of applications of the fabricated gratings, we will develop ML-based processing approaches to visualize and interpret sensing data for applications to be specified and defined with the industrial partner(s). We will explore possibility of writing helical fibre gating for structured light and optical vortices applications in telecommunications and sensing.

**2020/21-045 - Privacy Concerns of Connected Autonomous Vehicles**

**Supervisor:** Dr Kaniz Fatema (Engineering and Physical Sciences College/Computer Sciences)
**Assoc Supervisor:** TBC

**Areas of Research**
Cyber Security
**Knowledge and skills required in applicant:**
Applicants should hold or expect to gain a minimum of a 2:1 Bachelor Degree or equivalent in Mathematics or Computer Science. Good analytical and academic writing skill.
**Project Summary**.
Connected autonomous vehicles (CAV) technology proposed to provide huge social, industrial and economic benefits by improving safety and congestion. However, the use of this technology presents significant privacy issues that should be explored.
Automated vehicle would likely need to collect and store information about passengers and owner to authenticate authorized use, including customizable comfort, safety, and entertainment settings. It is likely that cars, based on setting preferences and other information collected while in use, will precisely be able to identify drivers, passengers and their activities.
Location data captured by automated vehicle helps in planning route in real time traffic, including point of interest or avoiding toll roads. Correlating location and other information allow someone to get a picture of when, where and how an individual travels. However, these data enable one to deduce other information about the owner or passengers, such as where they live and work as well as places they frequently visit and reveals information about their personal life. Furthermore, this type of private information makes them more

susceptible to physical harm or stalking if the information is accessible to the wrong person. Another factor that complicates the privacy issue is the potential that location data from autonomous cars would be shared with third parties, including the manufacturer or other service providers.
Autonomous cars contain various sensors that collect data relating to the operation of the vehicle as well as its surroundings. Voice recognition, image capturing capacity of autonomous vehicles could collect driving habits and other information about other drivers without their knowledge or consent. The goal of this research will be to analyse the legal issues and risks associated with obtaining and using personal data in automated connected vehicle with an aim to minimise such implication

**2020/21-046 - Mining and modernising legacy entity profiling pipelines**

**Supervisor: Dr. Antonio Garcia-Dominguez** (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE) )
**Assoc Supervisor: : Dr. Felipe Campelo** (College of Engineering and Physical Sciences, Aston Institute of Urban Technology and the Environment – ASTUTE, Department of Computer Science.)

**Areas of Research**
Knowledge extraction from source code, model-driven software engineering, and machine learning for entity matching.
**Knowledge and skills required in applicant:**
- Required: strong software development and programming skills.
- Desirable: experience in the areas of model-driven engineering, data integration, or machine learning.

**Project Summary**.
The financial and insurance industries heavily rely on the ability to build profiles of entities/individuals for risk assessment, collecting a large variety of heterogeneous data from a broad range of sources. The volumes of data to be integrated are becoming increasingly large, to the point where traditional overnight batch processing cannot provide results quickly enough to allow for timely and informed decisions, and a stream-oriented approach that reacts to incoming data in an incremental way would be beneficial. Likewise, in many cases these sources identify entities through different mechanisms, and the collation of this information usually relies on manually written logic which can be difficult to develop and brittle in operation: instead, the system could learn rules to associate data to entities. At the same time, these industries have made significant investments into these profiling approaches, and their current systems encode valuable insights into their business domains that should not be thrown away.

This thesis will study approaches to efficiently modernise these batch-oriented and manually specified entity profiling systems into stream-oriented and AI-based approaches. The envisioned approach is to extract knowledge models about how these profiles are being manually built in the legacy system, and enrich and transform these models to produce a modernised pipeline that processes new data as it arrives, and trains itself to associate that data with entities. The extracted knowledge models will include profiling rules that can be used to evaluate whether the learned profiling models are consistent with the original approach. Within this thesis, the student will develop notations to capture the existing knowledge, design automated model extraction and modernisation transformations, and investigate how to use the extracted knowledge to validate trained models for consistency

**2020/21-047 - Self-Securing Large Scale Internet of Things Systems**

**Supervisor: Dr Paul Grace** (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE) )
**Assoc Supervisors: Dr Nitin Naik** (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE)), **Dr Nelly Bencomo** (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) / Computer Sciences Department)

**Areas of Research**
Cybersecurity, IoT, threat modelling, software modelling, and emergent software
**Knowledge and skills required in applicant:**

- Computer Science degree
- Previous study of cybersecurity/information security
- Strong programming and software development skills

**Project Summary**.
Any computational device connected to the Internet can have its vulnerabilities exploited for malicious use. Securing them is hard. Yet we are connecting more and more of these systems; think of smart homes, locks, thermostats. The dynamic composition of these systems means there will be vulnerabilities that only emerge over time. A good example is the case of a casino whose customer database was hacked via a Smart fish tank later installed onto their network. Moreover, this is a relatively small-scale case—but what of large-scale smart city systems, integrated transport systems and smart digital healthcare (e.g. the integration of fitness devices or sleep monitors into primary care systems or assisted living environments). In such large-scale IoT-based systems, there will be large numbers of unknown devices and software connecting and interacting in unplanned and unanticipated ways—leading to a greater numbers of emergent threats that current cybersecurity solutions cannot address.
The aim of the project is to develop intelligent self-securing software to identify and automatically mitigate emergent security and privacy threats in the complex systems of systems that will realise tomorrow's smart-cities, supply-chains, intelligent transport systems and digital healthcare systems. The specific objectives of the project are:
i) To identify new and secure methods to collect data describing the dynamic integration and interaction of Internet of Things software and devices within large-scale systems such as smart cities.
ii) To develop new computational models of complex system-of-system interactions (from the previously collected data) that can be analysed at runtime to identify emergent security and privacy threats.
iii) To leverage emergent software engineering approaches (using techniques such as genetic programming, and graph learning) to intelligently create and deploy security control software on demand.

**2020/21-048 - Bayesian neural networks and transfer learning for signal processing in high-speed optical communication systems**

**Supervisor: Dr Maria Chli** (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE) )
**Assoc Supervisors: Dr Yaroslav Prylepskiy** (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT)); **Dr Morteza Kamalian Kopae** (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT))

**Areas of Research**
Optical communications, machine learning, artificial neural networks, signal processing, autonomous agents
**Knowledge and skills required in applicant:**
*Key*: Familiarity with the theory optical communications, signal processing, and/or machine learning methods
*Desirable*: Some knowledge in statistical analysis, scientific programing (Matlab, Python, Tensorflow, or similar), optics, nonlinear and stochastic processes
**Project Summary**.
Global telecommunication networks underpin Internet, broadband communications, and the whole digital economy. However, the surge of the Internet-based activities and on-line services (cloud computing, on-demand HD video streams) bring about the ever-escalating pressure on the rate and quality of information flows interconnecting network participants. The current capacity of optical links will soon become insufficient, such that we have to develop radically different and efficient methods to improve the throughput of optical fibre systems. This multi-platform project will address the aforementioned real-world problem and aiming to provide practical bespoke solutions for the next generation of high-speed coherent optical communication systems: our approach will be based on the utilisation of deep machine learning and transfer learning to make up an efficient decision maker (an autonomous agent). Since the "conventional" deep learning models are prone to overfitting and tend to be overconfident, the new devices will rely on stochastic deep neural networks to explicitly estimate the uncertainty of the autonomous agent. The Bayesian inference paradigm provides a rigorous framework to analyse and train such stochastic neural networks, paving the way for the beyond state-of-the-art processing devices. The developed deep Bayesian framework will further be generalised to other areas, such as engineering and health, etc. The project is the collaboration of two Aston institutes (ASTUTE and AIPT) and will benefit from the high-end industrial partners participation involved in the on-going projects (British Telecom, EPSRC project TRANSNET; Infinera, ITN FONTE; Nokia Bell Labs, ITN REAL-NET).
The key objectives of the project are:
1) Development of the methods based on Bayesian neural networks for efficient autonomous agents to be used in optical systems predictions.
2) Optimisation of the methods in terms of complexity and memory usage.
3) Experimental evaluation of the most successful theoretically developed methods using the data from industrial partners.

**2020/21-049- Developing a LoRaWAN Security Framework for Defending Against Security Threats in Smart Cities**

**Supervisor: Dr Nitin Naik** (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE) )
**Assoc Supervisor: Dr Paul Grace** (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE) )

**Areas of Research**
IoT Systems, LPWAN, LoRaWAN, Smart Cities, Cybersecurity
**Knowledge and skills required in applicant:**
- Computer Science/Cybersecurity degree/Networking degree
- Previous study of cybersecurity/information security
- Previous study of IoT Systems and LPWAN
- Good programming and software development skills

**Project Summary**.
The LoRaWAN is a Low Power Wide Area Network (LPWAN) technology which offers two features: small power budget and long range of transmission, which is a unique communication technology for wireless communications and a preferred choice for IoT systems implementation in smart cities. The LoRaWAN is based on spread spectrum which is difficult to detect, intercept, demodulate and jam; however, several cyberattacks have already been exposed in LoRaWAN based IoT infrastructure, such as Over-The-Air-Activation (OTAA) related

attacks, key distribution and management related attacks and Man-In-The-Middle (MITM) attacks. Additionally, IoT devices are usually characterized by limited resources (e.g., memory, processing, bandwidth and energy) that can pose many security challenges, such as: unable to apply standard and existing security algorithms and protocols, the growing threats of IoT malware and ransomware, compromising these fragile devices for IoT botnets aiming to mine cryptocurrency, incapable of implementing strong data security and privacy. As a result, the design and implementation of LoRaWAN based IoT infrastructure is also affected from all of these security risks. Therefore, it is crucial to investigate possible attack vectors on LoRaWAN and develop a security framework for its successful and secure implementation in smart cities.

This project will focus on developing a LoRaWAN security framework for defending against security threats in smart cities; and the project objectives are to:

1. Build a LoRaWAN network in order to conduct security experiments (using Raspberry Pi/Arduino).
2. Identify possible attack vectors on LoRaWAN with the view to evaluating their probability of success within the test environment.
3. Develop a security framework to prevent happening identifying attacks and minimise the effect of any attack on LoRaWAN.
4. Test the proposed security framework for LoRaWAN and its success within the test environment.
5. Make recommendations to the wider LoRa community to improve the security of LoRaWAN infrastructure.

**2020/21-050 - Ethics-aware Cognitive Architectures for Ambient Intelligence**

**Supervisor:** Dr Luis Manso (College of Engineering and Physical Sciences, Aston Institute of Urban Technology and the Environment – ASTUTE, Department of Computer Science.)
**Assoc Supervisor:** Dr Felipe Campelo (College of Engineering and Physical Sciences, Aston Institute of Urban Technology and the Environment – ASTUTE, Department of Computer Science.)

**Areas of Research**

Ambient intelligence, artificial intelligence, machine learning, robotics

**Knowledge and skills required in applicant:**

The successful applicant should have a first class or upper second class honours degree or equivalent qualification in Computer Science, Electronic Engineering, Mathematics, Physics or similar. Preferred skill requirements include experience in programming, deep learning and mathematics.

**Project Summary**.

The upcoming Society 5.0 is a new paradigm where humans and AI actors cooperate in activities of daily living. This will take place within ambient intelligence environments populated with a variety of sensors, actuators (e.g., voice, temperature and light control), and assistive robots. This cooperation will improve quality of life, particularly for the elderly and people with disabilities or life-limiting conditions.

There are however new and evolving challenges that have to be overcome. Climate change forces us to maximise energy efficiency. Privacy issues are increasingly relevant (e.g., data leakages, private data handed off to third parties) and must be considered. Cultural and populational diversity also need to be accounted for to prevent systemic biases in AI systems. These and other societal, cultural and economic issues are more relevant than ever and need to be considered in the systems that will run future technologies.

The selected candidate will study ambient intelligent systems, focusing on the artificial intelligence models and the cognitive architectures required to provide the services that we aim for. This will be done while accounting for the aforementioned economic and societal issues. Edge computing will be leveraged for privacy and energy efficiency purposes. Data curation and model auditing will be carefully studied and implemented to prevent systemic biases.

The student will deliver a cognitive architecture encompassing a series of state-of-the-art subsystems for perception, planning, user profiling and actuation, as well as a number of technology demonstrators to showcase the benefits of ethical ambient intelligence and the positive impact that it could have on our future society.

**2020/21-051 - Biofuel-fed solid oxide fuel cell (SOFC) lifetime: experimental and modelling investigation of SOFC longevity under biofuel impurities and thermal cycling scenarios**

**Supervisor:** Dr Amirpiran Amiri (Engineering and Physical Sciences College/)
**Assoc Supervisor:** Dr Vesna Najdanovic (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI) )

**Areas of Research**
Hydrogen, Fuel Cell, Biomass Gasification, Biofuels
**Knowledge and skills required in applicant:**
Chemical/Mechanical Engineering degree. Modelling and simulation background. MATLAB programming. Data science/ Machine Learning (desirable)
**Project Summary**.
Hydrogen is currently experiencing unprecedented momentum and biomass gasification is key for producing green hydrogen. The International Renewable Energy Agency has predicted that biomass could contribute 60% of global renewable energy usage by 2030 contributing to low carbon energy. A significant gap is the shortage of system level demonstrators that maximise the full potential of biomass to meet this ambition. Integration of a Biomass Gasifier and Solid Oxide Fuel Cell (SOFC) forms an excellent sustainable biomass-to-power process system. The SOFC is the most efficient device to convert chemical energy to heat and electricity. However, the main limitation is the lifetime of the SOFC which is seriously impaired by gasification product (syngas) impurities. The key research goal of this PhD project is to enhance the SOFC health and longevity by using its own data to develop a predictive model. The project aims to demonstrate an efficient system for biomass gasification based electricity production in which fuel cell longevity is central. It will introduce a novel step for impurities removal that is not only a carbon capture process, but also a ground-breaking technique to enhance the SOFC lifetime. The project objectives are:

- data-based understanding of SOFC degradation at different scales;
- developing SOFC longevity predictive model;
- investigation of life span and efficiency of the SOFC fed by various biofuels.

The outcome of this project will contribute to a more sustainable energy system with decarbonisation of renewable energy supplies. The deliverables will benefit other types of fuel cells, electrolysers, and batteries technologies realising a sustainable future. In this multidisciplinary project, the PhD candidate will get relevant computational skills by using physics-guided machine learning methods as a novel modelling approach in fuel cell research. It is a great opportunity to explore a new direction of research to enhance the Hydrogen Economy and Bioenergy sector

**2020/21-052 - Building Spatial Problem-Solving Skills: 3D Design Thinking**

**Supervisor: Dr Lyndon Buck** (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)
**Assoc Supervisor:** Dr Timothy Whitehead (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)

**Areas of Research**
Design, Design Practice, Design Research, Design Thinking
**Knowledge and skills required in applicant:**
We are looking for motivated and engaged individuals who have experience in User centred design, 3D modelling and visualisation, prototyping and model making to work as part of the design team. Applicants should be educated to masters level, or equivalent, in Product Design, Industrial Design, Design Engineering or a similar field.
**Project Summary**.
Product design education and practice rely on designers developing a well practised understanding of three-dimensional forms, and how to combine, subtract, edit and manipulate these both virtually and physically. While some have a natural affinity and ability with these properties, a well defined spatial awareness, others do not.

Growing evidence suggests that a focus on these characteristics of the material world can help designers hone their spatial thinking skills—and that such skills, in turn, support achievement in other STEM subjects such as engineering, applied science and mathematics.
It is well documented that successful design solutions are a result of design processes consisting of a structured process of ideation and iteration using various physical and virtual tools to elicit novel insights. Typically, this involves established design thinking methods such as sketching, 3D and virtual prototyping, drawing, visualising, and modelling which require extensive resources, materials and space. These resources may not be available to students and designers who are working remotely or in temporary live/work spaces or those on a limited budget.
A growing area of design research and design practice utilises new and innovative design methods to consider new ways of developing complex 3D forms through the use of readily available scanners and software for smartphones which will allow designers to develop low resolution 3D models and transfer them to digital and manipulate them to understand and explore their spatial relationships.
Aim: To investigate the implementation of new and emerging technologies to support product designers with affordable low resolution, low fidelity (lo-fi) modelling and prototyping facilities while working remotely.
Objectives:

- Establish current 3D modelling and visualisation practice and emerging technologies
- Develop design approaches to remote design visualisation and modelling
- Use practice based design research to test and develop the approach
- Validate the use of the technology

**2020/21-053 - Studying Intracellular Communication and Exosomes Quantification with Orbital Angular Momentum of Light**

**Supervisor:** Prof Igor Meglinski (Engineering and Physical Sciences College/ Department of Mechanical, Biomedical and Design)
**Assoc Supervisor:** Dr Sergey Sergeyev (Engineering and Physical Sciences College/ Aston Institute of Photonics Technology); Prof Ivan Wall (Life & Health Sciences College/ Biosciences

**Areas of Research**
In the last decade, consistent and successful innovations have been achieved in the field of lasers and optics, collectively known as 'photonics', founding new practical applications from space (by NASA) to modern biology, medicine and consumer good devices, offering since recently the wearable gear (e.g. Apple Watch). While the global photonics market has reached nowadays €600 billion, only 20% of the potential power and benefits of light technologies have been unlocked so far. Light can be more complicated and structurally diverse, i.e. the light beams can be radially or azimuthally polarized and carry so-called orbital angular momentum (OAM), related to their spatial structure. While using the polarization of light in various biomedical applications has already known for years, the interaction of light with OAM with cells has not yet been explored, and has been added to the potential practical toolkit only recently.
**Knowledge and skills required in applicant:**
Laser light, polarization, light-tissue interaction, cells, light scattering, basic experimental skills, basic knowledge of Matlab, programming skills.
**Project Summary**.
Current project is aimed at filling the gap in understanding of interaction of structured light with OAM and exosomes, leading to the development of a radically new optical imaging technique with an extraordinary transformative accuracy. The imaging advance of new technique could be a massive step forward in quantitative characterisation of exosomes and other extracellular vesicles with the possibility to identify subtle peculiarities in intracellular communications.
Thus, the overall goal of the project is to consolidate the fundamental concepts of modern physics – OAM and medicine and cells biology – extracellular vesicles, acknowledged by Nobel Prize awards (A. Ashkin in 2018, and J. Rothman, R. Schekman and T. Sudhof in 2013, respectively), to develop revolutionary new technological

capabilities of functional imaging and quantitative characterisation of exosomes with immediate technology transfer to current practice of cells biology studies, including examination of intracellular communications.
The results of the study will show how the fundamental properties of light can be practically used in cells biology. This would represent a major breakthrough, one that will define new physical phenomena, such as the interaction of complex structured light with the nanoscale inclusions (exosomes) in cells and cells cultures, with a primary target to detect exosomes and other extracellular vesicles with an extremely high sensitivity (beyond the standard microscopic limitations). The research is disruptive in the context of (a) development of OAM-based imaging/screening approach evolving at fast time scales will enable the time-resolved characterisation and active on the nano-scales; (b) introducing a new OAM approach for detecting and profiling exosomes as a process analytic technology for cell therapy bioprocessing and examination of intracellular communications. The project will be also linked with at least two EU-based multi-disciplinary projects associated with neuroimaging and cells studies

**2020/21-054 - Direct 3D Laser Fabrication of Photonic Gas Sensors**

**Supervisor:** Prof David Webb (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT)
**Assoc Supervisor:** Dr Vladimir Osipov (Engineering and Physical Sciences College / Aston Institute of Photonics Technology (AIPT)

**Areas of Research**
Photonics; Compact and precise gas sensors for industrial applications
**Knowledge and skills required in applicant:**
The project will involve laser physics, nonlinear optics, laser technology and sensing applications. Experience in some of these would be advantageous.
**Project Summary**.
The aim of this project is the development of a femtosecond laser, 3D, direct fabrication technology for new classes of gas analysers/detectors capable of sensing traces of infrared-active chemical compounds in gas samples of small volume. This project proposes to apply photoacoustic (PA) gas-detection techniques that, compared to the other optical detection methods, offer the advantage of the highest sensitivity at a compact design. The project is oriented to development of a novel high-sensitivity PA laser-spectroscopy gas detector that integrates a few-millimetre-scale PA cell and a micro-fabricated fibre-optical (FO) acoustic sensor finely fitted to each other.
The main goal of this project is the development of FO acoustic sensors and a proof-of-concept prototype of a miniature PA detector capable of analysing small gas flows at a sensitivity level better than one for the best up-to-date portable gas-leak detectors.
We propose to investigate femtosecond (fs) 3D fabrication techniques to create several ranges of new photonic gas sensors in fibre and planar formats, initially for greenhouse gases - carbon dioxide and methane detection. Whilst the project involves the investigation of fundamental physical aspects of the direct laser writing processes, we have chosen to pursue an important device engineering goal as the primary focus of the programme, seeking the earliest demonstration of the exciting capabilities offered. For technological efficiency, we propose a programme that integrates fibre and planar methodologies, and a range of progressively demanding applications all driven by identifiable present needs. Although the basic principles are applicable to the widest range of materials, we focus here primarily on silica glasses and on polymer materials, in both the fibre and planar formats. Our choice of predominantly environmental monitoring goals reflects our perception of urgent demands and novel opportunities in that sector, but we are keen to draw attention to the rather wider prospects for applications across multiple fields.

**2020/21-055 - Dynamic modelling and control strategy of organic Rankine cycle for industrial waste heat recovery applications**

**Supervisor: Dr Muhammad Imran** (Engineering and Physical Sciences College/ Department of Mechanical Engineering & Design (MBD)
**Assoc Supervisors: Dr Jose Ricardo Sodre** (Engineering and Physical Sciences College/ Department of Mechanical Engineering & Design (MBD); **Prof Patricia Thornley** (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI))

**Areas of Research**
Mechanical Engineering
**Knowledge and skills required in applicant:**
Basic programming skills in Matlab or object oriented language, thermodynamic modeling, heat transfer, heat engines, power cycle
**Project Summary**.
Waste heat from industrial processes is intermittent and characterised by fluctuations in temperature and mass flow of the waste heat, making it a difficult task to operate and control the organic Rankine cycle (ORC) to ensure safe operation and maximum power output. The transient waste heat source can cause severe damage to the components of the ORC system, especially expansion machine. The intermittent and transient nature of heat source forces the ORC system to operate far from the design-point power capacity, thus deteriorating its performance and economic potential. Therefore, it is of crucial importance to investigate the dynamic response of ORC system and develop a suitable control strategy for the ORC system for industrial applications, ensuring safe operation, long life of the ORC unit and maximum performance under varying conditions of the waste heat. This 3 year fully funded PhD project seeks to develop the optimum design, component level dynamic model, and optimum control strategy of an organic Rankine cycle for waste heat recovery from energy intense industries. The industry partner will provide the waste heat data, which will be used to develop the preliminary design of the ORC system. The preliminary design will be extended to 1-dimensional component level model and dynamic model of the system. The modeling work will be carried out either in the MATLAB or in Modelica language. Based on the results of the dynamic model, a non-linear model predictive controller will be designed and optimised. The dynamic model and controller will be experimentally validated with the data provided by the ORC manufacturer.
This project will resolve a major barrier for successful commercialisation of the ORC system and can be widely applied to energy intensive industrial sectors such as the iron and steel industry, ceramic manufacturers, cement factories, food industrial, etc.

## 2020/21-056 - Development of a Smart Glove for Remote Monitoring of Paediatric Limb Deformities

**Supervisor: Dr Ali Jabran** (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)
**Assoc Supervisor: Dr Antonio Fratini** (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department); **Dr Andrea Jester** (Consultant Plastic Surgeon
Department of Plastic Surgery, Birmingham Children's Hospital)

**Areas of Research**
Telemedicine & Wearable Healthcare
**Knowledge and skills required in applicant:**
Experience in mechanical design (CAD) and manufacturing
Experience in electronics and incorporation of sensors into mechanical devices
Experience in programming (MATLAB/Python)
**Project Summary**.
*Background*: Every year approximately 200,000 children are born worldwide with hand and upper limb deformities. These are caused by a wide range of medical conditions (e.g. cerebral palsy) and require medical and surgical interventions. A reliable assessment of fine motor skills is crucial for evaluating these interventions and monitoring the symptoms over time.

Objectively assessing hand and upper limb function in children is a challenge, due to communication difficulties. Since the onset of COVID pandemic, this has become even more challenging as there is now an increase in online video consultations (between patient and clinicians).

*Aims and Objectives*

This project aims to develop a smart glove for reliable objective measurement of hand motion and grip characteristics of children with hand and upper limb deformities. A software will also be developed to map these measurements to clinically relevant parameters and to allow remote transfer of these parameters to clinicians during video consultations and face-to-face appointments. This will allow clinicians to remotely perform diagnosis, assessment as well as pre- and postoperative analysis. The glove will be lightweight, low-profile and unobtrusive enough so that the compromised child can wear and play naturally in the home environment. The final design will then be assessed on children with upper limb and hand deformities at Birmingham Children's Hospital. Opportunities for commercialisation of the device will also be explored.

This project will be in collaboration with an experienced hand-surgeon at Birmingham Children's Hospital.

*Justification*

Many patients lack the ability of adequate communication. Incorrect diagnosis and poor-quality assessments can result in ineffective surgery, leading to further corrective procedures. The benefits of our glove will include: significant improvement in information on patient's functioning; savings in clinic and clinician`s time; number of visits to specialists units; limiting distress to patients; and ultimately improved quality of life and functioning.

## 2020/21-057 - Motion Planning in Autonomous Robots

**Supervisor:** Prof William Holderbaum (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)

**Assoc Supervisor:** Dr Mark Prince (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)

**Areas of Research**

Robotics; Energy Efficient, Control Theory; Mathematics, Hamiltonian Systems.

**Knowledge and skills required in applicant:**

The successful applicant should have a first class or upper second class honours degree or equivalent qualification in Bachelors or Masters Degree with pure mathematics and physics as major subjects. Preferred skill requirements include knowledge/experience of Robotics, Hamiltonian Mechanics, Group Theory, Topology, Geometry.

We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to EAS, and we pride ourselves on our vibrant, friendly and supportive working environment and family atmosphere.

**Project Summary**.

The project will focus primarily on Autonomous Robots: The general research theme involves theoretical and experimental study of Autonomous Vehicles with emphasis on advanced motion control for unmanned vehicles. This includes control of highly maneuverable and underactuated vehicles, collision avoidance methods, and formation control. Considered motion control scenarios include target tracking as well as path following, tracking, and maneuvering.

Hamiltonian systems and Lie group geometry are natural mathematical tools in this setting. This enables one to plan large maneuvers using an optimal controller. Current applications and motivations include:

- Spacecraft attitude problem – Controlling the orientation of a satellite is a well known problem. Firstly, the problem of reconfiguration where the satellite is maneuvered from an initial to final configuration. This problem can be tackled using optimal control while minimizing some practical cost function. In addition at equilibria, we may wish to stabilize the motion of the satellite. The Lie group framework can tackle this entire problem globally.

- Autonomous Underwater Vehicles (AUV) - The motion planning problem of an AUV has received much attention in recent years, as a result of a growing industry in underwater vehicles for deep sea exploration or ship inspection for maintenance on ship hulls. For an underwater vehicle to succeed it must be able to control its own motion while minimizing the amount of fuel required to perform its task. As in the spacecraft attitude problem we wish to design global optimal controls for these systems as well as use geometric techniques to stabilize its motion while minimizing fuel usage.

**2020/21-058 - Minimum infrastructure Internet of Things (IoT) sensor networks for air quality monitoring**

**Supervisor:** Dr Richard Nock (Engineering and Physical Sciences College / Department of Electrical and Electronic Engineering / Aston Institute of Urban Technology and the Environment (ASTUTE))
**Assoc Supervisor:** Prof Kate Sugden (Engineering and Physical Sciences College/Department of Mechanical Engineering & Design (MBD) / Aston Institute of Photonics Technology (AIPT))

**Areas of Research**
Smart city technologies, Internet of Things/wireless sensors for environmental sensing
**Knowledge and skills required in applicant:**
Hands-on experience of embedded systems, electronic design (schematic and PCB design) and software engineering are advantageous. This project will require strong problem-solving skills and enthusiasm to solve challenging technical problems. The candidate should preferably have an electronic engineering degree or a degree in a similarly numerical discipline. **Project Summary**.
Ambient Air Pollution (AAP) is becoming an increasing problem not only for climate change, but for human health as well. The World Health Organisation (WHO) estimates that 90% of people are breathing polluted air and that 7 million people die each year due to particulates entering the lungs and cardiovascular system. AAP is of particular concern in Asia and Africa, but many city centres in the UK also often suffer from particulate concentrations which exceed WHO recommended levels.
Currently, a network of sparse monitoring stations is utilised to monitor values hourly. In Birmingham, there are typically 4 monitoring stations, which provides poor spatial resolution to identify problematic areas. In addition, widespread installation of such stations is limited by cost. This project will investigate the deployment of wireless sensor nodes containing readily available low-cost sensors to sense the key components of AAP (PM2.5 amongst others). To reduce infrastructure requirements, LoRA mesh technologies will be investigated to reduce communication infrastructure costs, necessitating only a singular gateway in each city. In addition to this, energy harvesting and power reduction techniques will be investigated to ensure nodes can operate for as long as possible.
This work will be undertaken in the ASTUTE research institute and to trial this technique, it is envisaged that a small-scale demonstration system will be installed around the campus at Aston University to monitor AAP air quality values. In addition, wireless sensor nodes will be placed around the inside of the main building to monitor indoor air quality.
This system will be used to evaluate the performance of mesh sensor networks in real-life conditions. This approach will bring the highest data rate and spatial resolution possible to air quality monitoring, demonstrating smart city technologies and paving the way towards Aston being a green campus.

**2020/21-059 - Designing Ethically Driven Supply Chain Networks**

**Supervisor:** Dr Yasmine Sabri (Engineering and Physical Sciences College / Engineering, Systems and Supply Chain Management (ESSCM))

**Assoc Supervisor:** Dr Aristides Matopoulos (Engineering and Physical Sciences College / Engineering, Systems and Supply Chain Management (ESSCM))

**Areas of Research**
Supply Chain Management – Engineering Management, and Social Sustainability.
**Knowledge and skills required in applicant:**
We are looking for highly motivated applicants, with good analytical skills and eagerness for continuous learning and improvement. A good experience in logistics and supply chain management (demonstrated through an academic qualification or professional experience) is necessary. A research-based MSc degree is preferable. Good academic writing skills.
**Project Summary**.
Supply chains –as globally interconnected networks of multiple industrial actors– have gained significant importance due to their impact on the bottom line economic, social and environmental performance of businesses. However, global supply chain systems are infiltrated with malpractices due to the lack of visibility and transparency (such as human trafficking, forced and compulsory labour, modern slavery, health and safety hazards, corruption and bribery, unethical contracting and supplier bullying). Recently, the COVID-19 global pandemic has revealed how localising supply chains– particularly in medical, healthcare and food sectors– is key in national emergency response.
This proposal is centred on designing supply chain networks with social impact embedded in their strategies, configurations and execution, and will explore the extension of sustainability practices to supply chains with a focus on localisation of supply. The research will develop a framework to strengthen localisation in supply chain systems through supplier selection innovation and linking small and medium sized suppliers (often located in developing countries) to global supply chain networks. By doing so, this research will satisfy twofold objectives; firstly, contributing to the efforts of poverty alleviation and empowering vulnerable groups in the society. Secondly, to enhance national response and resilience to supply and/or demand uncertainties.
To this end, this research will address two interrelated topics; 1- Building supplier capacities and developing localisation of supply in medical supply chains with a particular focus on developing countries to face global uncertainties, and 2- Using digital technologies to enhance visibility and tracking in the supply chain

**2020/21-060 - Framework for Holistic Design of Networked Multi-Robot Systems**

**Supervisor:** Dr Alexandros Giagkos (Engineering and Physical Sciences College / Computer Science)
**Assoc Supervisor**: Dr Paul Grace (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE) )

**Areas of Research**
Multi-Robot Systems; Swarm Robotics; Network Protocol Engineering; System Simulation
**Knowledge and skills required in applicant:**
Understanding of computer networks and the OSI model. Understanding of principles of software distributed systems. Understanding of software integration, C++.
**Project Summary**.
A central aspect of multi-robot systems (MRS) research is to model the collective intelligence that emerges from the interactions between embodied agents, as they co-exist and work towards a common goal within dynamic, unconstrained environments.
Robots in MRS utilise their sensor and motor capabilities to collaboratively undertake tasks, whose success often depends on the synergy of their behaviours. The communication between them plays a crucial role in facilitating the sharing of information and subsequently in allowing them to achieve their goals. When designing MRS, dedicated mobile ad hoc networks are the obvious choice for fast and efficient data sharing. However, real-world deployments shed light on a set of problems, which are concealed by a strong, yet incorrect assumption; that the supporting communication network is and will remain a reliable infrastructure for the rest of the robotic mission, and thus does not influence the behaviours of the robots.

In this inter-disciplinary project, we will develop and evaluate a novel framework that aims to replace the aforementioned problematic assumption by taking a holistic approach to integrating the capabilities of a network protocol with the controlling and decision-making mechanism. It will be follow-up work on previous efforts on autonomous coordination for networked unmanned aerial vehicles (UAVs). We will investigate the hypothesis that being an internal part of a distributed controller, an underlying communication mechanism can act as a new stream of sensory data that capture i) topological conditions (obstacles, long distances, bottlenecks etc.), ii) the state of participating agents, and iii) the quality of the communication between them. Furthermore, we will examine how this new sensor contributes to the scenario of autonomous coordination of the UAVs in a network-enabled MRS. The impact delivered by this research will be on both network engineering and multi-agent systems.

**2020/21-061 - Arterial fluid mechanics and their influence on cardiovascular disease**

**Supervisor:** Dr Patrick Geoghegan (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)
**Assoc Supervisor:** Dr Antonio Fratini (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)

**Areas of Research**
Biomedical Engineering; Mechanical Engineering; Materials Science; Fluid Dynamics; Biofluids; Cardiovascular Disease; Particle Image Velocimetry; Computational Fluid Dynamics; Additive Manufacturing (3D Printing)
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree in biomedical engineering, mechanical engineering, aeronautical engineering, materials science or a related subject. Preferred skill requirements include knowledge/experience of fluid mechanics / experimental analysis / additive manufacturing / CAD / basic programming e.g. MATLAB.
We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to EPS, and we pride ourselves on our vibrant, friendly and supportive working environment.
**Project Summary**.
Cardiovascular Disease (CVD) accounts for 31% of all global deaths, with the UK estimated to spend £38.78billion per year on treatment. Currently, CVD is reactively treated; someone becomes seriously ill before medical intervention. If CVD risk could be identified from the geometry of an artery and its effect on biofluid mechanics and the generated forces, then we could save countless lives.
Aston University has recently invested in a state-of-art experimental fluid dynamics Particle Image Velocimetry (PIV) system and Computational Fluid Dynamics (CFD) software, which provides the candidate the best opportunity to perform world class biofluid research, while maximising the impact of our research facility.
The proposed research will use PIV, to produce complete time dependent 3D flow fields within arterial models. This will be acquired during the cardiac cycle within compliant, physiologically realistic, arterial geometries, constructed using investment casting and 3D printing. The ideal candidate could compliment this analysis and the development of an experimental benchmark with CFD simulations to perform a parametric analysis of geometrical effects on the flow field.
There is also an opportunity that the development of this experimental setup will serve as a perfect testbed for manufacturers of surgical devices; elucidating the affect their interventions have on the fluid dynamics post-surgery, thus leading onto industrial partnerships and applications.
Aim – To develop a model which can demonstrate the influence of arterial geometry as a predictor for CVD in comparison with a healthy aging person and can be used in the experimental testing of implantable medical devices.
Objectives
- Use additive manufacturing alongside other routes to create patient specific 3D geometries of human arteries

- Identify key geometric parameters that lead to CVD progression based on their influence of the arterial flow field
- Evaluate and validate models for the testing of implantable medical devices

**2020/21-062 - Development of Targeted Cancer Cell Hyperthermia Technique**

**Supervisor:** Dr Xianghong Ma (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)
**Assoc Supervisor:** Dr Greg Swadener (Engineering and Physical Sciences College/ Department of Mechanical, Biomedical and Design)

**Areas of Research**
Biomedical Engineering, Mechanical Engineering.
**Knowledge and skills required in applicant:**
Background in Mechanical or Electrical Engineering degrees. Knowledge in software modelling in general. Experimental skills of design and test rigs.
**Project Summary**.
Cell hyperthermia is a promising approach to the treatment of cancer. Through heating tumour tissue to a temperature of 40–43 °C , the cells will suffer a series of thermally induced metabolic events including apoptosis. When hyperthermia is designed properly, it potentially has no unpleasant side-effects associated with treatments such as chemotherapy or radiotherapy. Traditional hyperthermia methods include whole body hyperthermia, and local hyperthermia using high energy waves aimed at a tumour near the body surface from a machine outside the body or using a thin needle or probe injected into the tumour to release energy and heat the tissue around it. The common problems associated with this treatment is the difficulty to control temperature in the tumour site and surrounding tissues, and this has largely impeded the wide use of hyperthermia in cancer treatment.
The project is aimed to tackle the above issue and specific objectives are:
1. Develop an advanced modelling method to investigate the heat conduction with different tissue and organ types.
2. Develop a testing rig to investigate magnetic induced hyperthermia technique using Nanoparticles.
3. Provide methods to assist the decision making by clinicians on hyperthermia treatment, including hyperthermia agent concentration, temperature requirement and heat exposure time in different organs and tissues, and magnetic field strength needed

**2020/21-063 - Changing the landscape of Urban Mobility: Towards a sustainable and carbon-neutral future with Connected & Autonomous Electric Vehicles**

**Supervisor:** Dr. Muhammad Azmat (Engineering and Physical Sciences College / Department of Engineering Systems and Supply Chain management)
**Assoc Supervisor:** Dr Brian Price (Engineering and Physical Sciences College / Department of Engineering Systems and Supply Chain management)

**Areas of Research**
Innovation in vehicle technology, vehicular communication V2V, V2X, V2G and Business applications/use cases.
**Knowledge and skills required in applicant:**
Preferably a bachelor's in engineering or IT . Master in Business or Economics or Transportation. Excellent knowledge of Modelling and Simulation software. Excellent Quantitative and Qualitative methodology skills. Comfortable with mathematical modelling like SEM, ASEM, ARIMA, Holt's Winter etc. Prior experience of publishing in internationally recognised peer review journals is an advantage. Excellent (IELTS 7 or C1) English Language Skills
**Project Summary**.
Electric Vehicles (EVs) offer the potential to reduce dependence on fossil fuel and greenhouse gas emissions. They could be used as a highly effective tool in the fight against Climate Change, yet their sales are lower than expected, mainly due to range anxiety and limited access to charging infrastructure. Therefore, to encourage potential buyers to buy and use EVs as their daily driver and to minimise the global carbon footprint significantly, we need to develop smarter, readily available and viable technical and business solutions. Which would not only encourage consumers to cope with disruptive technologies but also promote businesses to invest in them for better profits.
The outcome of the study would dictate:
- Changes in the current vehicle charging policies and regulations,
- A strategy for rolling out Vehicle 2 Vehicle (V2V) / Vehicle 2 Grid (V2G) technology as a national technology roadmap,
- Promote less reliance on building physical infrastructure and providing a more consumer and environment-friendly smart solutions for charging an EV.

In a 3 years PhD program, the candidate would examine the current state of technology readiness for V2V applications along with assessing the severity of existing challenges with vehicle charging infrastructure, the current state of V2V charging technology and propose its maturity timeline. Furthermore, highlight consumer perception about electric vehicles and their willingness to adapt to the smarter ways of charging their vehicles, and develop a policy guideline and the strategy for rolling out V2V technology as a national technology roadmap. Consequently, the candidate is expected to present V2V/V2G potential business applications; it's socio-economic benefits and trade-off analysis.
This consumer-centric project is in line with both The Global Sustainable Development Goals and UK's ambitious plans to end sales of combustion engines by 2030. The project would also address three of the top four priorities of the Department of Transport UK i.e.
(i) Boosting economic growth and opportunity
(ii) Improving journeys
(iii) Safe, secure and sustainable transport

**2020/21-064 - Storage stability and advanced low temperature combustion of biodiesels**

**Supervisor:** Dr Abul Hossain (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) / Department of Mechanical, Biomechanical & Design)
**Assoc Supervisor:** Dr Gareth Griffiths (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC)))

**Areas of Research**
Biodiesel; Storage stability; Greenhouse gas emission (GHG); Engines; Advanced combustion
**Knowledge and skills required in applicant:**
Bachelor Degree in Mechanical or Chemical Engineering. Very good analytical and problem solving skills. Good background on engines and fuels. Ability to work in a multi-disciplinary environment
**Project Summary**.

Reduction of the greenhouse gas emission and increasing the renewables share in the energy mix is a top priority in order to protect the environment and human health. Although electrification is the future solution for mobility, use of conventional engines will continue in heavy goods vehicles (HGVs), aviation, agriculture, construction, poly-generation, and marine sectors; as electrification of these sectors are yet to be feasible. Sustainable biofuels especially biodiesels produced from waste resources (2nd generation) and algae (3rd generation) can mitigate significant amount of GHG emissions by replacing fossil fuels use in these sectors. According to EU Renewable Energy Directive, biofuels must achieve 35% GHG savings. This could be achieved only by developing the right fuel mix and efficient low emission combustion strategies. The fuel quality of biodiesels depends on feedstock type and conversion parameters; often biodiesels produced from single feedstock does not meet the EN14214 biodiesel standard. Biodiesels produced from various resources will be mixed together to produce 'biomix' fuels to meet the biodiesel standard. Other technical challenges facing by the industry is the storage instability of biodiesels and higher NOx emissions compared to fossil diesel. In this PhD project, novel additives produced from algae will be used to investigate the storage stability parameters of the biodiesel fuels. Novel low temperature combustion techniques such as homogeneous charge compression ignition (HCCI), variable compression ignition (VCR), and reactivity controlled compression ignition (RCCI) will be used to reduce the NOx gas emission of the biodiesels operated engines. A simulation model will be developed to optimise and develop the novel combustion strategies of the 'biomix' fuels. The developed model will be validated by performing the experiments in the engine laboratory

**2020/21-065 - Design, Development and Optimization of innovative Bipolar Plates for Proton Exchange Membrane Fuel cells**

**Supervisor: Dr Tabbi Wilberforce Awotwe** (Engineering and Physical Sciences College / Department of Mechanical, Biomechanical & Design)
**Assoc Supervisor: Dr Abed Alaswad** (Engineering and Physical Sciences College / Department of Mechanical, Biomechanical & Design)

**Areas of Research**
Hydrogen Energy, Fuel Cell Technology
**Knowledge and skills required in applicant:**
Bachelor degree in Engineering (Mechanical, Chemical, Electrical/Electronic or Similar), Mathematical modelling Skills, preferably CFD and MATLAB.
**Project Summary**.
With the global shift towards sustainable and renewable energy sources, it is increasingly recognised that there is a crucial need for practical and highly efficient storage systems in order to improve clean energy availability in different applications. Proton-exchange membrane fuel cells (PEMFC) are efficient and sustainable electro-chemical energy convertors to work with a variety of applications in transport, stationary and portable devices. Bipolar plates are a key component of PEMFC as they uniformly distribute fuel gas and air, conduct electrical current from cell to cell, remove heat from the active area, and prevent leakage of gases and coolant. Bipolar plates with its flow channels account for 80% of the total weight of the cell and 45% of stack cost in PEMFC. This project aims to tackle durability and cost issues linked to PEMFCs by designing, developing and optimising innovative bipolar plates using additive manufacturing techniques. The project has the following specific objectives:

- Investigate the bipolar plates' materials, design and fabrication using 3D printing
- Analyse the performance of the new bipolar plates using Computation Fluid Dynamics (CFD) modelling
- Develop experimentally validated model for PEMFC via mathematical modelling to evaluate the new fuel cell performance, and compare it with other commercial fuel cells
- Determine the optimal design and materials for the bipolar plates aiming to improve the fuel cell durability
- Perform a life cycle assessment (LCA) of the novel PEMFC bipolar plates.

**2020/21-066 - Antimicrobial polymer/bioglass nanofibers for chronic wound management**

**Supervisor: Dr Eirini Theodosiou** (Engineering and Physical Sciences College / Chemical Eng & Applied Chemistry (CEAC))
**Assoc Supervisor:** (**Prof Richard Martin** (Engineering and Physical Sciences College/ Electrical, Electronic and Power Engineering)

**Areas of Research**
This project falls at the interface of Engineering and Health, and is addressing two of the UN Sustainable Development Goals: Goal 3–Ensure healthy lives and promote well-being for all at all ages and Goal 9–Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree or equivalent qualification in Materials, Physics, Chemistry, Biology, Biotechnology, Biochemistry, Biomedical Science, or Chemical/Biochemical/Biomedical Engineering, with an interest in Biomaterials. Preferred skill requirements include knowledge/experience in a laboratory-based discipline.
**Project Summary**.
Chronic wounds, such as pressure ulcers, venous ulcers and diabetic foot ulcers, affect a large proportion of the world population, with an estimated 5.7 million patients in the US alone. This silent epidemic poses a major burden to healthcare systems, with annual costs for treatment far in excess of 20 billion USD. These open wounds are often contaminated with different types of microorganisms which are difficult to treat, and occasionally can even lead to amputation. For example, approximately half of the patients with diabetic ulcers develop an infection, with Staphylococcus aureus being the most common infecting organism and 46% of these isolates being methicillin-resistant (MRSA).
Infected surface wounds that ulcerate are difficult to treat. Widespread and prolonged use of antibiotics in the treatment of these ulcers contributes towards antimicrobial resistance, and a preventative strategy that reduces/eliminates infections, would clearly be of great benefit. Current research in wound management aims to create 'smart' or 'bioactive' materials through the incorporation of therapeutic and/or antimicrobial agents, in order to fulfil multiple parts of the wound healing process.
In this project, we plan to develop novel, bioresorbable, wound dressings containing antimicrobial agents with extended release characteristics, to address the issues associated with chronic wound treatment. Polymer-based non-woven mats will act as scaffolds to support and aid the delivery of bioactive glass containing antimicrobial ions. The latter will provide the antimicrobial properties necessary for infection prevention, whereas the former will offer the controllable porosity, and high surface area-to-volume ratio, to allow for cell proliferation, moisture retention, haemostasis and removal of exudates. The most promising multifunctional dressings will be tested for their antimicrobial efficacy against a range of clinically relevant pathogens, and their cytocompatibility using dermal fibroblasts, with a view to future clinical studies in diabetic patients

**2020/21-067 - Optimisation of hydrogel scaffolds for tissue engineering**

**Supervisor: Dr Anisa Mahomed** (Engineering and Physical Sciences College / Chemical Engineering & Applied Chemistry)
**Assoc Supervisor: Prof. Brian Tighe** (Engineering and Physical Sciences College / Chemical Engineering & Applied Chemistry)

**Areas of Research**
Biomaterials; Polymers; Tissue Engineering; 3D-printing;
**Knowledge and skills required in applicant:**
Masters in chemical engineering, material engineering or similar scientific subject. Experience in working with biomedical polymer materials. Experience in biomaterial synthesis techniques such as freeze-drying, electrospinning and others. Knowledgeable in biomaterial characterisation techniques. Experience in cell-

induced differentiation and stem cell culturing. Extensive knowledge in tissue regeneration technologies. Publication track record

**Project Summary**.

Functional scaffolds, that bear a resemblance to the native organisation of tissues, have enormous potential in tissue engineering to aid the reconstruction of clinically damaged tissue, such as skin, nerves, heart valves, tendons to name a few. Functional scaffolds are essentially three-dimensional porous biomaterials that (a) mimic the natural extracellular matrix (ECM) of tissue and promote cell-biomaterial interaction (b) provide the tissue with mechanical support (c) permit the transport of gases and nutrients for cell growth (d) biodegrade at a controllable rate and (e) provokes a minimal immune response.

Natural and synthetic polymers have shown potential as biomaterial scaffolds due to their biological, mechanical and structural properties. Poly (vinyl) alcohol (PVA), for example, is a hydrophilic polymer that has been reported to possess excellent pH-responsiveness, chemo-thermal stability and mechanical performance. PVA is reported to be non-haemolytic but can cause tissue irritation, however, this effect may be modulated when co-polymerised with other polymers. Natural polymers, such as alginate and poly (lactic acid) (PLA) have been successfully co-polymerised with PVA.

The aim of this PhD project is to develop a novel lab-based platform for understanding the material and processing variables of PVA-based hydrogel scaffolds for use in tissue engineering.

The objectives of this project are to:

1) assess the impact of design (formulation) on the processing of PVA and PVA-copolymer (potentially alginate and PLA) hydrogel scaffolds to provide adequate mechanical support and support cell growth

2) evaluate the effect of manufacturing (conventional versus 3D printing) on polymer network structure (porosity, pore size and pore interconnectivity), morphology, water structuring and the permeation of electrolytes and nutrients thus the ability this has to mimic the ECM and support cell growth

3) understand the impact of physiological flow parameters such as velocity and pressure on the permeation of electrolytes and nutrients.

**2020/21-068 - The use of agricultural wastes to support sustainable post harvesting in Sub Saharan Africa**

**Supervisor:** **Dr Abed Alaswad** (Engineering and Physical Sciences College / Department of Mechanical, Biomechanical & Design)

**Assoc Supervisors: Prof Robert Amoah** (University of Cape Coast, Ghana); **Dr Ahmed Rezk** (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)

**Areas of Research**

Sustainable Energy, Modelling, Optimisation

**Knowledge and skills required in applicant:**

Bachelor in Mechanical Engineering, Chemical Engineering, Agricultural Engineering or similar. Experience in systems modelling is preferable.

**Project Summary**.

A significant proportion of the food produced in Sub- Saharan Africa is lost due to the lack of affordable and sustainable post-harvesting solutions contributing to the food security issues in the region. Post harvesting solutions such as cooling, drying, etc. are needed to cut on the food loss and to improve the lifetime of the agricultural products, thus tackling hunger and improving farming productivity in the region. In collaboration with academic institutions in the Sub Saharan Africa, the project aims to utilise bioenergy technologies to power efficient and sustainable post harvesting solutions as needed for the agricultural products. To achieve the project's aim, the following objectives are specified:

1- Map and characterise agricultural residues such as the banana residual biomass in the region.

2- Analyse bioenergy conversion technologies needed to harness energy in different types of the residual biomass.

3- Model the full integrated system from the biomass handling towards the post harvesting solutions to analyse different synergies and optimise the system in different locations.
4- Perform a Geographic Information System assessment to assess the biomass distribution, facilities location, transport and other logistic optimisation.
5- Quantify the impact of such systems on the food availability and greenhouse gas emissions.

**2020/21-069 - Catalytic conversion of CO2 and biomass-derived phenols to high-value chemicals**

**Supervisor:** Dr Jude Onwudili (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))
**Assoc Supervisor:** Dr Qingchun Yuan (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI) / Chemical Eng & Applied Chemistry (CEAC))

**Areas of Research**
Carbon dioxide (CO2) Utilisation
**Knowledge and skills required in applicant:**
Demonstrable knowledge of bioenergy, catalysis applied to bioenergy, organic chemistry, mass and energy balances, chemical engineering unit operations and chemical process design; good laboratory skills and experimental data handling & processing and technical report writing skills.
**Project Summary**.
Carbon dioxide (CO2) is the most ubiquitous greenhouse gas and between 1950 and now, total CO2 emissions increased 5 billion tonnes to 36 billion tonnes per year [1]. Efforts to reduce carbon emissions through carbon capture and storage (CCS) and deployment of low-carbon energy resources are ongoing but there is a growing interest in utilising CO2 as a carbon source to produce high-value chemicals such as aromatic carboxylic acids (ACAs), e.g. benzoic acids and salicylic acids, which are valuable intermediates for pharmaceuticals and fine chemicals [2].
Project Aim: To produce ACAs via catalytic coupling of CO2 and biomass-derived phenols, offering both environmental and sustainability gains as a green route for chemical fixation of CO2.
Research Objectives
Year 1. Quarters 1-2: Extensive literature review leading to the identification of appropriate catalysts and reaction conditions.
Quarter 2-4: Initial laboratory trainings and experiments to screen various catalysts, including metal carbonates, transition metal salts and Lewis bases (K2CO3, AlCl3, AlBr3, SnCl4, ZnBr2, ZrO2, TiO2) and experimental conditions for the reaction of CO2 (with co-solvents) and a selection of commercially available biomass-derived phenols to produce their corresponding ACAs.
Output: Presentation at one international conference
Year 2. Quarter 1: Catalyst selection & optimisation, effects of co-solvents and identifying phenols that give high yields of their corresponding ACAs.
Quarters 2-4: Investigate the production and isolation of phenols from biomass via catalytic hydrothermal liquefaction/depolymerisation of commercial lignin feedstock [3], using catalysts (e.g. Pd/C, NiFe2O4, FeCl3) to enhance the yields of desirable phenols.
Output: One journal paper and more conference presentations
Year 3. Quarters 1-2: Investigate the conversion of lignin-derived phenols to their corresponding ACAs. Quarter 3: Detailed process synthesis and process design, followed by techno-economic assessment based on experimental results.
Quarters 3-4: Thesis write-up and submission.
Output: PhD Thesis, one journal paper and more conference presentations.

**2020/21-070 - Enabling policy environments for UK Bioenergy**

**Supervisor:** Prof Patricia Thornley (Engineering and Physical Sciences College / Energy and Bioproducts Research Institute (EBRI))
**Assoc Supervisor:** Dr Mirjam Röder (Engineering and Physical Sciences College/ Energy and Bioproducts Research Institute (EBRI), Supergen)

**Areas of Research**
Bioenergy, policy, modelling, climate change
**Knowledge and skills required in applicant:**
Candidates will require a strong numerical and analytical background, but also be capable of assimilating, understanding and synthesizing detailed descriptions, regulations and information. An aptitude for working as part of an interdisciplinary team and with a wide variety of stakeholders is essential
**Project Summary**.
Bioenergy can provide a significant proportion of the UK's primary energy supply across electrical, heat, transport and chemical/material sectors. However, this requires policy mechanisms that effectively incentivize the most sustainable options. This project will examine how different policy mechanisms and incentives support the deployment of bioenergy in different sectors.
You will start by reviewing UK bioenergy options for electricity, heat, transport fuel, chemical production and negative emissions from wood and waste. You will work with partners in the Supergen bioenergy hub to define the performance of typical systems compared to existing and evolving options in each demand sector alongside relevant carbon and cost targets. You will gather information from partners and published literature on the life cycle environmental and economic performance of different feedstocks and conversion options. You will work with colleagues to assess how different "whole bioenergy systems" perform under established economic and environmental criteria. You will review established policy options for bioenergy, gathering evidence on the advantages, disadvantages and unintended consequences of implementation of different schemes. This will be used to generate a set of possible policy frameworks which you will develop in consultation with external stakeholders. You will then apply these frameworks to the bioenergy systems and evaluate the extent to which selected frameworks would support key stakeholder objectives of carbon reductions and cost effective energy supply. This will allow you to build a set of recommendations around the types of policy instrument which will facilitate UK renewable energy objectives and bioenergy deployment.

**2020/21-071 - Autonomous history-aware decision-making with explanation and reasoning capabilities**

**Supervisor:** Dr Nelly Bencomo (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) / Computer Sciences Department)
**Assoc Supervisor**: Dr. Antonio Garcia-Dominguez (Engineering and Physical Sciences College/ Computer Science / Aston Institute of Urban Technology and the Environment (ASTUTE))

**Areas of Research**
Autonomous Systems and Decision-making under Uncertainty supported by Machine and Bayesian Learning
**Knowledge and skills required in applicant:**
* Required: strong programming and software development skills
* Desirable: experience with engagement in open-source software projects
* Desirable: experience with machine learning approaches (especially Bayesian and Reinforcement Learning approaches)
**Project Summary**.
There is growing interest towards the application of ML-based learning for self-adaptation. However, the self-* property "self-explanation" of self-adaptive and autonomous systems (SAS) has been neglected. This is paradoxical, as self-explanation is inevitably needed when using ML techniques.

In the SEA Research group, we are constructing our own infrastructure for SAS that use ML and Bayesian Learning (BL) to be able to (i) look at its own history to explain why the system has reached its current state and (ii) improve its decision making. The infrastructure and capabilities need to be built in such a way that the system's history can be stored and queried to be used in the context of the decision-making algorithms. The infrastructure is open source and managed by SEA, what allows external collaborations. The explanation capabilities are framed in four levels, (1) forensic history-aware explanation, (2) live history-aware explanation, (3) human-in-the-loop and (4) autonomous history-aware explanation. So far, 3 PhD students (one graduated) have constructed implementations for levels 1,2 and 3, with several international conferences and journal publications.

The aim of the PhD project is to develop level 4, i.e history-aware explanation capabilities to support autonomous behaviour of SAS that use ML and BL. The improved version of the existing decision-making process will take control over its history as another dimension to adapt and offer explanation of the behaviour. The specific objectives are:

- include other learning techniques not explored so far. These techniques build up on data structures, such as Q-tables in the Q-Learning model-free reinforcement learning algorithms, which have been used at level 2 and 3.
- explore links from deeper nuances of decision-making data with the time series modelling.

The student will work in the dynamic environment of SEA, interacting with other students, under the umbrella of the new Twenty20Insight EPSRC project.

## 2020/21-072 - Innovative Fabrication of Bioactive Glass Scaffolds for Tissue Engineering Applications (Bone Regeneration)

**Supervisor:** Dr Zhentao Wu (Engineering and Physical Sciences College / Chemical Engineering and Applied Chemistry (CEAC))

**Assoc Supervisor:** Prof Richard Martin (Engineering and Physical Sciences College/ Electrical, Electronic and Power Engineering) Dr Laura Leslie (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)

**Areas of Research**

Biomaterials, Material science, Interdisciplinary Physical / Chemical and Biological Sciences.

**Knowledge and skills required in applicant:**

This is a highly interdisciplinary research project and the student will be working at the material/ engineering/ life science interface. A good first degree in science such as materials, physics, chemistry, biomedical science, or engineering such as chemical engineering and mechanical engineering will be appropriate. Students with research experience in subjects above are preferred. The applicant must be prepared to learn new knowledge, skill and technique across disciplines. The student will also undertake mechanical and biological experiments within wider research groups at Aston. Full training will be provided, together with opportunities of participating international conferences and visiting research groups in EU and China.

**Project Summary**

Applicants are invited to apply for a multidisciplinary PhD studentship developing and characterising novel bioactive scaffolds for tissue (bone) repair and regeneration.

The project will focus on bioactive glasses, which have a unique ability to bond to host bone and stimulate new bone growth. These materials have already been successfully used as filling agents in maxillofacial and dental repair. However, for larger bone fracture repairs mechanically robust scaffolds, which mimic the morphology and structure of bones, are necessary. Successful fabrication of such bioactive scaffolds has the potential to significantly reduce patients healing time after surgery.

In this highly interdisciplinary project, an innovative material processing method will be developed to enable larger bone defects to be treated. This will effectively address the long-standing trade-off between bioactivity and mechanical robustness of bioactive glass scaffolds. Meanwhile, methodology of fabricating inorganic porous materials with hierarchical pore structures will be employed to control morphology and microscopic structure of bioactive glass scaffolds. Effectiveness of these innovations will be assessed via mechanical and bioactivity tests, in addition to a wide range of material characterizations.

The project will benefit from a highly experienced and multi-disciplinary supervisory team who have expertise in porous inorganic materials (Dr Zhentao Wu), bioactive glasses (Prof Richard Martin), evaluation of mechanical properties (Dr Laura Leslie) and biological properties (Prof Ivan Wall).

Aim and Objectives:

The overall aim of this project is to develop bioactive and mechanically robust bioactive glass scaffolds for bone repair and regeneration, through innovations in both material design and processing. To this end, following Objectives will be made:

1. Synthesize bioactive glass materials of consistent chemical composition and physical properties;
2. Processing the bioactive glass material into scaffolds with desired microscopic structures;
3. Evaluation of mechanical and bioactive properties, together with material characterizations

**2020/21-073 - Development and validation of a system for evaluation of forensic evidence**

**Supervisor:** Dr Geoffrey Stewart Morrison (Engineering and Physical Sciences College / Computer Science)
**Assoc Supervisors:** Dr Roberto Puch-Solis (Engineering and Physical Sciences College / Computer Science); Dr George Vogiatzis (Engineering and Physical Sciences College / Computer Science); Dr Patrick Geoghegan (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)

**Areas of Research**

Forensic Data Science, Forensic Inference and Statistics

**Knowledge and skills required in applicant:**

Applicants should have Master's level knowledge and skills in applied statistics or machine learning (which may have been gained in the context of an area of application). They should also be competent in coding in languages such as Matlab, Python, or R. Existing skills and knowledge specifically in forensic inference and statistics, forensic data science, or one or more areas of forensic science would be advantageous, but are not essential.

**Project Summary**.

The student will work on the development of a system for evaluation of forensic evidence, and the validation of that system under casework conditions. The system will calculate likelihood ratios or Bayes' factors based on relevant data, quantitative measurement, and statistical models. Application may be to an area of existing interest for the Forensic Data Science Laboratory (FDSL) or to another area of interest to the student, depending on the practicality of obtaining suitable data. Existing areas of interest for FDSL include: forensic speech science, evaluation of DNA profiles, firearms, gait analysis, bloodstain pattern analysis, cell-site analysis, fingerprints, authorship analysis. The student will be supervised by at least two members of FDSL (or a member of FDSL and a member of another unit of the Aston Institute for Forensic Linguistics), the exact combination depending on the area of application. Information about FDSL and its membership is available at http://aston.ac.uk/forensic-data-science. Prior to submitting an application, applicants should consult with Dr Morrison, the Director of FDSL.

**2020/21-074 - Automated Simulation Generator for Deep Reinforcement Learning**

**Supervisor:** Dr George Vogiatzis (Engineering and Physical Sciences College / Computer Science)
**Assoc Supervisor:** Dr. Luis Manso (College of Engineering and Physical Sciences, Aston Institute of Urban Technology and the Environment – ASTUTE, Department of Computer Science.)

**Areas of Research**

Deep Reinforcement Learning, Deep Learning, AI, Automated decision making.

**Knowledge and skills required in applicant:**

The ideal candidate has a first degree in Mathematics, Computing or Electronic/Information Engineering, strong analytical/maths/programming skills. A MSc in a related area (statistics, machine learning, robotics etc) will be very desirable, as well as any previously published work.

**Project Summary**.

The project aims to optimise Artificial Intelligence (AI) agent training and deployment in real-life problems. Reinforcement Learning (RL) is an AI technique that has boasted remarkable achievements, including robotic control problems and intelligent conversational systems. In RL, an agent is deployed within an unknown

environment without any prior experience and, through its actions, it attempts to maximise a reward signal. Its lack of prior experience, however, necessitates a significant number of interactions with the environment to learn even the simplest of tasks. In the case of situated agents such as robots and vehicles, environment interactions are extremely expensive in terms of time, energy and hardware damage, but most importantly, in terms of potential damage to human beings. This raises the risk and cost of deployment and prohibits the use of RL for the most interesting problems of situated autonomous behaviour.

The mainstream solution is to train RL agents within a simulation of the problem in hand. If the simulated environment is realistic enough, agents can then extrapolate what they have learned onto the real world. Unfortunately, creating realistic simulations is extremely difficult and requires significant energy expenditure. In this project, we will devise an efficient process to generate simulator environments automatically, with the minimal amount of environment interactions. We will use the real situated agent to obtain carefully selected observations from the real environment and use this data to train a generative model acting as a learned simulator. Harnessing the power of some of the most advanced deep generative models (GANs, VAEs, GNNs etc.) we will create an automatic simulator which will produce sensory input identical to that of the real environment. These simulators will be used to safely train agents without the need for costly environment interactions and reduce the carbon footprint of training RL agents.

**2020/21-075 - Topological optimisation of urban transportation networks and regional structure**

**Supervisor:** Dr Jens Christian Claussen (Engineering and Physical Sciences College / )
**Assoc Supervisor:** Dr Edward Sweeney (Engineering and Physical Sciences College/ Engineering, Systems and Supply Chain Management (ESSCM) / Aston Institute of Urban Technology and the Environment (ASTUTE)

**Areas of Research**
Mathematics
**Knowledge and skills required in applicant:**
A solid mathematical background and very good programming skills are required, as well as interest in interdisciplinary modelling and data analysis.
**Project Summary**.
Transportation networks, and logistic networks in general, have to serve several optimisation goals which typically are conflicting each other. The computational complexity of finding global optima often exhibits a scaling with size that becomes prohibitive, therefore heuristic and stochastic optimisation approaches come into play. In addition, resilience is a crucial feature in networks operated at high load. Current demands for climate targets will impose additional constraints and costs on transportation, towards reducing commuting, and avoiding congestion. However, the structural optimality of the transportation networks is important as well. Paradigmatic changes in society goals towards a greener society could make more significant changes viable, but should be corrobated by a scientific understanding of the respective scenarios. City structures and transportation networks are usually historically grown, driven by demands changing over time. This can be described by generalised growth models, as in physics, but incorporating nonlinear, stochastic and long-range interactions accounting for the social and economic processes. This has led to extensive research, including the development of theoretical models as scaling laws for spatial densities and important system properties. In this project, the co-evolution of residential, industrial and retail areas will be modelled together with the transportation network. This requires to combine complex network science approaches, statistical ensembles, and reduced equations for averaged densities. The project will combine development of mathematical models and computer simulations with regional traffic and urban structure data. It will allow to study the structural influence of systematic changes, e.g. adding additional transportation structures, or rearrangement of residential and industrial areas.

**2020/21-076 - Revolutionising eye care: combining OCT and optical-wavefront sensing for visual impairment prevention**

**Supervisor:** Dr Antonio Fratini (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)
**Assoc Supervisor:** Dr Patrick Geoghegan (Engineering and Physical Sciences College/ Mechanical, Biomechanical & Design)

**Areas of Research**
Biomedical Engineering, Neuroscience, Postural control, Cortical Dynamics, Virtual reality
**Knowledge and skills required in applicant:**
The successful applicant should have a first class or upper second class honours degree in biomedical, mechanical, electronic or optical engineering or related subject. Preferred skill requirements include knowledge/experience of wavefront sensing / optical coherence tomography / experimental analysis / CAD / basic programming e.g. MATLAB.
**Project Summary**.
Eye conditions are one of the most prevalent impairing illnesses of modern society. Some, such as glaucoma, cataracts, retinal detachment, maculopathy, lead to vision impairment/loss while others still significantly decrease the quality of life of the affected subjects.
Diagnostics and treatments have greatly advanced during the past decades, allowing earlier diagnosis, improved treatment and better patient outcomes with consistent savings for the healthcare systems.
State of the art of eye imaging include Optical Coherence Tomography (OCT) and Optical wavefront sensing (aberrometry). However, while OCT provides depth and cross-sectional information of human cornea at micro-scale resolution, it has minimal data on optical power. Similarly, optical-wavefront sensing measures the irregularities in wavefront patterns of light emerging from the eye (due to imperfections of anterior/posterior surfaces of crystalline lens and cornea) but provides no information on their location.
This project aims at combining the two technologies in one single device to simultaneously provide geometric and power data of the analysed optical path. Such a system can be used in clinical practice (e.g. live surgical imaging, impact on eye surface shape combined with analysis of lens fit) and in manufacturing (e.g. metrology of contact and intra-ocular lens).
This project will benefit from Aston University long-standing expertise in the area of medical devices design and it will be developed in collaboration with Optimec Systems, a leading industry in the metrology of contact lenses.
Aim: To develop an innovative ophthalmic device combining OCT and optical-wavefront sensing into a single system to revolutionise the diagnosis and treatment of eye conditions.
Objectives:
- Identify the key principles of each technology and develop the theoretical optical setup
- Develop a functional prototype combining OCT and optical wavefront sensing systems
- Evaluate and validate the system with ex-vivo (manufacturing metrology) and in-vivo (clinical assessment) testing

**2020/21-077 - Optical spectroscopy for agricultural and food samples monitoring**

**Supervisor:** Dr Alex Rozhin (College of Engineering and Physical Sciences, Aston Institute of Photonic Technologies (AIPT)/ Department of Electrical and Electronic Engineering)
**Assoc Supervisor:** TBC

**Areas of Research**
Nanoscience, Photo-physics or photo-chemistry of soft and organic materials, Optical spectroscopy, Optical sensors
**Knowledge and skills required in applicant:**
Processing of advanced materials, Optical Spectroscopy, Optical sensors.
**Project Summary**.
Household and industrial food waste is one of the main environmental pollutants. Therefore, the issue of developing sensor systems for the food and agricultural industries is of serious economic and social importance. The problem of this area is that there are very many sources of pollution of foods, including fertilizers, micro/nano plastic, bacterial contamination etc. Additionally, the composition of plant and animal products is very dependent on the biochemistry of soil, which use for plants grows or animals graze. Presently, the food industry still depends on the methods of the 19th century to control the quality of the products, which are mainly based on long-term bacterial analysis in Petri dishes. In most cases, the analysis requires high precision and expensive equipment and highly qualified personnel. Hence, the cost of the analysis is high and is unaffordable to small producers and retailers. Optical spectroscopy has a great potential for use in the food and agricultural industries. Testing of samples can occur both in the liquid and solid phases, enabling to define chemical and bacterial pollution as well as biological components of plant and animal products. In most cases, the analysis requires high precision and expensive equipment, which can only be managed by highly qualified personnel. Hence, the cost of the analysis is high and is unaffordable to small producers.
Within the framework of this project, we plan to perform the following Research Objectives: development of efficient sampling protocols, spectroscopic characterisation of food samples, and building of USB based spectrometer for express analysis of food samples

**2020/21-078 - A Social Science Model of Conflict to Instability – Can Criminality be Predicted through Behavioural Modelling?**

**Supervisor:** **Dr Amit K Chattopadhyay** (Engineering and Physical Sciences College / Aston Institute of Urban Technology and the Environment (ASTUTE) / Mathematics )
**Assoc Supervisors:** **Dr Juan P Neirotti** (Engineering and Physical Sciences College /), **Prof Siddhartha Bandyopadhyay** (College of Social Sciences, University of Birmingham/ Economics)

**Areas of Research**
Interdisciplinary remit combining mathematics, opinion dynamics, network modelling, machine learning, artificial intelligence, statistical data modelling – Smart Cities
**Knowledge and skills required in applicant:**
*Required*: Basic knowledge of mathematical modelling and computer programming skills, including data modelling; experience of analysing coupled equations
*Preferred*: Knowledge of elementary machine learning (visualization, dimensional reduction) and advanced statistical data modelling skills.
Training to be offered on: Stochastic mathematics; Probabilistic modelling.
**Project Summary**.
Combining probabilistic modelling and discrete simulation, this project will analyse conditions under which a heterogeneous society can be a peaceful society by studying interaction patterns of networked individuals with widely different opinions. The overarching research question will be to comprehend how individual belief patterns evolve with time and can grow into collective extreme mindsets. Results from agent based 'stochastic opinion dynamic' models (Chattopadhyay & Neirotti) will be validated against spatial level crime data (Bandyopadhyay) to understand the dynamics of crime and analyse the evolution of a low conflict society.
*Key Research Questions*
(i) How agents with different 'opinions' (say ideology, priors, contrarians, etc.) exchange their opinions and beliefs?

(ii) Which sociological conditions abate belief avalanches ('wildfire' and 'epidemic' models) driven by individuals' nature, belief patterns, population size.
(iii) Can evolution of extremist belief pockets be mitigated over time by tuning appropriate 'social pressure' modes?
(iv) Data based verification using criminal spatial data.

*Methodology*

Knowledge gap:

Agent based social interaction have conventionally been modelled within the 'opinion dynamics' framework. While partially successful in modelling behavioural evolution of individuals, they suffer from limitations that constrain their direct applications in urban planning: a) opinion differences of individuals are arbitrarily set at a global threshold that neglect specific societal identities and requirements; b) evolution of public opinion require adaptive learning strategy (unlike Bayesian inference structure); c) decisions in modern societies often appear as opinion avalanche that necessitate 'crowd' interactions (inter-connected networks), e.g. strong religious beliefs on family planning are often crosslinked with political affiliation and voting patterns.

*Key deliverable:*

The proposed project will establish an artificially intelligent social predictive model that will use public opinion data as input and probabilistically predict social instabilities or insurgency arising from individual opinion patterns ⍰ 'only a safe city is a smart city'

**2020/21-079 - Keep your balance: use virtual reality to analyse and improve postural control and motion sickness**

**Supervisor: Dr Surej Mouli** (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)
**Assoc Supervisor:** Dr Antonio Fratini (Engineering and Physical Sciences College / Mechanical, Biomedical & Design Department)

**Areas of Research**

Biomedical Engineering, Neuroscience, Postural control, Cortical Dynamics, Virtual reality

**Knowledge and skills required in applicant:**

The successful applicant should have a first class or upper second class honours degree in biomedical engineering, neuroscience, computer science or a related subject. Preferred skill requirements include knowledge/experience of electrophysiology/ experimental analysis / VR / basic programming e.g. MATLAB.

We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to EPS, and we pride ourselves on our vibrant, friendly and supportive working environment

**Project Summary**.

Motion sickness is a complex syndrome and a common complaint among those who passively travel: susceptibility to motion sickness is the highest in childhood and usually decreases in adulthood. Modern technologies have challenged human perceptions and provided more opportunities for the sickness to appear: spaceflights (space sickness), flight simulators and car training (visual induced motion sickness), as well as computer games.

Common characteristic of those scenarios is the mismatch between actual versus expected sensory inputs: while the person is generally motionless the environment is providing real or virtual lateral and vertical motions. Decrypting these neuromuscular processes is crucial to understand motion sickness and can be used in a number of human functional disabilities including postural control disorders, such as falls in the elderly population, visual and vestibular diseases, dizziness and vertigo after trauma.

This project aims at evaluating postural control strategies and the occurrence of motion sickness induced by external stimulation. The proposed research will use physiological analyses (EEG, EMG and HRV) measured in a simulated VR environment to generate predictive biomarkers of sensory or balance deficit.

Aston has recently invested in a state-of-the-art facility (ALIVE laboratories) that includes a CAVE, a gait/posture analysis lab with a 12-camera VICON stereophotogrammetric system, 2 AMTI force platforms and portable high-density EEG/EMG device and has longstanding collaboration with Reykjavik University, a key partner of this project with specific interests in sea-sickness.

Aim: To develop an evaluation platform to study postural control and motion sickness during real and simulated motion scenarios.

Objectives:

- To develop an evaluation platform to measure postural control and motion sickness using state of the art electrophysiology and VR technologies.
- To distinguish motion sickness prone individuals from non-prone individuals and to validate the questionnaire used in clinical motion sickness settings.
- To identify key biomarkers for prediction of sensory or balance deficit

**2020/21-080 - Applications of Ozone Microbubble Technologies for Hospital Wastewater Treatment and Remediation**

**Supervisor:** **Dr Kiran Tota-Maharaj** (Engineering and Physical Sciences College / Department of Civil Engineering)
**Assoc Supervisor:** **Prof Mujib Rahman** (Engineering and Physical Sciences College / Department of Civil Engineering)

**Areas of Research**

Water and Environmental Engineering.

**Knowledge and skills required in applicant:**

Applicants should have a minimum of a 2.1 degree in Engineering (Chemical, Civil, Environmental, Mechanical, Process Engineering) or Natural Sciences (Chemistry, Physics, Environmental Science) and a Master's degree or equivalent in a relevant subject area (Chemical and Process Engineering, Civil Engineering, Civil and Environmental Engineering, Environmental Engineering, Environmental Science and Management, Water and Wastewater Management, Renewable Energy Technology)

**Project Summary:**

Conventional treatment of organic hospital wastewater is still very challenging to meet the effluent discharge standard (e.g. World Health Organisation, EU Water and Wastewater Treatment Directives), restricting the development of related industries across the developing world. In real-life, organic wastewater treatment practices still need to incorporate more advanced remediation and treatment regarding onsite hospital discharges which is still a significant negative impact on ecosystems and natural hydrosystems in the developing world today due to increase use of medication in this global pandemic. The deep and exhaustive treatment of organic wastewater can further reduce the pollutants in the wastewater to eliminate the harmfulness to the environment in small island developing states (SIDS). This research project adopts micro-bubble catalytic ozonation technologies specific to pharmaceutical wastewater and sewage generated by hospitals specific to Caribbean SIDS. Pharmaceutical wastewater in the Caribbean often includes acid and alkali wastewater, toxic organic substances, and other grey water sources. The pH and water quality of the wastewater fluctuates greatly. In recent years, several experimental studies have only focused on simulated concentrations of synthetic wastewater, whilst the general composition of hospital generated wastewater is often relatively complex and difficult to degrade, remediate and even reuse. The project aims to address the existing gaps for hospital wastewater remediation and treatment onsite across the developing world for solving authentic technical issues of organic loading and the quality of wastewater discharges and its effluent, proving an efficient, technical and economical solution for the application and promotion of novel technologies within the water and wastewater sectors. Taking dissolved ozone concentration as the main index, this PhD study will evaluate the effects of ozone dosage, pH and temperature of liquids on final composition content. The wastewater in this PhD project will be extracted from medical facilities as well as synthetic hospital wastewater. The study will look at various stages including ozone and wastewater mixing, photochemical catalytic oxidation rates and physiochemical conditions of varying flowrates, water pressures and micro-bubble aeration. The study will utilise pure oxygen as the source,

simulating an ozone generator in producing ozone (O3) and look at the theoretical, empirical and practical aspects of the kinetic reactions within the wastewater treatment process.

**2020/21-081 - Analysing the impact of Blockchain technology for digital supply chain evolution**

**Supervisor:** Dr Qiang Wu (College of Engineering and Physical Sciences / Department of Engineering Systems & Supply Chain Management)
**Assoc Supervisors:** Dr Muhammad Azmat (Engineering and Physical Sciences College / Department of Engineering Systems and Supply Chain management); **Professor Qile He** (College of Business, Law and Social Sciences / Derby Business School)

**Areas of Research**
Supply chain engineering and digital technologies
**Knowledge and skills required in applicant:**
The applicant should have academic and professional (preferable) background in supply chain field. Engineering and IT experience is highly valued.
**Project Summary:**
Globalisation of supply chains makes their management and control more difficult. As the response, digital supply chain transformation and integration received increasing attention, because next-generation digital technologies have the potential to increase transparency, traceability, and security of supply chain. In particular, Blockchain, as a distributed digital ledger technology, shows the promise to reconfigure current supply chain structure, with the ultimate goal to fully ensure secure and flexible supply chain operations at a lower cost. Nevertheless, the research on Blockchain and its relationship with supply chain management stills remains as a theoretically nascent field. Scholars and practitioners are not fully aware of the potential of Blockchain and how this technology will disrupt traditional supply chain management models. In this regard, the objective of this PhD project is twofold. First, it aims to establish a theoretical model to explore the disruptive potential implications of the Blockchain for supply chain management. The possible relevant theoretical perspectives that can be adopted by this project include principal agent theory (PAT), transaction cost analysis (TCA), resource-based view (RBV) and network theory (NT). Second, in the project, case study approach will be applied to test and verify the theoretical model in various supply chain settings. In short, this PhD project is a multi-disciplinary research encompassing knowledge from supply chain engineering, digital technologies and system design.of varying flowrates, water pressures and micro-bubble aeration. The study will utilise pure oxygen as the source, simulating an ozone generator in producing ozone (O3) and look at the theoretical, empirical and practical aspects of the kinetic reactions within the wastewater treatment process.