Research Councils UK

Satellites and commercial applications of space

RESEARCH COUNCILS UK

Research funded by the Research Councils and the UK Space Agency (UKSA) provide a vital contribution to the UK's economic growth, prosperity and well-being.

The Research Councils 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. The UKSA is at the heart of UK efforts to explore space and develop new technology, exploit space-based applications and support academic and industrial communities. It works collaboratively with the Research Councils and other agencies world-wide.

Often the impact of research is realised through the combination of several investments over time. The Research Councils and the UKSA 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 provide a key contribution to UK growth. For example, in 2002 the world's largest earth observation satellite Envisat was successfully launched, with the UK playing a key role. This satellite has now provided ten years of invaluable environmental data on air quality, the size of the ozone hole, the extent of sea ice, and the risks from earthquakes, volcanos and floods. But even before its launch UK company Proneta used Envisat technology to develop a camera that could see through oil, now of potential interest to international giants Shell, BP, Amerada Hess and Chevron. Envisat software is also helping the medical community analyse brain scans. Originally designed to process satellite images, it is now being developed as a simple method of screening for Alzheimer's disease.

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 them commercially. Satellites and commercial applications of space 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.

Satellites and commercial applications of space

Space has an important influence on our everyday lives and is one of the key enablers of the global economy.

Research into space has given us an amazing insight into our universe and the forces that govern it, much of which directly affect our lives here on earth.

It has also revolutionised many technologies such as security and navigation systems, and has underpinned new industries such as telecommunications and environmental monitoring. For example, Mars Express arrived at Mars in 2003 and since then has found evidence for water and detected methane in the Martian atmosphere. Importantly, this suggests there could have been life on the Red Planet, at least in the form of primitive micro-organisms. Even the well-publicised loss of Beagle 2 was not the failure it may have seemed. Its technology is now being developed for a portable mass spectrometry device that will be used to detect tuberculosis in developing countries.

Today, the UK space industry is strong and growing, with a favourable balance of commercial and public sector space programmes.

With over 230 UK based companies and an estimated turnover of over £9.1 billion, the UK industry employs over 28,000 highly skilled staff and supports over 100,000 wider jobs in the UK.

The UK space industry is highly cooperative and most programmes involve many different collaborators from across the UK and internationally. The future of the UK's space industry is promising, with UK based companies and Government supported Centres continuing to win contracts from around the world. For example, Surrey Satellite Technology Ltd (SSTL), one of the UK's single most successful university spinouts, is the world leader in high-performance small satellites, building around 40% of the world's small satellites. Additionally, a quarter of the world's commercial telecom satellites are made by UK company Astrium.

UK SPACE AGENCY

Satellites & Astronomy

1962: Ariel-1 is the world's first solar mission and is the first international satellite. It carries experiments devised and operated by the UK, making the UK the world's 3rd space faring nation.

1967: The UK's Chilbolton Observatory, an internationally important atmospheric research station, is first opened. It is now one of the world's most advanced meteorological radar facilities.

1978: Supported by the UK, the European Space Agency (ESA) launches the world's first high orbit telescope the International Ultraviolet Explorer (IUE). This operated until 1996, making it one of the longest-lived and most productive astronomical satellites.

1985: With instruments built in the UK, Giotto is the first European deep space mission. It sends back unprecedented images; confirming Halley's comet is billions of years old.

1990: The Hubble Space Telescope is launched. One of the most important astronomical projects of all time, it changes our understanding of space and leads to breakthroughs in astrophysics, such as calculating the rate of expansion of the universe. An international collaboration between ESA and NASA; UK scientists play a key role.

1995: The Solar & Heliospheric Observatory (SOHO) is launched and revolutionises our ability to forecast space weather; playing a lead role in early warning systems. The UK plays a significant role and Astrium is the prime contractor.

1997: Cassini-Huygens is the first mission to make a long-term study of Saturn. A joint NASA/ESA/Italian Space Agency project with instruments designed in the UK, the original 4 year mission has proven so successful that it is now extended to 2017.

2000: The UK manages 3 of the 11 major investigations being carried out by the Cluster mission. This investigates solar wind, which can cause electrical storms - damaging satellites or even causing power cuts on the ground.

2002: The International Gamma Ray Astrophysics Laboratory (INTEGRAL) is the most sensitive gamma ray observatory ever launched. It is now supported by the UK Space Agency (UKSA) and continues to change the way astronomers think of the cosmos.

2004: Rosetta launches and is the first spacecraft to make a long-term study of a comet at close quarters. It is one of the most challenging missions ever undertaken and is due to rendezvous with the Comet 67P in 2014. UK researchers have contributed to the space probe and lander.

2009: ESA launches Planck to observe the artefacts from the Big Bang. This mission has a strong UK involvement.

2009: ESA launches Herschel, to study the formation of stars and galaxies at previously unexplored wavelengths of light. The UK made a major contribution to the instruments and UK scientists are leading the exploitation of this mission.

2011: ESA approves Euclid, a mission to study dark energy. The UK is contributing to the imaging instrument and the data processing activities.

2013: The UK-supported Swarm mission is launched; a trio of satellites designed to study aspects of the Earth. In particular, it will study its protective magnetic field, without which the atmosphere as we know it would not exist, rendering life on Earth virtually impossible.

2013: A team from Surrey Space Centre at the University of Surrey launches the Surrey Training, Research and Nanosatellite Demonstrator (STRaND-1), a Cubesat which aims to test normal technologies for space research using a smartphone you can buy on the high street as its on-board processor.

2013: The Mid Infrared Instrument (MIRI) is successfully integrated into the James Webb Telescope. MIRI is designed and built by a consortium of ten EU countries, led by the UK in partnership with NASA. A number of UK institutions are involved, in particular STFC's UK Astronomy Technology Centre (lead) and Rutherford Appleton Laboratory, the University of Leicester and EADS Astrium.

2013: ESA's first Large Class mission is selected; the Jupiter Icy Moons Explorer (JUICE) will make observations of Jupiter's atmosphere and magnetosphere; an important step in the exploration of our outer Solar System. The UKSA is funding the Magnetometer instrument.

Health

Late 1970s: A small device that measures radiation is developed by REM Ltd (Oxford) and used on the Hubble Space Telescope and Meteosat-3. Later it is developed for medical use, to help treat heart and cancer patients.

Mid 1990s: First developed by ESA, shape memory alloys are now used in the repair of broken bones and repositioning of teeth. Anson Medical, a company created on the back of this technology, is subsequently acquired by a major UK company, Lombard Medical, for €40 million in 2001.

1996: UK scientists show that ecological data from satellites can highlight factors affecting malaria transmission, supporting decision making systems for malaria control.

2000: UK scientists demonstrate that the mortality rates of tsetse flies, which transmit sleeping sickness killing tens of thousands of Africans a year, are significantly correlated with data from meteorological satellites, particularly land-surface temperature.

2005: ESA funds medical researchers to track dust storms blowing across Africa's Sahel belt using satellites in order to learn more about lethal meningitis epidemics that often follow in the dust's wake.

2007: Satellites detect a rise in surface temperatures in the equatorial part of the Indian Ocean, bringing heavy and sustained rains and warmer air, causative agents for mosquito population multiplication. This allows pre-emptive measures to prevent a Rift Valley fever epidemic in East Africa.

2007: Based on the technology developed for Beagle 2, the 2003 mission to search for life on Mars, UK researchers develop a portable mass spectrometry device that can be used to detect TB in resource-poor settings.

2009: UK scientists treat a multicellular organism *(C.elegans)* in space with RNAi, a regulator of gene expression in diseased tissue, demonstrating that this could be used to control muscle degradation in spaceflight and help people who suffer from muscle wasting.

2010: UK scientists develop the SSO i-Tour, which uses Google mapping technology to undertake virtual assessments on neighbourhood factors related to children's health.

2012: UK scientists identify the metals that played a crucial role in the production of RNA, the building block of life on earth; suggesting that these were contained within the meteorites that collided with Earth billions of years ago.

2012: UK scientists develop a new cost-effective geographic information system to characterise the areas outside of villages in Africa which may present an elevated epidemiological risk of human sleeping sickness.

2013: Software for processing satellite pictures taken from space is now helping medical researchers to establish a simple method for wide-scale screening for Alzheimer's disease. The tool, based on software for ESA's Envisat satellite, was used to create a program that analysed human brain scans.

Environment

1977: Supported by the UK, Meteosat-1 is Europe's first weather satellite in a series of satellites. These satellites now provide invaluable and continuous data for weather forecasts and images for earth observation.

1980: The UK National Remote Sensing Centre is formed as a Government Centre of Excellence for Earth Observation. In 1991, it becomes a private company, Infoterra, which is now a subsidiary of the world-leading Astrium Group.

1991: ESA's European Remote Sensing satellite (ERS-1) is launched to provide a wealth of data about the Earth, its climate and changing environment. This included the Along-Track Scanning Radiometer (ATSR), designed in the UK to measure sea-surface temperature from space with unprecedented accuracy.

2000: Supported by UK funding, the Disaster Monitoring Constellation (DMC) is a network of satellites designed by UK company Surrey Satellite Technology Ltd. (SSTL) and built with the active involvement of a number of countries. The DMC provides detailed images of any part of the world to assist relief efforts and ultimately save lives.

2002: Launch of ESA's Envisat, the world's largest earth observation satellite. This provides ten years of invaluable environmental data on air quality, the size of the ozone hole, the extent of sea ice, and the risks from earthquakes, volcanos and floods. The prime contractor for the mission is EADS Astrium Ltd.

2002: The first Geostationary Earth Radiation Budget (GERB) instrument is developed and built in the UK, and launches on Meteosat-8. Part of a series of four instruments, GERB is designed to provide accurate measurements of the Earth's radiation balance, and will operate over a period of 12-14 years.

2006: NERC Earth Observation Data Acquisition and Analysis Service launches, bringing together the expertise at the Dundee Satellite Receiving Station and remote sensing data analysis at Plymouth, focusing on areas such as sea surface temperature and ocean colour.

2006: Launch of Antarctic Polar View service, using satellite imagery to provide ships in the Southern Ocean with timely information about sea ice. This is part of Copernicus; a network disseminating information concerning the environment and security.

2004: ESA's EarthCARE mission is selected to examine the role of clouds and aerosols in climate change. UK scientists lead the mission.

2010: ESA launches Cryosat-2 to measure the shape and thickness of polar ice. The mission is conceived and led by UK scientists.

2008: NERC launches the National Centre for Earth Observation (NCEO) to provide a focal point for research related to Earth observation and the environment, particularly looking at global change and natural hazards.

2011: UK government invests in the NovaSAR satellite. This enables UK company SSTL to launch an innovative and highly competitive new space-based radar remote sensing programme in the international market.

2011: Copernicus, the joint EU/ ESA Earth Observation Programme, starts operations. This is a European system for monitoring the Earth; providing information on how our planet and its climate are changing, the role played by human activities in these changes and how these will influence our daily lives.

2011: UK government approves funding for the facility for Climate and Environmental Monitoring from Space (CEMS). This is a major new investment in IT infrastructure to develop new products and services using Earth observation data.

2013: Go-ahead for Biomass mission, scheduled to launch in 2020. This is being developed with a UK science lead and will produce the first accurate maps of forest biomass from space. These maps will help scientists address fundamental questions about changes in forest structure, and the impact of deforestation and land use.

2012: The National Risk Register of Civil Emergencies is amended to include space weather by the Government. It now identifies that severe space weather can cause disruption to a range of technologies and infrastructure, including communications systems, electronic circuits and power grids.

Technology

Late 1980s: ESA's simulation software is applied to extraction and processing of North Sea natural gas. Developed in the UK, the ESA Simulation Language has been widely used in the space community for over 20 years and is now used for gas flow and capacity strategies.

1985: UK company SSTL is set up to commercialise UK-funded research; building high performance low cost satellites and ground systems. It is sold in 2008 to space technology giant EADS Astrium for £40m. With 300 staff, it is the world's leading small satellite company, with export sales of over £150m.

1997: UK company Proneta uses its experience of designing electro-optic instruments for satellites such as ESA's Envisat and ERS to develop a camera that can see through oil. After successful laboratory test rig experiments, Shell, BP, Amerada Hess and Chevron are now all supporting the development of this technology.

2001: Launch of the Project for OnBoard Autonomy (Proba-1), produces some of the best satellite images of Earth in recent years. Funded and built in the UK, the CHRIS instrument on board (Compact High Resolution Imaging Spectrometer) has found a wide variety of uses from mapping ancient Roman remains to monitoring pollution in Hong Kong.

2000: Conceived by the Surrey Space Centre and SSTL, the SNAP program is the UK's first nanosatellite mission. It demonstrates the feasibility of using clusters of low-cost satellites that can fly in formation and conduct multipoint remote sensing.

2007: The Centre for Earth Observation Instrumentation (CEOI) is set up with support from Industry, the Technology Strategy Board and RCUK. It brings together scientific expertise and industrial capabilities that will put the UK in a much stronger position to win international contracts.

2005: GIOVE-A is the first Galileo satellite to be launched and is built by UK company SSTL, with support from UK scientists. They are now building the navigation equipment for this new European GPS system, due to be launched in 2018.

2009: A ground-breaking metal production process is currently being commercialised in the UK by Metalysis Ltd. This University of Cambridge spin-out will commercialise funded research, addressing the issue of how a manned moon base could be cost-effectively supplied with oxygen.

2012: Research at the Centre for Secure Information Technologies at Queen's University Belfast is testing ways to increase the telecom and antenna capabilities of satellites. The work could potentially lead to greatly increased internet access.

2012: The Government, through the UKSA, agrees a £1.2bn package for space investment in some of Europe's biggest and most lucrative space projects, providing the UK with increased leadership in a rapidly growing global sector and building on the British space industry's £9.1bn contribution to the economy.

2013: UK company Rezatec develops a unique remote sensing, Earth observation platform which provides organisations with global business decision-making information for managing their carbon footprint. They won the Climate-KIC Award at ecoConnect's Cleantech Innovate 2013.

2013: The TSB's Space Catapult as well as ESA's first facility in the UK, the European Centre for Space Applications and Telecommunications (ECSAT), open at Harwell Oxford Campus space cluster. These centres will support space related activities in the UK, with the Catapult focusing on four programmes - transport, energy, security and the internet of things - which have a global potential of more than £60bn over the next decade.

2013: UK funding for the Synergetic Air-Breathing Rocket Engine (SABRE) is agreed; a British designed rocket engine which could revolutionise the fields of propulsion and launcher technology, and significantly reduce the costs of accessing space.

Satellites and commercial applications of space

RESEARCH COUNCILS UK

The seven Research Councils are:

- Arts & Humanities Research Council (AHRC)
- Biotechnology & Biological Sciences Research Council (BBSRC)
- Economic & Social Research Council (ESRC)
- Engineering & Physical Sciences Research Council (EPSRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Science & Technology Facilities Council (STFC)

Research Councils UK
Polaris House, North Star Avenue
Swindon, Wiltshire SN2 1ET
United Kingdom
Tel: +44 (0) 1793 444420
Fax: +44 (0) 1793 444009
Email: info@rcuk.ac.uk
Web: www.rcuk.ac.uk

www.rcuk.ac.uk

Research Councils UK is the strategic partnership of the UK's Research Councils.

We invest annually around £3 billion in research. Our focus is on excellence with impact. We nurture the highest quality research, as judged by international peer review providing the UK with a competitive advantage. Global research requires we sustain a diversity of funding approaches, fostering international collaborations, and providing access to the best facilities and infrastructure, and locating skilled researchers in stimulating environments.

Our research achieves impact – the demonstrable contribution to society and the economy made by knowledge and skilled people. To deliver impact, researchers and funders need to engage and collaborate with the public, business, government and charitable organisations.

Image credits:

Proba-V's first image
European Space Agency

MIRI integration into JWST payload module
European Space Agency

RESEARCH COUNCILS UK