Autonomous transport

1940s: The autopilot is invented to take over the control and guidance of an aircraft.

1950s: Researchers at the Royal Aircraft Establishment, Farnborough conduct the world's first fully automatic landing of an aircraft.

1979: RCUK funded feasibility study of a 'Free Swimming Vehicle'aleads to the UK's first Autonomous Underwater Vehicle 'ROVER' at Heriot-Watt University in 1981.

1990s: RCUK support for the Automation of Subsea Tasks (AST) programme and subsequent Technology for Unmanned Underwater Vehicles (TUUV) programme are used to inspire and support the Institute of Oceanographic Sciences (now National Oceanography Centre) realising the first Autosub programmes.

1995: Coda Ltd is created as the first commercial enterprise to build economic value from the portfolio of RCUK-funded underwater technology research in Edinburgh.

1996: The first missions are completed in which Autosub, a National Oceanography Centre community project, is unmanned and fully autonomous.

1999: Autosub is used on an Antarctic mission, the first time the Automated Underwater Vehicle (AUV) travels beyond communication range of its support facility.

2001: Autosub 1 technology is licensed to Halliburton Subsea for use in the oil, gas and subsea cable markets.

2001: SeeByte Ltd, a spin-out company from Heriot-Watt University, becomes a global leader in software for unmanned underwater robotic systems, based in Edinburgh and San Diego.

2005: QinetiQ achieves the world's first automatic landing of a short take-off vertical-landing aircraft on a ship.

2005: Autosub explores 25 kilometres under an ice sheet, the Fimbulisen Glacier in Antarctica. This mission is the Autosub under Ice programme's equivalent of a moon landing, and, in 27 hours, gathered data on ice thickness and shape that conventional drilling could have taken hundreds of thousands of years to collect.

2005: Autosub becomes part of the national marine equipment pool, available to scientists across the UK.

2007-2008: Autosub6000, designed to go to depths of at least 6,000m and to extend the usefulness of Autosub to science of the deep seafloor, enters service as an unmanned scientific vehicle.

2011: Demon, the world's first flapless aircraft, takes to the skies. The Unmanned Aerial Vehicle (UAV) which uses directed air jets rather than moving-flap technology, is jointly funded by RCUK and BAE Systems.

2011: RCUK-sponsored engineers at the University of Southampton design and fly the world's first '3D printed' aircraft, which could revolutionise the economics of aircraft design. The entire structure of the UAV, including wings and integral control surfaces, was printed on an EOS nylon laser sintering machine, which fabricates plastic or metal objects, building up the item layer by layer.

2011: RCUK-supported researchers at Oxford University develop a low-cost radar-based technology that enables cars to literally drive themselves.

2011: UK scientists begin collaborative development of the StarTiger Seeker project at the Rutherford Appleton Laboratory. This autonomous system was developed to provide robust long range navigation software for the next generation of Mars rovers.

2011: A fleet of 'Ultra Pods', quiet, driverless shuttle vehicles, designed by Professor Martin Lowson with RCUK funding in the 1990s, is launched at Heathrow Airport. The mass transit network runs from Terminal 5 to its business parks, and is expected to carry 500,000 passengers a year.

2012: The Greenhouse Observations of the Stratosphere and Troposphere (GHOST) instrument begins collaborative development at the Astronomy Technology Centre. This novel instrument will be operated on the autonomous NASA Global Hawk aircraft, and will be used in high-altitude, long-duration missions to provide critical information on greenhouse gases and their movement.

2012: Subsea7 Ltd, originating from RCUK funded research, in collaboration with SeeByte Ltd, offer the Autonomous Inspection Vehicle (AIV) as the world's first commercial service using a hover capable AUV for inspection of deepwater oilfield infrastructure.

2013: Autosub Long Range is deployed on its first science mission.

2013: The same team of Oxford University researchers who have been developing and testing autonomous car technology around Oxford Science Park will test driverless cars on public roads.

Health

1963: Research Council scientist Dr A B Kinnier Wilson begins designing the 'Hendon' arm, an early prosthetic arm for use by children with severe upper-limb deficiencies.

1985: The first surgical robot based on the PUMA 200 is used to place a needle in a brain biopsy.

1988: Researchers at Imperial College London develop the PROBOT for prostate resection. The first prostate surgery was performed at Guy's and St Thomas' Hospital, London in 1991.

1999: The world's first robotically-assisted heart bypass is carried out.

2001: Clinical introduction of da Vinci surgical robot in the UK and the UK's first totally endoscopic robotic coronary artery bypass (TECAB) was performed at St Mary's Hospital, Imperial College London in 2003. The robot has been used extensively for radical prostatectomy, partial nephrectomy, trans-oral otolaryngology surgery, hiatal hernia surgery, paediatric surgery, and low pelvic and rectal surgery.

2002: Research Council scientist Dr Oliver de Peyer builds robot to undertake automatic biochemistry experiments.

2003: The Beagle 2 lander, designed and built in the UK, and once intended to drill into the surface of Mars to look for 'signatures' in life, is developed into a new, more accurate method of diagnosing tuberculosis by UK scientists.

2004: RCUK-funded researchers develop high-throughput robotic systems to screen and optimise crystallisation conditions of biological macromolecules, now used in institutions world-wide.

2006: RCUK-funded scientists at the University of Glasgow start work on ROBOCUS, a project to develop a robotic surgery system using an ultrasonic cutting blade.

2006: RCUK-funded research on perceptual docking and its subsequent demonstration of gaze controlled robot manipulation on the da Vinci surgical robot.

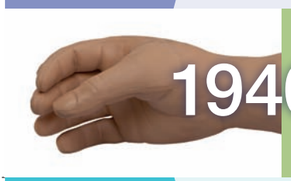
2007: UK engineer David Gow invents the first commercially available hand prosthesis with five individually-powered digits.

2008: The world's first robotic transvascular aneurysm repair is performed at Imperial College London.

2012: The first complex aortic aneurysm stenting with a fenestrated endograft using the new Magellan robot is performed at Imperial College London.

2013: The world's first mind-controlled robotic arm that can be permanently attached to the body is produced.

2013: RCUK-funded micro-engineering facility for miniaturised surgical robot is established at Imperial College, London.



Society

2007: A Rights for Robots public debate is held to highlight the ethical implications of robotics research.

2007: RCUK-funded statisticians and computer scientists at the University of Nottingham work together to improve the reliability and consistency of automatic face recognition.

2009: The Artificial Culture Lab, stemming from a RCUK-supported initiative, investigates how behaviour becomes culturally ingrained by creating an artificial society of tiny robots.

2010: The UK Research Councils hold a Robotics Retreat to encourage and challenge researchers to think more broadly about the potential ethical and societal impacts of their work. A set of principles is agreed advising those who design, sell and use robots about how they should act.

2010: The RCUK-supported Walking with Robots team are awarded The Royal Academy of Engineering Rooke Medal for the Public Promotion of Engineering for their programme that enabled the public to engage with advanced robotics in highly accessible ways.

2012: RCUK-supported researchers at Plymouth University build a robot to study how humans interact with it paving the way for a generation of more lifelike androids. The robot is capable of reproducing subtle and natural expressions, thanks to computer-generated responses projected onto its 'face'.

2013: Research Council scientists from Bristol Robotics Laboratory use urine to produce electricity to charge a mobile phone.

Monitoring and observation

2001: OC Robotics is launched. The company is a world leader in robot platforms for confined and hazardous spaces using unique snake-arm robots.

2004: In a world-first, Perpetuum, a University of Southampton spin-out company set up to commercialise RCUK-funded research, develops an autonomous energy harvesting system which uses vibration produced by industrial machinery to monitor the machinery's own performance.

2010: ALADDIN, an RCUK-supported project, is initiated with researchers designing a system of multiple agents in sensors, cameras and unmanned aerial vehicles working together to give an overall picture of an emergency situation as it develops.

2010: The EPSRC Centre for Innovative Manufacturing in Intelligent Automation is launched, led by Loughborough University with Cranfield University. The research aims to change the way manufacturing machinery is designed, operated, support, upgraded, re-used and retired.

2011: ORCHID, an RCUK-supported project, is launched with the aim of establishing the science needed to understand, build and apply human-agent collectives (HACs) across the three domains of disaster response, smart grid and citizen science.

2012: The National Plant Phenomics Centre opens at the Institute of Biological, Environmental and Rural Sciences in Aberystwyth. Computer-controlled cameras are used to automatically monitor the physical characteristics of plants carried on a conveyor belt system, and answer questions about how these traits relate to the plants' genes and the environment.

2012: Bristol Robotics Laboratory at the University of the West of England is officially opened.

2012: Designed and built by a UK consortium, the K-Band Multi Object Spectrometer (KMOS) is a new high-tech instrument with 24 robotic arms on one of the European Southern Observatory's Very Large Telescopes. It is an invaluable tool to investigate the formation and evolution of galaxies.

2012: The Micro-Autonomous Positioning System (MAPS) begins development by UK scientists. This uses wireless autonomous micro robots to arrange mirrors into any desired configuration. This is designed for mirror deployment in the European Extremely Large Telescope, a revolutionary new ground-based telescope with a mirror 39 metres wide, due to be built in 2020.

2013: RCUK researchers work on the impact drone strikes have on affected groups and the effect of these on relations between the intervening state and the state within which the drones are operating.

2013: RCUK researchers create and control autonomous swarms of UAV helicopters that collaborate to sense the environment and can report on pollution monitoring, disaster recovery, or flood damage.

2013: Stefan Winkvist, an RCUK-sponsored PhD student at the University of Warwick, develops an unmanned aerial inspection vehicle capable of navigating indoors in uncertain environments, away from GPS and an operator, such as nuclear facilities. Winkvist has fitted the craft with laser-based radar, which produces a 3D image of its surroundings.

2013: A 'tactile helmet' developed by RCUK-funded researchers at the University of Sheffield's Centre for Robotics could provide fire-fighters operating in challenging conditions with vital clues about their surroundings. The helmet is fitted with ultrasound sensors that detect the distances between the helmet and nearby walls or other obstacles.

Robotics and autonomous systems

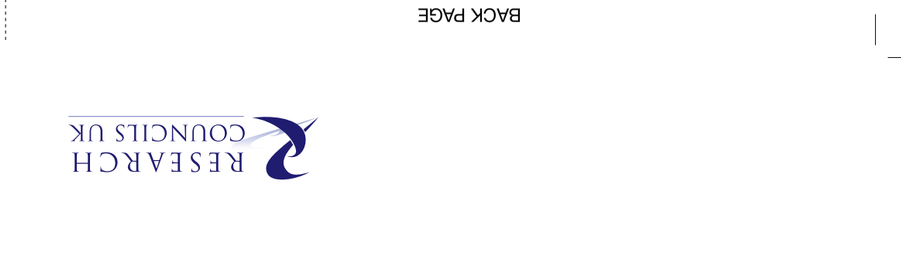
RESEARCH COUNCILS UK

Research funded by the Research Councils makes a vital contribution to the UK's economic growth, prosperity and well-being.

We take a variety of approaches to support innovation and deliver impact from research, including the development of collaborative research programmes, investment in major research capabilities, such as national research facilities, and the support of impact-related capabilities.

Often the impact of research is realised through the combination of several investments over time. The Research Councils seek to ensure that the outputs and outcomes of their funded research have significant long-term benefits for the economy and society. This timeline, one of a series, highlights how investments made in research over the long term combine to create a significant impact in particular areas. In addition, research in one area can combine with that from another to drive innovation and make a key contribution to UK growth. For example, robotics and autonomous systems have been used across a range of sectors over recent decades, with Dr Kinnier Wilson designing an early prosthetic arm for use by children in 1963 and the first flapless aircraft, the Demon Unmanned Aerial Vehicle (UAV), developed jointly by RCUK-funded researchers and BAE systems, taking to the skies in 2011.

A key part of the Government's Industrial Strategy is supporting technologies where the UK has the depth of research, expertise and the business capability to develop and exploit commercially. Robotics and autonomous systems is one of 'Eight Great Technologies' identified by the Chancellor of the Exchequer in autumn 2012 when he announced an additional £600 million to help support their development. These eight are: Big Data and energy-efficient computing; Satellites and commercial applications of space; Robotics and autonomous systems; Synthetic biology; Regenerative medicine; Agri-science; Advanced materials and nanotechnology; and Energy and its storage.



Robotics and autonomous systems

RCUK-funded research in the field of robotics and autonomous systems has progressed rapidly over the last few decades and has led to significant impacts across a variety of sectors including transport and healthcare.

From the invention of the first autopilot in the 1940s to the development of cars that can literally drive themselves, robotics and autonomous systems have changed the way we think about transport. What was previously only seen in the movies has now become reality. Similarly, within the healthcare sector the use of surgical robots is no longer just a future aspiration. The world's first robotically assisted heart bypass was carried out in 1999 and the first robotic transvascular aneurysm repair was performed in 2008.

The use of robotics and autonomous systems has attracted public interest and led to public debate on the ethical implications of robotics research. RCUK has encouraged and in some cases initiated these discussions about the potential ethical and societal impacts in this field to help determine the future direction of research.

Research Councils UK

Robotics and autonomous systems