Research excellence sits at the heart of the Department and influences everything we do. Key to our world-leading research is our thriving and vibrant research community. This community includes all academic staff, researchers, technicians, administrative staff and students, and seeks to bring people together, promote discussion and celebrate success.

With thanks.

Professor Daniel Coca, Head of Department.
THE ONLY Department in the UK
... and one of the best in the world
DEDICATED to Control & Systems Engineering
Research at the Department of Automatic Control & Systems Engineering (ACSE)

“Our vision is to carry out groundbreaking research to address challenges posed by the complexity of natural and man-made systems and the demand for higher levels of autonomy and intelligence of future engineering systems.”

Professor Daniel Coca
Head of Department

“Thanks to our academics, researchers, PhD students and support staff, the department produces world leading research resulting in impact to industry, the public sector and government. Our highly interdisciplinary approach ensures the results of our research are felt across not just engineering, but also life sciences, healthcare and the environment.”

Dr Robin Purshouse
Director of Research and Innovation
Cross-Cutting Research Application Areas

AEROSPACE & TRANSPORT
We have always been at the forefront of research into systems and control engineering applied to aerospace and transport. Our work seeks to reduce operating costs, fuel consumption and environmental impacts and improve performance.

ENERGY & ENVIRONMENT
Our research into control technologies applied to energy and the environment will improve the efficiency and security of energy generation, reduce the carbon footprint and help us to understand and manage the risks associated with climate change.

LIFE SCIENCES & HEALTHCARE
We use systems engineering methodologies and tools to address some of the challenges posed by an ageing population and the complexity of biological systems, which will increase quality and reduce the costs of healthcare.

MANUFACTURING & ROBOTICS
We are in a very strong position to address key challenges in manufacturing and robotics. Manufacturing is one of the key technological challenges in developing engineering products of the future and maintaining the UK as a global economic power.
Research Groups

Life Sciences and Healthcare
Energy and Environment
Manufacturing and Robotics
Aerospace and Transport

Complex Systems & Signal Processing
Intelligent Systems, Decision & Control
Autonomous Systems & Robotics

AUTONOMY
INTELLIGENCE
COMPLEXITY
Research Centres & Institutes

ROLLS-ROYCE CONTROL & MONITORING SYSTEMS

UNIVERSITY TECHNOLOGY CENTRE
We’re home to the University Technology Centre (UTC) in Control and Monitoring Systems Engineering supported by Rolls-Royce. This Centre carries out co-ordinated and directed programmes of research in the fields of control and monitoring systems.

SHEFFIELD ROBOTICS
Sheffield Robotics is an exciting initiative involving the Departments of ACSE, Computer Science, Psychology, and Sheffield Hallam University. The world-leading Centre of Robotics is involved in developing robots and algorithms across a wide range of application areas, including advanced manufacturing, healthcare and challenging environments.

THE INSIGNEO INSTITUTE FOR IN SILICO MEDICINE
INSIGNEO is a collaborative initiative between the University of Sheffield and Sheffield Teaching Hospitals NHS Foundation Trust. It is a multi-disciplinary institute involving 140 academics and clinicians who collaborate to develop computer simulations of the human body and its disease processes.

RAIL INNOVATION & TECHNOLOGY CENTRE (RITC)
The RITC at the University of Sheffield extends across the entire Engineering Faculty. The focus of the RITC’s activity is intelligent systems engineering involving detection, sensing, communication, materials, structures and software technologies that can be applied to rail infrastructure, operations and traffic.

CENTRE FOR SIGNAL PROCESSING & COMPLEX SYSTEMS
The Centre for Signal Processing and Complex Systems supports a diverse range of multi-disciplinary research projects that span several departments and institutions. The Centre provides the underpinning signal processing, system identification, dynamical analysis, control and modelling to support emerging multi-disciplinary research themes in the life sciences and other related fields.

CENTRE FOR ASSISTIVE TECHNOLOGY & CONNECTED HEALTHCARE (CATCH)
The Centre for Assistive Technology and Connected Healthcare is a translational research centre based at the University of Sheffield. It researches, develops and implements new healthcare technologies to enable people to live and age well.
Research Groups

AUTONOMOUS SYSTEMS & ROBOTICS
This research group carries out world leading research in autonomous and robotic systems by investigating key research problems of sensing, control, decision making and system integration. The group is a major contributor to the activities of Sheffield Robotics and collaborates widely with industrial partners and other universities.

The ASR team has nine core academic members with a broad scope of internationally leading research activity, including Dr Sean Anderson, Dr Dana Damian, Professor Tony Dodd, Dr Roderich Gross, Professor Lyudmila Mihaylova, Professor Sandor Veres and Dr Shiyu Zhao.
Themes include: design of autonomous industrial robots, biologically inspired principles of sensing and control, self-assembling robotic systems and swarms and advanced software architectures for decision making.

COMPLEX SYSTEMS & SIGNAL PROCESSING
This research group is internationally leading in the development of techniques and algorithms for complex systems analysis, control and signal processing and the application of these in emerging areas of science, engineering and medicine. The group collaborates widely with academic and industrial partners, such as the European Space Agency, Vestas and BAE Systems.

The CSSP team has ten core academic members with a broad scope of internationally leading research activity, including Dr Mahnaz Arvaneh, Professor Michail Balikhin, Professor Daniel Coca, Dr Dana Damian, Dr Iñaki Esnaola, Dr Viktor Fedun, Dr Lingzhong Guo, Dr Bryn Jones, Dr George Konstantopoulos, Professor Zi-Qiang Lang, Professor Ashutosh Tiwari and Dr Hua-Liang Wei.
Themes include: identification and analysis of complex spatio-temporal systems, nonlinear signal processing, and the analysis and design of nonlinear systems in the frequency domain.

INTELLIGENT SYSTEMS, DECISION & CONTROL
While collaborating with industrial partners such as Rolls-Royce, Tata Steel, Jaguar Land Rover, Network Rail and Airbus, this research group makes a global impact on advances in multiobjective evolutionary optimisation algorithms, intelligent health monitoring and fault diagnosis, decision support systems for biomedicine, information processing and computational data modelling.

The ISDC team has ten core academic members including Professor Peter Fleming, Professor Rob Harrison, Professor Visakan Kadirkamanathan, Professor Mahdi Mahfouf, Dr George Panoutsos, Dr Simon Pope, Dr Robin Purshouse, Dr Anthony Rossiter and Dr Paul Trodden.
Themes include: multi-criteria decision-making, modelling and optimisation for manufacturing, modelling of systems behaviour for monitoring and prediction, modelling of social systems, and control design and predictive control.
Aerospace & Transport

Our work seeks to reduce operating costs, fuel consumption and environmental impacts and improve performance. We seek to achieve this through the development of active flow control, noise reduction and autonomous technologies; health monitoring; through-life system optimisation solutions; model-based systems engineering and multidisciplinary modelling and control.
TRANSIT: A NEW AIRPORT SYSTEM TO SAVE TIME, MONEY AND CARBON EMISSIONS

Professor Mahdi Mahfouf

With increasing global demand for air travel and overloaded airport facilities, the inefficient movement of aeroplanes - or airport taxiing operations - is identified as a major contributor to unnecessary fuel burn and a substantial source of pollution.

TRANSIT (Towards a Robust Airport Decision Support for Intelligent Taxiing) is a research project that has the potential to increase airport capacity, while reducing the environmental impact of the growing aviation sector.

A £1 million UK-Engineering and Physical Sciences Research Council (EPSRC) sponsored research grant to develop a pioneering new aircraft routing and scheduling system, that could see operations increase by 50% at some of the world’s busiest airports, has been secured by aviation engineering specialists.

TRANSIT will see researchers and industry experts working together for three years to develop a new on-the-ground system that will reduce aeroplane taxi times, operating costs and environmental impact.
A NEW DESIGN METHODOLOGY FOR CIVIL AERO-ENGINE CONTROL

Professor Visakan Kadirkamanathan & Dr Andrew Mills

Researchers from the Department of Automatic Control and Systems Engineering have developed a unified design methodology for tuning gas turbine engine controllers, which is now being used by Rolls-Royce across its latest fleet of Civil Aero Trent engines - allowing them to realise significant cost savings. Trent engines are used to power, for example, Boeing 787 Dreamliner aircraft that have been adopted by the world’s leading airlines.

Rolls-Royce Civil Aerospace has historically used linear, gain-scheduled proportional-integral (PI) compensation for the control of gas turbine fuel flow. Engine dynamics vary with flight and power conditions, and a lengthy design and verification process is required to meet the specification for all conditions.

The new control law minimises dependence against engine power level and removes dependence against altitude. It also delivers improved transient performance whilst maintaining robustness. Further, the new design methodology requires fewer tuning parameters, thus accelerating development time and significantly reducing the cost of downstream software verification.

The simplified design process is intuitive and makes the controller easy to tune, thereby making it easier to train engineers to use it. By adopting the same design methodology across the emerging Rolls-Royce fleet, the company has made continued cost savings across numerous projects.

This research was carried out at the Rolls-Royce University Technology Centre (UTC). During the course of the research programme within the UTC, besides demonstrating the enormous practical advantages of this new design, difficult tuning and architectural problems were overcome by the introduction of a number of practical innovations.

Over 20 customers have selected the Trent 1000 to power their 787 Dreamliners and these include All Nippon Airways, Air China, Air Europa, Air New Zealand, British Airways, Delta, Icelandair, International Lease Finance Corporation, LOT, Thai Airways and Virgin Atlantic.
“This is the first new radical control law for over 20 years.”

Jonathan Holt
Associate Fellow, Complex Systems Integration and Optimisation.
Rolls-Royce.
SIMULATION AND CONTROL OF UNMANNED SURFACE VEHICLES

Dr Bryn Jones

Unmanned Surface Vehicles (USVs) are set to play a vital role at sea across a range of activities, including mine clearance, autonomous surveying of the marine environment and autonomous patrol of marine fisheries and nature reserves. However, designing the autonomy that will enable USVs to operate safely and efficiently in a variety of sea conditions is a highly challenging engineering problem.

As a first step, our work with Thales UK, ASV Ltd and the University of Southampton has focused on designing a realistic simulation environment that will allow various autonomous behaviours to be tested upon a virtual USV across a full range of sea conditions, thereby reducing the need for costly and time consuming sea-trials.

The ultimate aim of this research is to allow the USV to sense, predict and react to the surrounding sea environment in an optimal fashion according to a variety of mission scenarios, including fuel efficient course tracking in mild conditions and survival in high sea states.

"Thales UK has been working in collaboration with The University of Sheffield on an Innovate UK Project, where the University has been responsible for the design and development of a simulator that will enable the modelling of unmanned surface vehicles (USVs) upon dynamic sea surfaces. With a programme of continuous product development and research supported by sea trials, the unmanned surface vehicle simulation environment developed at The University of Sheffield comes at a suitable point in our development programme to provide significant benefits."

- Richard Herbert, Project Manager, Thales
In the last 5 years we have secured 131 Research Grants worth over £19m.
A NEW AIRBUS CHAIR IS ANNOUNCED

Professor Ashutosh Tiwari

We are very pleased to announce the appointment of Professor Ashutosh Tiwari as the new Airbus/Royal Academy of Engineering (RAEng) Research Chair in Digitisation for Manufacturing. This is a senior position, aimed at establishing a unique, world-leading research collaboration in Advanced Manufacturing between ACSE, Airbus UK and the internationally renowned University of Sheffield Advanced Manufacturing Research Centre (AMRC).

The focal point of this collaboration will be the £43 million state-of-the-art ‘Factory 2050’ – the UK’s first fully reconfigurable assembly and component manufacturing research facility. Supported by ACSE, Airbus and the AMRC, Professor Tiwari and his team will develop and demonstrate, in a realistic factory environment, highly automated and flexible manufacturing solutions that deliver a step increase in productivity of aircraft wing manufacturing and assembly.

This partnership will focus ACSE’s world-leading research expertise upon Airbus’ medium term manufacturing challenges within a real-world factory setting. There will be a clear expectation of transitioning this underpinning research to high technology readiness levels (TRLs). Airbus will support this position by providing direct funding of relevant research programmes, supporting research grant applications and by contributing towards the Chair’s salary.

Professor Tiwari will be based in the Department of ACSE and will work closely with the Integrated Manufacturing Group at the AMRC. He will also have access to the expertise within Sheffield Robotics, drawing on specialist knowledge in the areas of human-robot interaction, verification and validation, field robotics and manufacturing.

Professor Tiwari comes to us from the Manufacturing Department in the School of Aerospace, Transport and Manufacturing at Cranfield University, UK. Over the past 17 years he has established Cranfield as one of the centres of excellence in the development and application of informatics techniques for manufacturing technologies, processes and systems and has developed a very strong research track record, both at national and international level. He has led (as principal investigator) 8 Engineering and Physical Sciences Research Council (EPSRC) projects, 5 Innovate UK projects, 3 projects funded by the EPSRC Centre for Innovative Manufacturing, 5 Knowledge Transfer Partnerships (KTP), a Low Carbon KEEP project, and 30 PhD/EngD studentships. He currently holds an EPSRC High Value Manufacturing Catapult Fellowship and is a Chartered Engineer and a Fellow of the Institution of Mechanical Engineers (I MechE) and the Institution of Engineering and Technology (IET).
Energy & Environment

We are uniquely placed to undertake research seeking to improve the efficiency, autonomy and security of energy generation and distribution. We understand and manage the risks associated with climate change, human health and the natural environment. We aim to reduce carbon footprint through the development of key enabling control technologies for smart grids, energy saving solutions, better models of the terrestrial climate, chemical and radiation pollution, and through the development of advanced technological solutions to monitor environment and identify precursors for natural disasters.
The survey and maintenance of water pipes is crucial to ensuring a safe water supply and reducing wastage of a precious resource. However, the inspection, maintenance and repair of water distribution systems is a costly and complex operation, with pipes buried deep underground.

The use of robotics is revolutionising this maintenance process, and our groundbreaking research is at the heart of this. A key issue for the use of robots within water pipes is navigation, with a lack of landmarks to support a normal navigation process. The SPIERBOT (Small Pipe Inspection-Exploration RoBOT) is a novel robotic device we are developing to allow the simultaneous inspection, assessment and mapping of water distribution pipes. The robot will navigate using ultrasonic scanning of the voids in the ground outside the pipe to create a map of the pipe network and locate its position within the network. At the same time the SPIERBOT will use its sensor array to assess the condition of the pipes.

This research will support more effective monitoring of water pipe damage and allow water companies to more effectively target their maintenance efforts and reduce their costs.
Integrating renewable energy and other distributed energy sources into smart grids, often via power inverters, is arguably the largest “new frontier” for smart grid advancements. Inverters should be controlled properly so that their integration does not jeopardize the stability and reliability of the power network.

ACSE researchers have been investigating modern control strategies for smart grids, exploring grid connected inverters that can achieve accurate real and reactive power regulation or offer ancillary services to the grid, guaranteeing the stability of the entire system. This new generation of smart inverters has advanced control and protection features that will lead to large-scale utilisation of renewable energy sources and will enhance the resilience of the future power network.

Currently, the Control and Power Systems (CAPS) laboratory at The University of Sheffield hosts the largest OPAL-RT real-time digital simulator in Europe and North America and therefore is ideally equipped to carry out high-level research in smart grids. The simulator is capable of performing hardware-in-the-loop implementation and real-time simulation of a power system with thousands of nodes, allowing ACSE researchers to investigate power systems with multiple generators, renewable sources, electric vehicles, energy storage systems and active loads that represent the core elements of a smart grid. In addition, the OPAL-RT system has the ability to interact with external hardware in order to implement real-time control of power converters and microgrid systems.
More than £216.6 million is being invested as part of the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC), by the EPSRC and other partner organisations in order to create a network of new state-of-the-art experimental facilities. These urban laboratories will conduct world-leading research to upgrade the nation’s infrastructure.

As part of this initiative ACSE will be working in collaboration with researchers in the Department of Civil and Structural Engineering to establish Sheffield’s own Urban Flows Observatory. This is a comprehensive platform for monitoring the city which will consist of a large and diverse array of sensors distributed across the metropolitan area, such as using fixed and mobile sensors and thermal cameras attached to drones, balloons and cars to scan the city. It will also create a computational infrastructure which is required for storing, analysing and visualising the data generated in real-time. The Sheffield Urban Flows observatory will be part of a network of interlinked urban infrastructure ‘observatories’ that includes Newcastle and Bristol.

Urban Flows will provide a platform for urban research, which will help developers understand and predict better the complex interrelations and interactions of urban systems with the environment, people and society.
SPACE CLUSTER MISSION

Professor Michail Balikhin

Our planet is constantly bathed in a stream of charged particles emanating from the Sun, the solar wind. Accelerated to supersonic speeds, these particles flow through the solar system dragging the solar magnetic field with them. The Sun is not a quiet place. Huge explosive events within its atmosphere results in the release of massive clouds of energetic particles that propagate through the solar system. Some of these clouds may have an Earth bound trajectory and their interaction with the Earth can have severe repercussions on communications, navigation, and power transmission systems.

In late 2000 the European Space Agency launched the Cluster mission - a fleet of 4 similarly instrumented spacecraft flying in formation. These satellites were designed to probe the small scale processes occurring within the shock wave, or bow shock, that exists upstream of the Earth’s magnetosphere (the volume of space around the Earth dominated by the terrestrial magnetic field) and the tail region. One of the instruments on board each of the satellites was designed, built, tested and operated by members of the Space Systems Laboratory (SSL) which is based in the Department of Automatic Control and Systems Engineering. Originally designed to operate for two years, the Cluster mission is still in operation today.

The research carried out within the SSL investigates two areas of the interaction of the solar wind with the Earth, including; the processes of dissipation and redistribution of the energy contained within the solar wind as it encounters the bow shock and the modelling of electron fluxes within the radiation belt region of the magnetosphere.

Image Credit: ESA/Cluster
100% of our home & overseas undergraduates are employed or in further study within 6 months after completing their studies.

(Destinations of Leavers from Higher Education 2017)
Life Sciences & Healthcare

Through our research we are seeking to increase the quality and reduce the costs of healthcare and address the challenges posed by an aging population and by the inherent complexity of biological systems. We are achieving this through the development of better imaging solutions, assistive technologies, decision support systems and by applying systems engineering methodologies and tools to further our understanding of biological processes as well as to the design and manufacture of cell therapies, biologically based parts, devices and systems.
Over the last three decades, Brain-Computer Interface (BCI) has attracted a lot of attention from robotic groups, neuroscientists, computer scientists and neurologists, triggered by new scientific progress in understanding brain functions and by impressive applications.

ACSE researchers have been working with a BCI system that connects the brain and computer or electronic device together, recording brain signals while the users perform different types of mental tasks. A number of signal processing algorithms are applied to improve signal-to-noise ratio and relevant patterns of the brain can then be extracted.

Such a system can greatly help people with generalised paralysis to gain some level of independence. The BCI input is the brain signals carrying informative neural features. The BCI outputs are used to control a device, such as an assistive robot, a wheelchair or a prosthetic hand.
INGESTIBLE ORIGAMI ROBOT: THE HEALTHCARE OF THE FUTURE

Dr Dana Damian

One of the goals for healthcare in the future is the development of non-invasive or less invasive alternatives to standard surgery. Such non-invasive techniques are frequently less risky and have a faster recovery time than traditional surgery, thus providing a benefit to the patient and to the medical team.

ACSE academic Dr Damian has been involved in a cutting edge project with MIT and the Tokyo Institute of Technology to create an ingestible origami robot. It is hoped that the robot will be able to undertake a range of tasks, for example remove foreign objects, repair wounds and deliver medicine at designated locations, thus eliminating the need for surgery.

The robot is made from a biocompatible material, and consists of layers of structural material, sandwiching a material that shrinks when heated. A pattern of slits in the outer layers determines how the robot will fold when the middle layer contracts. The robot is folded into its smallest position and placed into a capsule of ice, once ingested the ice melts in the stomach allowing the robot to fold out into its functional form. The robot can then be controlled via an external magnetic field.
No. 1
IN THE UK
for research output
and quality of our research publications.

General Engineering Unit of Assessment
(Research Excellence Framework 2014)
THE SHEFFIELD ALCOHOL POLICY MODEL (SAPM)

Dr Robin Purshouse

The University of Sheffield has developed the Sheffield Alcohol Policy Model (SAPM), a mathematical simulation model which can be used to appraise a wide range of alcohol policy interventions.

Since 2008, SAPM estimates have informed debates on alcohol policy in all four nations of the UK and beyond. The model has been used to inform the threshold for minimum unit pricing in Scotland and underpin NICE guidance for primary care Identification and Brief Advice (IBA) programmes in England & Wales.

The model has two elements. The first is a simulation model of the relationship between policy and alcohol consumption, considering age, sex and socioeconomic status. For pricing policies, population differences in purchasing preferences (beverage types, prices paid, balance of on-trade and off-trade) is taken into account and the relationship between price and demand using 9 years of survey data is estimated. The second element is a simulation model of the relationship between alcohol consumption and health, crime and workplace outcomes, accounting for different patterns of consumption, socioeconomic gradients, and the time lags between consumption and risk. Key outcomes considered include mortality, hospital admissions and volumes of violent crime.

The model has given policy makers a tool to answer their questions in creating new policies, and to be able to counter the criticisms that have been levelled at policies in the past. This research was funded by The Department of Health, The National Institute for Health and Care Excellence and The Scottish Government.
Researchers at the University of Sheffield have launched an ambitious project to simulate a complete model of the adult fruit fly brain for the first time.
THE FRUIT FLY BRAIN OBSERVATORY

Professor Daniel Coca

In collaboration with researchers from Columbia University in the US and National Tsing Hua University in Taiwan, we launched an ambitious research project to construct, analyse and simulate a complete model of the fruit fly (Drosophila Melanogaster) brain, for the first time.

The project has been selected out of nearly 100 submissions as one of the six winners in the first phase of the Open Science Prize Challenge.

The Fruit Fly Brain Observatory (http://fruitflybrain.org/) is a unique open source software platform for studying fruit fly brain function and for investigating models of human neurological and psychiatric disorders.

The software platform a) stores and processes data related to the neural circuits of the fly brain including location, morphology, connectivity and biophysical properties of every neuron, b) seamlessly integrates the structural and genetic data from multiple sources that can be queried, visualised and interpreted and c) automatically generates models of the fly brain that can be simulated efficiently using multiple Graphics Processing Units (GPUs).

The open software platform will enable researchers from around the world to contribute data, models and tools to construct a comprehensive model of the fruit fly brain. By working collaboratively, such models can be built far more rapidly and efficiently than would be possible by working independently.

Because many of the genes and proteins found in the human brain are also found in the fruit fly’s brain, a complete model should provide insights that will help develop a better understanding of diseases such as Alzheimer’s or motor neurone disease, as well as help identify potential new drug targets.
World Top 100 UNIVERSITY

We’re a member of the Russell Group of leading UK research universities, renowned for our teaching and research.

QS World University Rankings 2018
Manufacturing & Robotics

Through world leading research we aim to increase resource efficiency, flexibility and competitiveness of UK manufacturing through the development of integrated system modelling, simulation and optimisation tools, advanced process monitoring & automation, reconfigurable systems and smart multifunctional materials. Our pioneering work in the field of robotics seeks to develop enabling technologies for fully autonomous cooperative robots.
TACDAM: TAILORABLE & ADAPTIVE CONNECTED DIGITAL ADDITIVE MANUFACTURING

Dr George Panoutsos and Professor Visakan Kadirkamanathan

TACDAM is a 2 year Innovate UK and EPSRC co-funded project that will remove the final hurdles for the adoption of additive manufacturing in automotive applications in a staged low-mid-high volume approach.

The TACDAM project will perform targeted Additive Manufacturing pre and post-process value chain technology developments. develop an adaptive quality assurance model, introduce parametric design as a key process variable and demonstrate the capability to deliver cost and quality outcomes to the automotive industry.

Key enabling technologies that will be developed by ACSE, include the creation of model-based approaches that are used to optimise the part life-cycle in the manufacturing environment. This includes the identification of key factors in the value-chain, and data-driven methodologies that will 'learn' from data towards the better fundamental understanding of the process.
WATER-BASED RECONFIGURABLE ROBOT COULD HELP IN SEARCH AND RESCUE MISSIONS

Dr Roderich Gross

Researchers from ACSE have created an aquatic robot which could be used during underwater search and rescue operations.

The study looks at a set of robotic modules that can be assembled into robots of arbitrary shape. This allows robots to be customised to meet the changing demands of their task. Each module is a cube and has four micro pumps which allow it to move around independently in the water. When modules are joined together, they can draw in fluid from each other, as well as the environment. The routing of the fluid through the network of modules causes the robot to move. The more modules in the network, the more precisely the robot moves, and the better it copes with faults. This new concept is termed Modular Hydraulic Propulsion (MHP). Six prototype modules of an MHP robot were constructed, which float on the surface of water.

The researchers set the robot a task – to detect and move towards a light source. The robots can solve this task reliably without having a central brain. Rather, each module makes its own decisions independently, and only needs a few bytes of sensor information to do so. The modules could split up and search for survivors more quickly and recombine to manipulate the environment, for example, to open up a passageway.
NEUROBOTICS

Dr Sean Anderson

Advances in our knowledge of the brain have led to the ability to 'embody' models of neural function in robots that can physically replicate human and animal behavior. These physical models go beyond the limitations of computer simulations to enforce the consideration of real world complexities and constraints in neural control systems.

Our research, at the exciting interface between neuroscience and engineering, aims to pioneer new understanding of human and animal neural function through the embodiment of biologically-derived neural control algorithms in physical robotic systems. We focus on the cerebellum, which is associated with skilled motor control in humans. An interesting fact illustrating the importance of the cerebellum is that it contains about 80% of the neurons in the human brain.

Specific examples of embodiment of cerebellar processing from our work include:
- Implementing internal models in robots that can predict the sensory consequence of actions, improving operational robustness
- Neural control of soft robotic systems that use electroactive polymers - a new type of actuation technology that falls within a broad class known as artificial muscle
- Control of camera movements using distributed feed forward adaptive control, modelled on the human vestibulo-ocular reflex, where the adaptive component is in the cerebellum.
WE HAVE
30 Academics

46 Postdoctoral Research Associates

& 105 PhD Students
As of 2018
Work With Us

The department has a well-established history of successful relationships with industry and other external organisations. Through these, the department incorporates contemporary business and societal challenges into its teaching and research activities, allows us to share our world-leading expertise, and ensures our graduates have a thorough understanding of industrial best practice.

We can tailor collaborations to suit your individual company’s needs and timescales; activities can include short-term student projects, academic-led consultancies to longer-term collaborative research projects and knowledge transfer partnerships. Intellectual Property Rights (IPR) are determined on a case-by-case basis.

Research Knowledge & Transfer

We have extensive experience of working with companies of all sizes from micro-SMEs through to large multinationals. In all cases we harness our state-of-the-art expertise, technology, and insight to help you gain the competitive edge. We aim to establish long-term strategic partnerships allowing us to benefit all parts of your business from R&D and manufacturing through to talent acquisition.

We have extensive experience of attracting funding from a broad range of sources including Research Councils UK (RCUK), the European Commission, Innovate UK, and national charities. Alternatively, collaborations can be partly- or wholly-funded by industry.

Student Projects & Placements

The department runs a Year in Industry option on all of our undergraduate courses in which students normally spend their penultimate year putting their skills into practice within an industrial context. We also offer Industry Placements to our MSc Advanced Control and Systems Engineering students, which means they receive all of the academic advantages of our one year standard MSc with the added benefit of an Industry Placement. These both provide excellent opportunities to access a pool of highly talented and enthusiastic undergraduate and MSc students.

You also have the opportunity to part- or fully-fund a PhD student to work on longer term, innovation challenges based on your company’s needs.

“Our ACSE placement student is proving to be a really good Industry Placement, she has integrated well with the team and is already owning her own mini-projects so is therefore regularly contributing to the day to day progress at GSK. She is a great ambassador for the Industrial Placement Process at The University of Sheffield.”

- Stephen Lee-Shield, GlaxoSmithKline
Industrial Advisory Board

Strategic guidance relating to our curriculum, employability and research is provided by members of our Industrial Advisory Board (IAB). IAB members are drawn from a diverse range of organisations and are at varying points in their careers.

Furthermore, you will have the opportunity to engage directly with our world class student cohort by contributing to the assessment of MEng Engineering Level 3 group project presentations and demonstrations.

As a member of the IAB, you will have the ability to influence the department’s research and teaching direction and share in our activities to enhance the employability of ACSE graduates.

To get involved in the IAB, contact us on +44 (0)114 222 5250.

Find out more: sheffield.ac.uk/acse/iab
Academic Profiles

**Dr Jonathan Aitken**  
**University Teacher in Robotics**  

**Dr Sean Anderson**  
**Senior Lecturer** - Key Research Areas: Robotics, System Identification, Control and Biomechatronics.

**Dr Mahnaz Arvaneh**  
**Lecturer** - Key Research Areas: Biomedical Signal Processing, Neural and Rehabilitation Engineering, Machine Learning and Pattern Recognition with Applications in Healthcare.

**Professor Michail Balikhin**  
**Head of the Space Systems Laboratory, Professor of Space Systems** - Key Research Areas: Space Plasma, Solar-terrestrial Physics, Space Weather, Spacecraft Instrumentation and Nonlinear Systems.

**Professor Daniel Coca**  
**Head of Department, Professor of Nonlinear and Complex Systems and Director of the Centre for Signal Processing and Complex Systems** - Key Research Areas: Complex Systems Modelling and Analysis, System Identification and Signal Processing, Inverse Problem Theory and GPU/FPGA Computational Acceleration.

**Dr Dana Damian**  

**Professor Tony Dodd**  
**Professor of Autonomous Systems Engineering** - Key Research Areas: Autonomous Systems, Robotics, Advanced Manufacturing and Infrastructure.

**Dr Iñaki Esnaola**  
**Senior Lecturer** - Key Research Areas: Information Theory with application to Cybersecurity in the Smart Grid, Mismatched Estimation, and Multiuser Communication.
Dr Viktor Fedun  
**Senior Lecturer** - Key Research Areas: Mathematical Modelling of Physics of Solar/Space Plasmas; Sun-solar Wind; Solar-terrestrial Systems.

Professor Peter Fleming  
**Professor of Industrial Systems and Control** - Key Research Areas: Evolutionary Computing and Multi-Criteria Decision Making; Applications include Aerospace, Power Generation, Automobile, Food Processing, Pharmaceuticals and Manufacturing.

Dr Roderich Gross  
**Senior Lecturer** - Key Research Areas: Swarm and Reconfigurable Robots and Machine Learning.

Dr Ling-zhong Guo  
**Lecturer** - Key research Areas: Identification of Spatio-temporal Systems and Partial Differential Equation; Frequency Domain Analysis of Nonlinear Infinite Dimensional System; Proxy Measurement, Surrogate Modelling, and Model Reduction; Multiscale Modelling of Biomedical System.

Professor Robert Harrison  
**Professor of Computational Data Modelling** - Key Research Areas: Computational Data Modelling and Machine Learning; Applications include: Clinical Decision Support, e.g. heart disease, diabetes, endocrinology; Aerospace Prognostics; Network-wide Energy and Passenger Satisfaction Optimisation for Rail Operations.

Dr Bryn Jones  
**Senior Lecturer** - Key Research Areas: Feedback Control and Estimation of Fluid Flows and Systems Operating within Fluid Flow Environments.

Professor Visakan Kadirkamanathan  
**Director of Rolls-Royce University Technology Centre in Control and Systems Engineering, Professor of Signal and Information Processing** - Key Research Areas: Signal Processing, System Identification, Control Systems, Aerospace Systems and Biomedical Systems.

Dr George Konstantopoulos  
**Lecturer** - Key Research Areas: Power Electronics, Micro-grids, Smart Grids and Nonlinear Control.
# Academic Profiles

**Professor Zi-Qiang Lang**  
Professor of Complex Systems Analysis and Design  
- Key Research Areas: Nonlinear System Modelling, Analysis and Design; Health Monitoring and Fault Diagnosis for Engineering Systems and Structures; Smart Structures and Systems; Wind Turbine Component and System.

**Professor Mahdi Mahfouf**  
Head of the Intelligent Systems Research Laboratory, Professor of Intelligent Systems Engineering  

**Professor Lyudmila Mihaylova**  
Professor of Signal Processing and Control  
- Key Research Areas: Broad Research in the areas of Signal Processing; Bayesian Methods; Monte Carlo Methods; Nonlinear Estimation; Target Tracking; Smart Cities; Assisted Living and eHealth Systems.

**Dr Simon Pope**  
Lecturer  
- Key Research Areas: Active and Passive Acoustic/Elastic Metamaterials; Active Control of Sound and Vibration; Development of Next and Future Generation Active Materials, such as Self-healing and Adaptive Materials; Detection and Removal of Magnetic Noise in Space Based Scientific Measurements; Planetary and Space Plasma Physics.

**Dr Robin Purshouse**  
Department Director of Research and Innovation, Reader in Decision Modelling and Optimisation  
- Key Research Areas: Multi-objective Optimization and Social Systems Modelling.

**Dr Anthony Rossiter**  
Reader  
- Key Research Areas: Predictive Control, specifically Modifying the Basic Algorithm to Optimise Computational Efficiency and/or Simplicity; Efficient and Pragmatic Application of Advanced Control Methods; Effective Teaching Practice at Tertiary Level.

**Dr George Panoutsos**  
Reader  

**Professor Ashutosh Tiwari**  
Airbus/Royal Academy of Engineering (RAEng) Research Chair in Digitisation for Manufacturing  
- Key Research Areas: Digitisation of Skill-intensive Manufacturing, Simulation and Optimisation of Manufacturing Processes, Manufacturing Informatics, Digital Manufacturing.
Dr Paul Trodden
Lecturer - Key Research Areas: Control Theory and Optimization, specifically in: Distributed Model Predictive and Optimization-based Control; Cooperative and Distributed Decision-making for Agents with Shared Constraints; Path-planning and Trajectory Optimization for Vehicles and Spacecraft; Robust Model Predictive Control.

Professor Sandor Veres
Director of the Autonomous Systems and Robotics Research Group - Key Research Areas: Optimal Decision Making in Autonomous Systems; Mobile Robotics; Agent Supervised Feedback Control Systems; Architectures and Programming of Reasoning Based Intelligent Agents; Formation Flying Control of Robotic Vehicles.

Dr Hua-Liang Wei
Senior Lecturer - Key Research Areas: System Identification and Data Analytics for Complex Systems; Signal Processing and Predictive Data Modelling and Mining; Analysis, Modelling and Forecasting of Complex Dynamic Processes.

Dr Shiyu Zhao
Lecturer - Key Research Areas: Multi-vehicle Systems including: Formation Control, Cooperative Manipulation, Swam Intelligence; Autonomous Vehicles including: Unmanned Aerial Vehicles, Vision-based Localization and Navigation.
Research Fellows

Dr Andrew Hills
Research Fellow - Key Research Areas: Fault detection, diagnosis and prognosis; Embedded systems and cloud computing architectures; Data structures for big data; Machine learning.

Dr Andrew Mills
Senior Industrial Research Fellow, Rolls-Royce UTC in Control Systems - Key Research Areas: Advanced Control and Condition Monitoring of Gas Turbines.

Dr Simon Walker
Research Fellow - Key Research Areas: Interaction of the solar wind with the terrestrial magnetosphere, energy re-distribution at the terrestrial bow shock, forecast of geomagnetic activity, Cluster DWP archive scientist, Horizon 2020 project PROGRESS manager, NERC project RadSat investigator.

Dr Keith Yearby
Research Fellow - Key Research Areas: Mission operations for the Wave Experiment Consortium on the ESA Cluster fleet of spacecraft, developing onboard data compression software for the Radio and Plasma Wave Instrument on the ESA Jupiter icy moons explorer (JUICE) spacecraft, developing an Electron Density Sounder as part of the Fields and Waves experiment of the proposed Turbulence Heating Observer (THOR) spacecraft, planned for launch (if selected) in 2026.