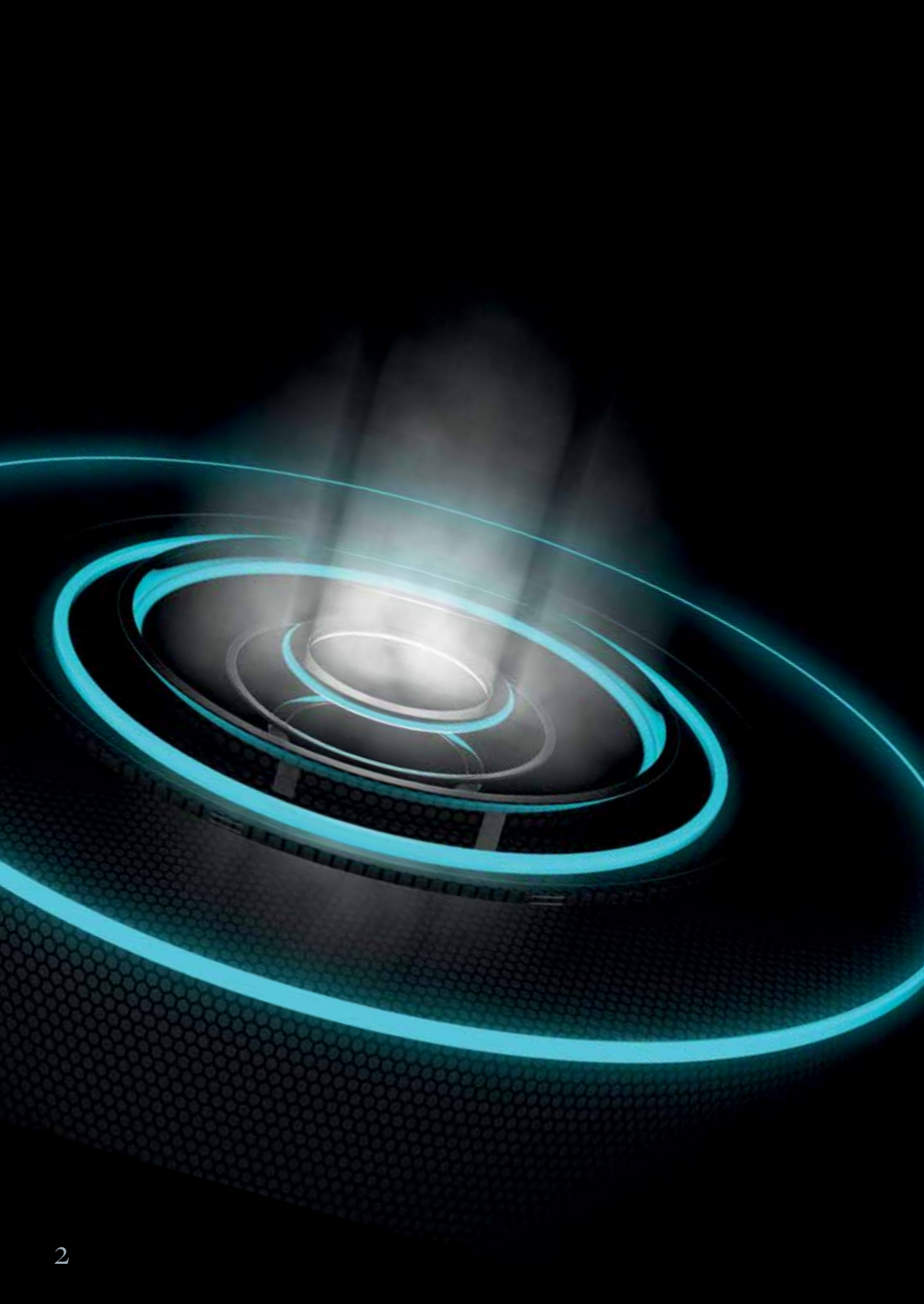UNIVERSITY OF
Southampton

Engineering the future.
Southampton Regius Lecture 2015

An Autonomous Systems Showcase
9 June 2015, Royal Academy of Engineering

Engineering@Southampton Showcase 2015

Welcome to the Engineering@Southampton Showcase – a celebration of our world-leading research in autonomous systems, and our Regius Chair of Computer Science.

We are proud to be a leading UK institution for engineering research. Our pioneering and innovative work is solving some of the world's most pressing problems, benefiting society and improving lives through a connected, inter-disciplinary approach.

The quality of our work at Southampton has been recognised both nationally and internationally and we were honoured to be one of only 12 UK institutions to be awarded a prestigious Regius Chair by HM The Queen to mark her Diamond Jubilee. The award is a rare privilege that reflects our exceptionally high quality of teaching and research and is the only one to be awarded in Computer Science.

Our academics are regularly consulted to help shape future policy both in the UK and around the globe, while our autonomous systems research is among the government's 'Eight Great Technologies' that will change and shape the future of our world.

Our speakers are drawn from business, industry, government and academia, and we hope that today will provide a thought-provoking, challenging debate. There will be the opportunity to see how theory is being applied to real-life research in autonomous systems, and where the technology may lead us next.

Thank you for joining us.

Contents

#UoSRegius

Username: PPH
Password: RAEngineering

Programme

Time	Event
10.30	Registration and coffee
11.00	**Morning keynote session – introduction and welcome by Professor Dame Wendy Hall, University of Southampton**
	– Dr Kedar Pandya, EPSRC
	– Professor Alex Rogers, University of Southampton
	– Professor Stephen Turnock, University of Southampton
	– Professor Paul Newman, University of Oxford
13.00	Lunch
14.00	**Afternoon plenary session – guests welcomed by Professor William Powrie, University of Southampton**
	– Professor Jim Scanlan, University of Southampton
	– Professor Andy Doherty, Network Rail
	– Professor Noel Sharkey, University of Sheffield
15.00	Afternoon refreshments
15.30	**Inaugural lecture – Regius Professor Nick Jennings, University of Southampton** Introduction by Professor Bashir Al-Hashimi, University of Southampton and presentation by Vice-Chancellor, Professor Don Nutbeam, University of Southampton

Time	Event
16.15	**Panel discussion chaired by Professor Nick Jennings** *The Future of Autonomous Systems: Challenges, Promises, Impediments.*
	– Professor Dave Cliff, University of Bristol
	– Professor David Lane, Heriot-Watt University
	– Sir Mark Walport, Government Chief Scientific Adviser
	– Professor Alan Winfield, University of West England
	– Professor Andy Wright, Director of Strategic Technology, BAE Systems
17.30	**Autonomous Systems Showcase and drinks reception** Demonstrations of our cutting-edge work in autonomous systems, including fixed and rotary-wing unmanned aerial vehicles; unmanned marine vehicles; disaster response and safety assurance.
18.45	**Event close**

Engineering@Southampton

Engineering@Southampton represents the largest and most diverse engineering grouping in the UK. We are a leading centre for engineering research, and are at the forefront of developing technologies that are shaping the future of our world.

The 2014 Research Excellence Framework (REF) demonstrated that we are the highest ranked single UK institution for the volume and quality of work - our 'power' - across General Engineering (including in each individual discipline) and in Electrical and Electronic Engineering. We were also ranked the first place in the country to carry out engineering research, for the world-class quality and range of our facilities.

Our internationally-renowned researchers are among the leaders in their fields, working closely with industry on pioneering projects to change the way we live. Our industry partners include Shell, National Grid, Airbus, Rolls-Royce, ARM, BAE and Microsoft, as well as Lloyd's Register, whose marine Global Technology Centre is now located at our new £140m Boldrewood Innovation Campus.

Further afield, our University of Southampton Malaysia Campus (USMC) provides an international integrated engineering education where students spend two years of study in Malaysia followed by two years of study in the UK. USMC has excellent links with research universities and strong relationships with government and international schools, working closely with many key industry partners from the USMC Industrial Advisory Board.

Professor Bashir Al-Hashimi, FREng

Bashir is Dean of Physical Sciences and Engineering at the University of Southampton and is also an ARM Professor of Computer Engineering.

He is an internationally recognised authority on energy efficiency and dependable computing systems and is leading a £5.6m EPSRC programme – PRiME – investigating the future of high-performance, energy-efficient, dependable embedded systems.

Professor William Powrie, FREng

William is Dean of Engineering and the Environment at the University of Southampton and has been elected a Fellow of the Royal Academy of Engineering in recognition of his work.

He is a Professor of Geotechnical Engineering and his research focuses on transport infrastructure, and sustainable waste and resource management.

Professor Dame Wendy Hall, FREng, FRS

Wendy is a Professor of Computer Science at the University of Southampton, and is Executive Director of the University's Web Science Institute. In 2009 she became a Dame Commander of the British Empire and became a Fellow of the Royal Society in the same year. Wendy co-founded Engineering@Southampton during her tenure as Dean of Physical Sciences and Engineering 2010-2014.

Regius Chair of Computer Science, Professor Nick Jennings

Professor Nick Jennings is the University of Southampton's first Regius Professor in Computer Science following the award of the prestigious title to the University by HM The Queen in recognition of our exceptionally high quality of teaching and research.

Nick is an internationally-recognised authority in the areas of artificial intelligence, autonomous systems and agent-based computing, and is a Chief Scientific Adviser to the UK government.

A Professor of Computer Science at Southampton, Nick has pioneered the application of multi-agent technology developing real world systems and leads the innovative ORCHID programme investigating how people and software agents can effectively work together to improve disaster response operations and enable smart energy systems.

A rare accolade

The University of Southampton was one of just 12 UK institutions awarded a Regius Professorship by HM The Queen to mark her Diamond Jubilee.

The permanent award is a rare privilege that reflects the high quality of teaching and research at the institution. Prior to the recent awards only two Regius Professorships had been created in the past century and Southampton is the only institution ever to be awarded a Regius Professor in Computer Science.

Southampton's world-leading achievements in Computer Science include the development of pioneering hypermedia systems, laying the foundations of agent-based computing and intelligent systems, and creating and developing the innovative discipline of Web Science.

Keynote speakers

Dr Kedar Pandya

Kedar Pandya is Head of the Engineering theme at EPSRC. He is responsible for research, training and impact strategy across Engineering. He also leads the Robotics and Autonomous Systems strategy for EPSRC, working with partners in business, academia and government. Prior to his current role, Kedar led the Cross-Disciplinary Interface, Life Sciences and Basic Technology programmes.

Professor Alex Rogers

Alex is head of the Agents, Interactions and Complexity Research Group at the University of Southampton. His research focuses on applying artificial intelligence, machine learning and agent-based approaches to address real world sustainability problems. His work is at the forefront of research addressing the future of the world's energy systems, particularly the smart grid, and he is the co-founder of the award-winning home heating advice spin-out named Joulo. He is also interested in applying these approaches in autonomous environmental monitoring systems, and is leading a citizen science project to search for the critically endangered New Forest cicada.

2Seas, entirely built and developed at Southampton, is capable of flying for over five hours at nearly 100mph, and has applications including search and rescue, and pollution monitoring.

Professor Stephen Turnock

Stephen is head of the University of Southampton's Fluid Structure Interactions research group that explores the behaviour of engineering systems in a maritime environment.

He leads the group in improving the integration of the design, production and operation of maritime systems including ships, submarines, yachts, submersibles and offshore structures. In particular, Stephen has led on the Delphin2 project, a hover-capable autonomous underwater vehicle for lake and coastal exploration. Current work is exploring a number of enabling technologies for maritime autonomy including energy harvesting, deep underwater gliders, ship tank inspection systems, hull cleaning and also how greater autonomy can improve safety and reduce shipping costs.
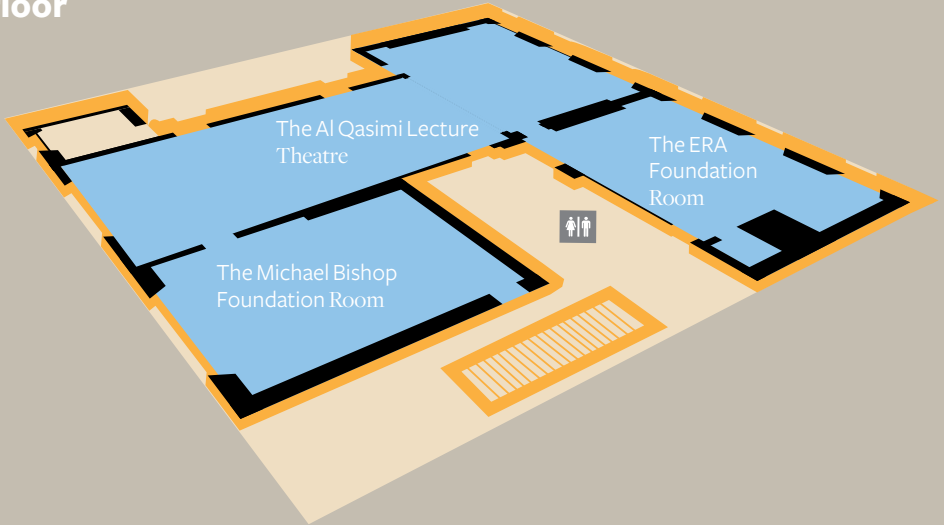
Professor Paul Newman

Paul Newman is BP Professor of Information Engineering at the University of Oxford and an EPSRC Leadership Fellow. He heads the Mobile Robotics Group (**mrg.robots.ox.ac.uk**) within the Department of Engineering Science which enjoys a world-leading reputation in mobile autonomy: developing machines, robots and cars which map, navigate through and understand their environments.

He is on the board of the Robotics Science and Systems Foundation, the International Journal of Robotics Research and the Journal of Field Robotics. He is an inaugural member of the BIS UK Robotics and Autonomous Systems Special Interest Group and sits on the Scientific Advisory Council for the UK Department of Transport.
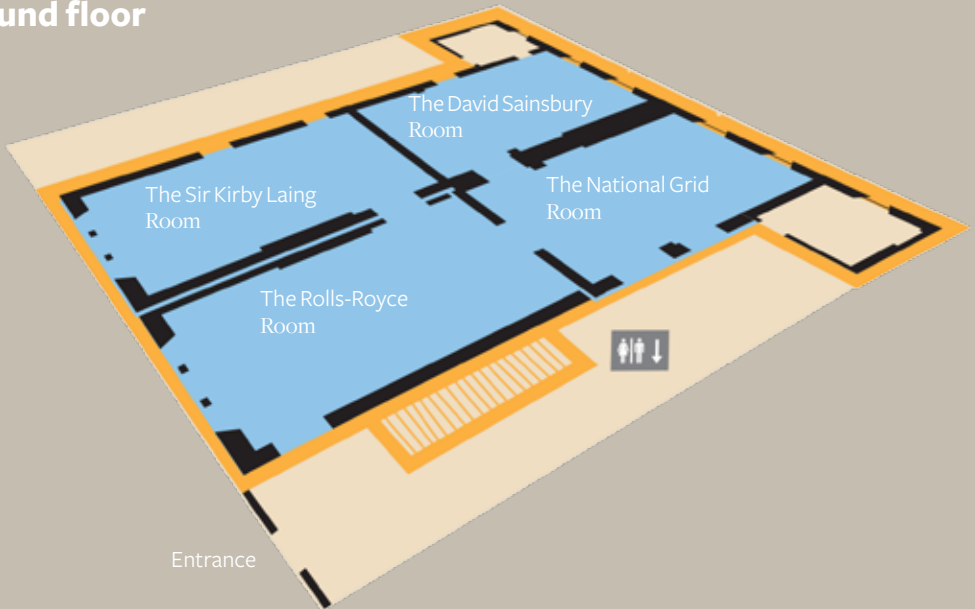
In September 2014, he was elected Fellow of the Royal Academy of Engineering.

Royal Academy of Engineering - floor plan

First floor

The Al Qasimi Lecture Theatre

The ERA Foundation Room

The Michael Bishop Foundation Room

Ground floor

The David Sainsbury Room

The Sir Kirby Laing Room

The National Grid Room

The Rolls-Royce Room

Entrance

Throughout the ground floor rooms you will find a showcase of our research into autonomous systems for a broad range of applications. These include marine, search and rescue, outreach, disaster response and safety assurance. Outside you will find one of our ground control vehicles and tethered observation platform 'Aether'.

Talks will be held in the Al-Qasimi Lecture Theatre on the first floor.

Plenary speakers

Professor Jim Scanlan

Jim is a leading academic in the University of Southampton's Computational Engineering and Design Group that brings together experts from autonomous system technologies, and is Chair of the University's Strategic Research Group on Autonomous Systems.

He leads research into the design of unmanned vehicles particularly in airframe design and the optimisation of unmanned aerial vehicles, and explores the logistics, simulation and optimisation of autonomous systems production. His current projects include '2Seas' (pictured on pages 8-9), which aims to develop low-cost maritime surveillance aircraft.

Professor Andy Doherty

Andy Doherty is an Ambassador for Network Rail, leading engineering interaction with the UK railway industry and within the European railway sphere.

He is a Fellow of the Royal Academy of Engineers, an Electrical Systems Engineer and is a Visiting Professor at Cranfield, Southampton, and Newcastle universities.

Previously, Andy was the chair of the Network Rail Acceptance Panel for some nine years, setting policy and approval of all systems and products used by Network Rail, and has held a number of senior roles in London Underground, including Project Director and Engineer for the conversion of the 'Underground to Driver Only Operation' project.

Professor Noel Sharkey

Noel Sharkey is an emeritus Professor of AI and Robotics and Professor of Public Engagement at the University of Sheffield (Department of Computer Science) and journal editor. He is well-known for his early work on many aspects of neural computing, machine learning and genetic algorithms. As well as writing more than 150 academic articles, he also writes for national newspapers and magazines, and has created thrilling robotics museum exhibitions and mechanical art installations.

Noel's core research since 2006 has been on ethical, legal and human rights issues in the application of robotics and AI in areas such as the military, child care, care of the elderly, policing, autonomous transport, robot crime, medicine, border control, sex and civil surveillance. He is a co-founder and chairman elect of the International Committee for Robot Arms Control (ICRAC) NGO.

Panel speakers

Professor Dave Cliff

Dave Cliff is a Professor of Computer Science at the University of Bristol. His research is in autonomous adaptive trading algorithms for financial markets, and systemic risk. He has worked as a trader/director at Deutsche Bank FX, was one of the lead expert group for the UK Government Office for Science's (GOfS) two-year review of computer trading in the financial markets, and also recently served on the expert panel of the GOfS Review of UK FinTech.

Professor David Lane

David Lane is Director of the Edinburgh Centre for Robotics, (**www.edinburgh-robotics.org**), a £35m joint venture between Heriot-Watt and Edinburgh universities.

In 2001, he founded SeeByte Ltd and Inc (**www.seebyte.com**), a multimillion dollar organisation, commercialising a 20-year portfolio of research in autonomous subsea robotics in the international offshore energy and defence markets.

In public leadership roles, he chaired the BIS/Innovate UK Robotics and Autonomous Systems Special Interest Group (RAS-SIG) from 2013-14, formulating and launching the UK's national RAS innovation strategy for the Minister for Universities and Science. From 2013-15, he was a Director of the euRobotics AISBL not-for-profit organisation, shaping the EU Horizon2020 Robotics public-private partnership between research and industry.

Professor Sir Mark Walport

Sir Mark is the Chief Scientific Adviser to HM Government and Head of the Government Office for Science.

Previously, Sir Mark was Director of the Wellcome Trust, which is a global charitable foundation dedicated to achieving extraordinary improvements in human and animal health by supporting the brightest minds.

Before joining the Trust, he was Professor of Medicine and Head of the Division of Medicine at Imperial College London.

He received a knighthood in the 2009 New Year Honours List for services to medical research and was elected as Fellow of The Royal Society in 2011.

Professor Alan Winfield

Alan Winfield is Professor of Electronic Engineering and Director of the Science Communication Unit at the University of the West of England, Bristol, and Visiting Professor at the University of York. He conducts research in swarm robotics in the Bristol Robotics Laboratory and is especially interested in robots as working models of life, evolution, intelligence and culture. Alan is passionate about communicating science and technology. His latest book, Robotics: A Very Short Introduction, was published by Oxford University Press in September 2012, and he blogs about robots, open science and related topics at **www.alanwinfield.blogspot.com**.

Professor Andy Wright

Andy is Director of Strategic Technology for BAE Systems responsible for the development of the company's strategy in the UK on technology to support the company's current and future products.

After his first degree in Physics he achieved a PhD in Cosmology from Newcastle University.

He joined BAE Systems in 1985 and in 2015 became Director of Strategic Technology reporting to the Group Managing Director for the UK business.

He was awarded an Industrial Fellowship of the Royal Society in 2002, is a Fellow of the IET and visiting Professor at the University of Southampton.

Showcase

Our showcase demonstrates some of our exceptional work in autonomous systems, with examples drawn from undergraduate level through to state-of-the-art EPSRC and EU-funded projects. The showcase will be open throughout the day as well as during the drinks reception, and our researchers will be happy to talk you through their work and answer your questions.

ORCHID - working together in a crisis

A global internet outage, a virus outbreak or a nuclear disaster are just some of the scenarios that are the focus of innovative investigations by world-leading academics exploring how human and software agents can effectively work together to collect the best possible information from a disaster environment.

The pioneering ORCHID programme is based at the University of Southampton and brings together industry experts and internationally-recognised academic groups from Southampton, Oxford and Nottingham universities, to research how the use of citizen science, unmanned autonomous systems, and agent-based coordination can improve the response of emergency services and populations to disasters.

Rodin - assuring system safety

The University of Southampton is part of an international consortium developing an open source integrated toolbox that can test and analyse embedded and autonomous systems based on realistic scenarios before they are built.

The Rigorous Open Development Environment for Complex Systems (Rodin) enables early stage analysis of embedded and autonomous systems and highlights specification and design errors early in the development process before the physical systems are actually built.

The Rodin toolset is already being applied to real-world applications involving the safety assurance of intelligent control in smart grids, railway interlocking and unmanned aerial vehicles .

Complex technology

The University of Southampton's Centre for Complex Autonomous Systems Engineering inspires a multidisciplinary collaboration between a range of leading scientists to develop deployable practical autonomous systems.

One of the Centre's headline projects is the £800,000 EPSRC-funded Decision Environment for Complex Design (DECODE) programme that aims to develop a set of software tools and design methodology to allow users to quickly explore the design space for unmanned vehicles.

The tools are being tested with the development of a set of air vehicles that will meet a very demanding long range maritime reconnaissance mission.

Powerful observation

The University of Southampton's Autonomous Systems Laboratory specialises in the design and development of novel robotic technologies.

Their research into unmanned aerial and ground vehicles is at the cutting edge, and for many years our researchers have been developing increasingly sophisticated rotary-wing unmanned aerial vehicles.

Recent research has seen the team collaborating with an external security company to develop a unique tethered unmanned aircraft system observation platform.

The innovative platform boasts an indefinite endurance capability powered by an onboard generator, battery backup and a lightweight but strong 300m tether.

Unmanned marine vehicle

Showcase

Driving forward maritime exploration

The University of Southampton's maritime autonomous systems research is tackling many of the challenges facing society and the maritime industry today.

Exploring and monitoring the world's oceans is expensive and raises many safety challenges, while maintaining and inspecting the world's shipping fleets also presents a multitude of safety questions.

At Southampton we are at the forefront of research into how autonomous robots can meet these challenges at a lower cost and more effectively.

Our robots such as the Delphin2 and the Octopus Robot have been designed to operate in aggressive marine environments with a high degree of reliability and minimal environmental impact.

Keeping information grounded

The University of Southampton is home to two unusual ground control vehicles that are capable of remotely monitoring unmanned vehicles.

The two 5.5 tonne vehicles – Osprey and Gannet - are kitted out with a plethora of high-spec communication technologies to control unmanned vehicles in the air, on land and under the sea.

An onboard power generator, a trailer for transporting the unmanned systems, and a large waterproof awning mean research can be carried out whatever the weather; reducing the risk of human error and allowing users to easily and quickly capture their required data in a safe environment.

Taking on a robotic challenge

Every year Student Robotics, Southampton, challenges young people to design, build and test a fully-autonomous robot to compete in challenges against other teams.

The independent society was originally set up by students from the University of Southampton, but has now grown to involve volunteer students from the universities of Bristol and Surrey, teams from Germany, as well as an increasing number of volunteers from industry.

The society aims to share its members' excitement about engineering with others and inspire an interest in engineering with future generations.

Exploring at extreme altitudes

The University of Southampton's Atmospheric Science Through Aircraft (ASTRA) Research Group develops light, unmanned aircraft that are capable of delivering scientific instruments to extreme altitudes including up to the stratosphere.

The observations made by such platforms are key to enhancing the accuracy of weather prediction and climate models.

The latest development by the research team is MAVIS (Massive Atmospheric Volume Instrumentation System), an unmanned air system consisting of a large number of low cost, biodegradable flying sensors that can be released en masse from a high altitude balloon and map the physical variables of a specific block of airspace.

A connected University

The University of Southampton is a founding member of the Russell Group, the UK's leading research-intensive universities, and in the top one per cent of universities worldwide. Through world-leading research and enterprise activities, the University of Southampton connects with businesses to create real-world solutions to global issues. Through its educational offering, it works with partners around the world to offer relevant, flexible education, which trains students for jobs not even thought of. This connectivity is what sets Southampton apart from the rest; we make connections and change the world.

Search "we are connected"