

# Robotic Solutions



Department for  
International Trade



BRITAIN & NORTHERN IRELAND



# Version control

---

Version	Date	Change since last	Version owner
1.0	21/06/2019	Draft proposition for consultation	JM
2.0	18/07/2019	Second draft following consultation	JM
3.0	06/08/2019	Final version signed off	JM
4.0	08/08/2019	Updated maps	JM



# Contents

---

The scope of robotics	<u>04</u>
Reasons to invest in UK robotics	<u>05</u>
UK robotics applications	<u>13</u>
<i>Surgical</i>	<u>15</u>
<i>Long-term care</i>	<u>19</u>
<i>Space</i>	<u>23</u>
<i>Industrial</i>	<u>27</u>
<i>Agricultural</i>	<u>32</u>
<i>Extreme environments &amp; infrastructure</i>	<u>37</u>
<i>Urban</i>	<u>43</u>
Rich and diverse ecosystem	<u>48</u>
DIT support	<u>51</u>

## DIT Contacts

### Philip White

Technology Specialist, Technology,  
Entrepreneurship & Advanced Manufacturing  
+44 (0)7825 362993  
[phillip.white@trade.gov.uk](mailto:phillip.white@trade.gov.uk)

### Shahriar Zakaria

Investment Manager for Latin America, Canada  
& Turkey  
Technology, Entrepreneurship & Advanced  
Manufacturing  
+44 (0)20 7215 4553  
[shahriar.zakaria@trade.gov.uk](mailto:shahriar.zakaria@trade.gov.uk)

# The scope for robotic solutions

## Defining robots

This proposition looks at robotics through the solutions they provide in end markets. Using this approach you can select the market, or markets, that your technology supports and then discover how the UK can provide you with:

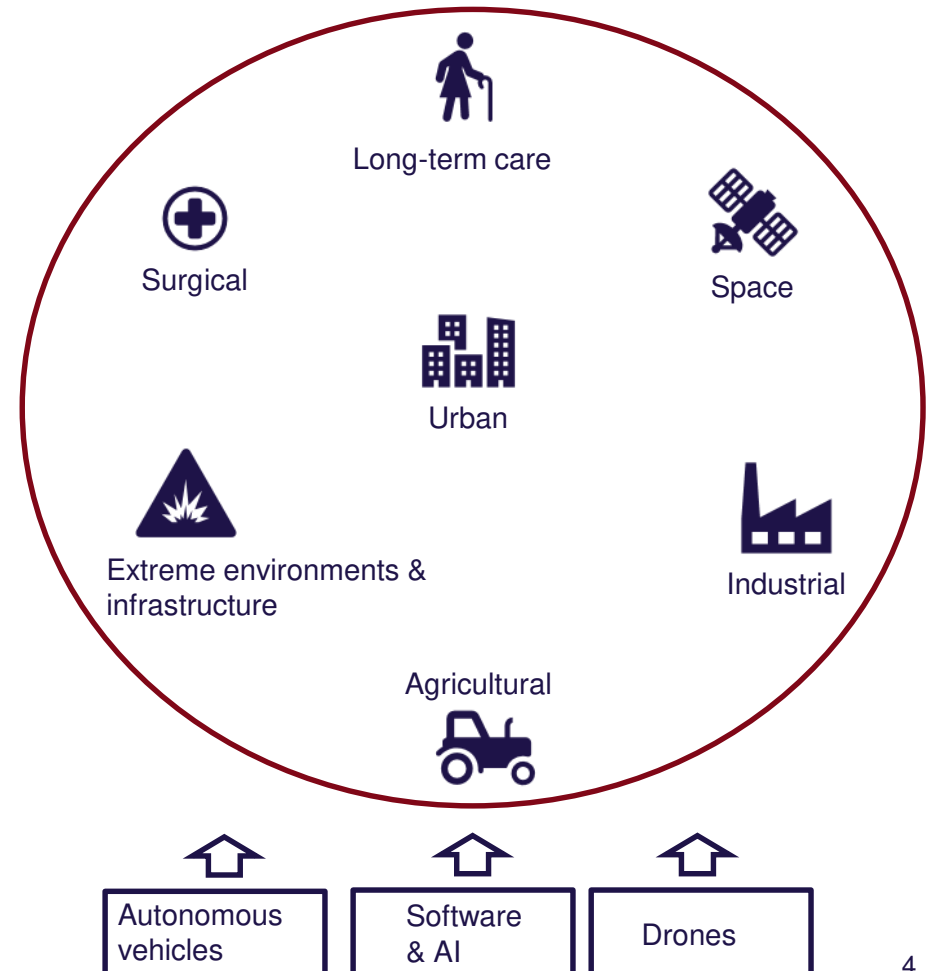
- **Opportunities:** describing solutions that are in demand.
- **Support:** what financial and technical support can you receive.
- **Facilities:** what R&D facilities can you use.
- **Success:** examples of companies and projects.

There is no universally agreed definition of robotics but this proposition considers a robot as **a physical device with a degree of autonomy and interaction with humans.**

As shown by the diagram on the right there are a diverse range of sectors looking for robotic solutions. These cover health, industry, energy, agriculture, space and cities.

Areas that are mentioned but not covered directly in this proposition include enabling factors (such as software and AI) and technologies that overlap with robotics such as autonomous vehicles and drones.

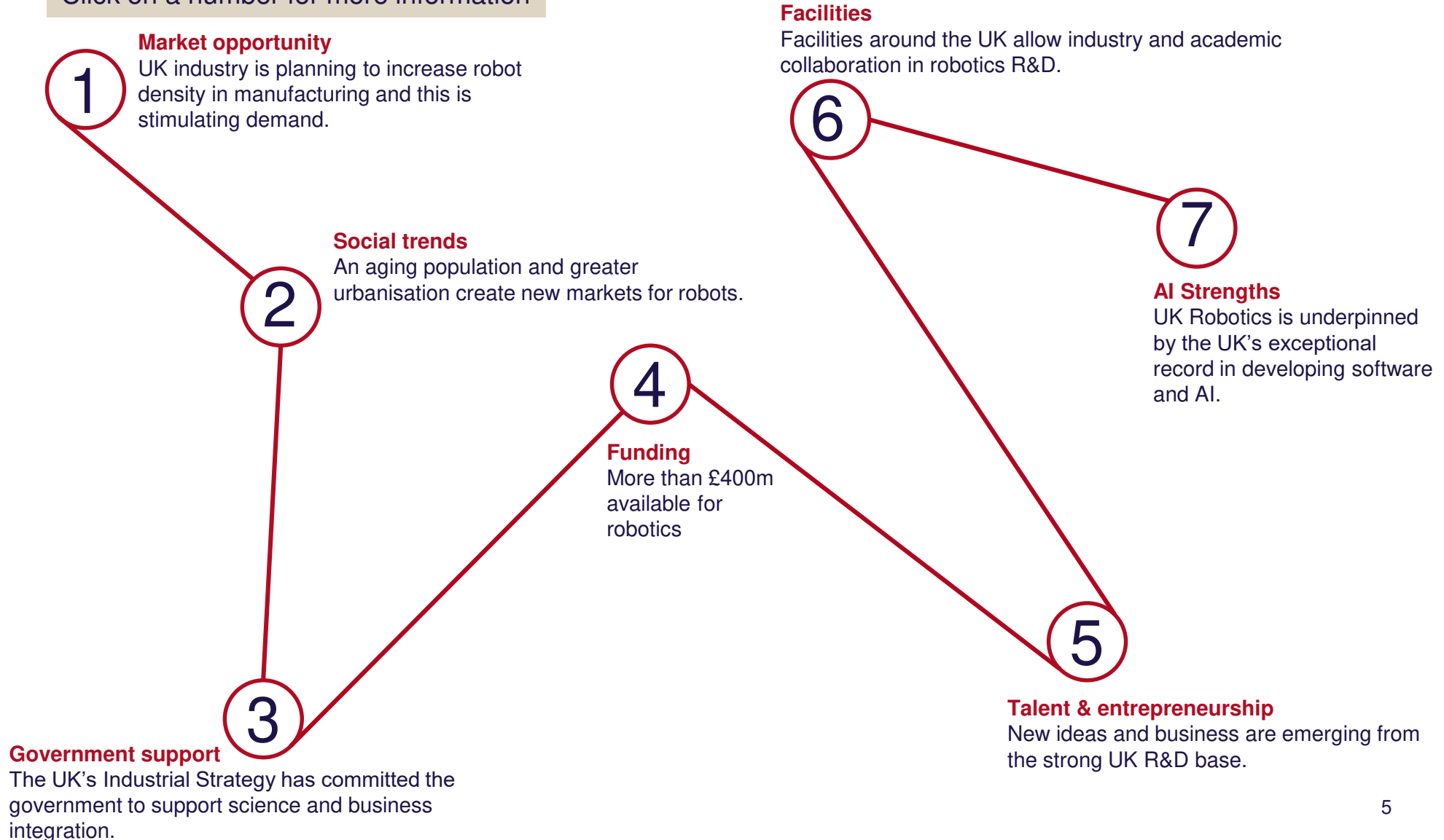
## This proposition focuses on the end market for robot technologies





# Reasons to invest in UK robotics

Click on a number for more information



# The UK is a growing market for robotics

## Digital manufacturing will lead to more demand

The UK is the ninth largest manufacturing economy in the world, however it has a lower robot density than other major economies. While the relatively flexible and competitive UK labour market has allowed many companies to achieve world-class productivity at lower levels of automation, the potential exists to use new technologies to significantly increase competitiveness.

This has been acknowledged by the UK Government in their Made Smarter Review and the next few years will see significant investment in technologies including robotics.

When an economy the size of the UK seeks to increase robot density to match other nations it creates demand that makes the UK an attractive market for investment. Taking the example of the Netherlands shows how a programme to increase robot density can increase the use of robots by 65% in two years.

With a much larger manufacturing sector, a 65% increase in robot density would represent a significant increase in demand.



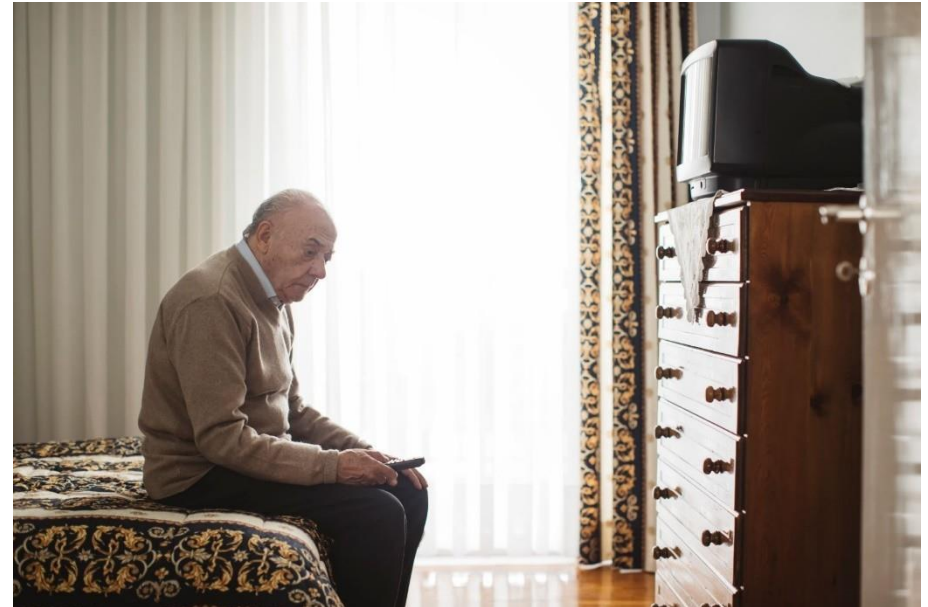
Source: Consultancy UK (2018) 71 industrial robots installed per 10,000 workers in UK  
<https://www.consultancy.uk/news/17481/71-industrial-robots-installed-per-10000-workers-in-uk>

# Social trends are increasing demand for robotic solutions

## Social trends are increasing demand for robots

Societal change is having a knock-on effect on the demand for robotics. This covers both softer robotics designed to increase human-robot interaction and robots that can handle the dirty, difficult and dangerous tasks in a modern society. Key trends and impacts include:

- An aging population is putting greater strain on health and long-term care and these industries are turning towards robotics innovation.
- Increasing urbanisation is forcing new ways of thinking about the delivery of services, with robotics key to future delivery in a number of areas.
- Greater awareness and resilience in environmental and industrial emergency situations can utilise increasing capabilities of robotics and intelligent sensor systems for a safer world.
- Greater connectivity relies on satellite services and new ICT infrastructure that will require greater robot interaction to service industries that operates in such extreme environments.



Sources: Parliamentary Office of Science and Technology (2018) *Robotics in Social Care*  
UK RAS Network (2017) *Robotics in Social Care*



# Government is supporting the drive towards robotics

## Industrial Strategy Challenge Fund

The government's Industrial Strategy Challenge Fund brings together leading research and businesses to tackle the big societal and industrial challenges today. The Fund is a core pillar in the government's commitment to **increase funding in research and development by £4.7 billion over 4 years** to strengthen UK science and business.

Since 2014 the government has invested £360m in robotics and this has been more than exceeded by private sector investment.

## Futureproofing regulation

The UK already has some of the most business friendly regulations in the world and is ranked 9th among 190 economies for the ease of doing business in the UK. In June 2019 they set out their intention to reshape the regulatory approach to match the increasing digitalisation of industry. Their new approach will

- Reform regulation in response to technological innovation.
- Increase flexibility in the system.
- Enable greater experimentation.
- Support innovators to navigate the regulatory landscape.

Sources: Parliamentary Office of Science and Technology (2018) *Robotics in Social Care*  
 World Bank (2019) *Doing Business*  
 Department for Business, Energy & Industrial Strategy (2019) *Regulation for the Fourth Industrial Revolution*

## The Challenges

Within this document you will find information on Challenges relevant to robotics in each sector and more information about how to get involved. Click [HERE](#) to find out more.







# More than £400m available for robotics research

---

## Innovate UK co-ordinate R&D activity

Innovate UK deliver the Industrial Strategy Challenge Fund along with a number of other activities in their role as the Innovation Agency for the UK. These include:

- Delivering a programme of support for innovation in the technologies in relevant sectors.
- Assisting the Catapult network to ensure businesses have access to the expertise, facilities and collaborations to commercialise innovation.
- Delivering a programme of activity for UK businesses seeking to go global.

Innovate UK is part of UK Research and Innovation, a non-departmental public body funded by a grant-in-aid from the UK government. They often support projects deemed to risky for private investment and **over the last 12 years they have invested £2.2bn in 11,000 innovation projects.**

To search for innovation competitions run by Innovate UK click [HERE](#).

Innovate UK have also produced a short video to explain their funding process. Click [HERE](#) to watch.

## Funding university collaboration in robotics

The Engineering and Physical Sciences Research Council (EPSRC) is the main funding body for engineering and physical sciences research in UK universities. They invest in research to build the knowledge and skills base needed to address the scientific and technological challenges facing the nation.

Robotic applications play an important role in the work of the EPSRC through investment in research projects and hubs that bring together academics from across the country.

**Currently, EPSRC have a robotics funding portfolio of £80m spread across 97 projects.** These projects allow university researchers to partner with industry to develop new robotic applications.

There are a number of robotics networks that can provide access to potential collaborations with researchers and universities involved in cutting edge research. Click [HERE](#) for more information.



# Talent and ideas underpin new business growth

## A strong talent base in the UK

The UK's thriving R&D base is supported by a stream of new talent emerging from universities. The talent network within UK robotics includes:

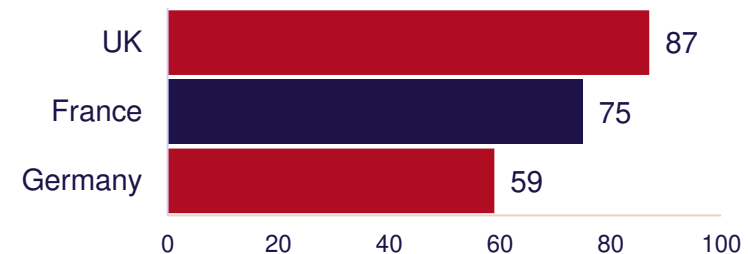
- 95,000 graduates each year, and 320,000 students in mathematical science, computer science, engineering and technology.
- The UK Robotics and Autonomous Systems (RAS) which acts as a portal to interface with industry and deliver technological advances.
- Five Centres for Doctoral Training supporting some of the brightest minds in UK academia to study for PhD's in agri-food robotics (University of Lincoln), autonomous and intelligent machines and systems (University of Oxford), human interactions with intelligence driven systems (Swansea University), autonomous robotic systems (University of Bristol), and robotics and autonomous systems (Heriot-Watt University in Edinburgh).
- 28 universities involved in the UK Robotics and Autonomous Systems (RAS) network.
- Companies with robotics expertise such as Dyson and BAE systems run their own academies to train the next generation of workers.
- £11m Future Technologies Lab at the University of Sussex offering new degrees in intelligent systems, smart technologies and 5G.

Sources: Dealroom.co database accessed on 12/06/2019 (search for robotics industry startups and scaleups since 2014)  
Dealroom.co <https://blog.dealroom.co/uk-unicorn-tech-update-for-london-tech-week/>

## A leader in entrepreneurship

In the last five years there have been 87 robotics startups and scaleups in the UK, ahead of comparator nations such as Germany and France.

### Robotics startups and scaleups since 2014



The UK has traditionally been the startup capital of Europe, attracting more venture capital than any other market (\$35bn between 2013 and 2018). In the robotics sector, over 40 of the leading Venture Capital investors\* with an office in London have invested in robotics companies.

Robotics innovators can also take advantage of specialised investment funds such as Britbots. Managed by Sapphire Capital Partners this is a fund specifically for UK-based robotics startups that has already invested in 15 companies since 2016.

\* Leading VC investors categorised as top 5% of investors by deal volume.



# Access facilities around the UK

Robotics innovation is supported across the UK through research facilities that allow collaboration between industry and academia. Leading centres are shown below with more specialist centres listed in relevant sections throughout this document.

## 1 National Robotarium

A multimillion pound investment to create an innovation hub for robotics, delivering leading-edge research and support for business creation and growth, as well as data skills. To be built at Heriot-Watt University in collaboration with the University of Edinburgh.

## 2 Centre for Intelligent Autonomous Manufacturing Systems

A multidisciplinary research centre at Queens University Belfast, developing innovative technologies for digital manufacturing. Research themes include flexible automation, human/robot & robot/robot collaboration, and autonomous decision making.

## 3 EUREKA Robotics Lab

A flagship research cluster at the Cardiff School of Technologies, EUREKA Robotics Lab undertakes international collaborators with companies and universities with a focus on social and service robotics.

## 4 Centre for Autonomous Systems

Based at the University of Liverpool, the Centre provides expertise in practical autonomous systems for industrial, healthcare and environmental uses. The Virtual Engineering Simulation Lab and Robotic Autonomy Simulation Laboratory at the Virtual Engineering Centre, provide high-fidelity simulation and analysis for autonomous systems across sectors.

## 5 Robotics Leeds

A network of more than 100 researchers across multiple disciplines with an interest in robotics and AI. Working with industrial partners to perform world leading research in medical robotics, field and infrastructure robotics and enabling technologies for autonomy.

## 6 Sheffield Robotics

A partnership between universities in Sheffield with one of the largest portfolios of ongoing publicly-funded robotics. Working with industry on new robotic technologies and human-robot interactions.

## 7 Lincoln Agri-Robotics

The UK's first global Centre of Excellence in agri-robotics with world-leading expertise from over 40 scientists in robotics, AI and agriculture. Facilities include the world's first fully robotic fruit farm and industrial scale robotics for food processing.

## 8 Bristol Robotics Lab

The most comprehensive academic centre for multi-disciplinary robotics research in the UK. Home to a community of over 200 academics, researchers and industry practitioners.

## 9 Oxford Robotics Institute

Via numerous collaborations and industry partnerships focused on field robotics, ORI's researchers and engineers have extensive experience in developing and deploying autonomous systems that apply AI to solve real world problems.

## 10 Remote Applications in Challenging Environments

The UK Atomic Energy Authority's centre for remote applications in challenging environments is the global leader in fusion remote operations and maintenance.

## 11 Hamlyn Centre

Based at Imperial College London, the focuses on technological innovation in robotics with a strong emphasis on clinical translation.





# UK strengths in software and AI support robotics

## Underpinning the future of robotics

Software and AI is essential for the evolution of robots from repetitive tasks to more sophisticated roles and collaboration with people. This is a vast area covering rapidly evolving, complementary general purpose technologies, applied across many sectors and the UK has an exceptional record in developing these technologies.

Developments in this area include:

- Visual perception to identify objects or patterns from unprocessed image data.
- Neural networks, machine learning and deep learning to improve a robots ability to perform tasks by training their ability to learn.
- Natural Language Processing to help robots discern meaning from spoken words and therefore cooperate with humans.

## Assuring safety and public confidence

The UK is at the forefront of research to assure the safety of robotics and autonomous systems, providing the evidence to ensure public confidence and support for the next stage of adaption.

This includes a £12 million partnership between Lloyd's Register Foundation and the University of York to work with industry, regulators and research teams to address global challenges in assuring the safety of robotics and autonomous systems.

## The strengths of the UK

While the line between AI and the physical functions that AI controls is becoming increasingly blurred, this document focusses on the physical actuation, or hardware, of robots. However, any investment in UK robotics will be placed within an ecosystem that provides proximity to some of the pioneers of AI. These include:

- The Alan Turing Institute is the national institute for data science bringing together researchers in mathematics, statistics, computer science, social science and data ethics, software engineering, machine learning and AI to generate world class research.
- Leading startup companies such as DeepMind, Oxbotica, Ravn, Agrimetrics and Swiftkey.
- The UK's leading advanced digital technology innovation centre (the Digital Catapult) accelerates access to new digital markets and carries out applied research and development to identify new applications of emerging technologies.
- Geographical clusters around the UK that have a track record of producing new AI companies such as London, Cambridge, Oxford, Bristol and Edinburgh.

*Sources: Department for Business, Energy and Industrial Strategy (2017) Growing the artificial intelligence industry in the UK*

## UK Robotics Applications



# UK robotics applications

---

	Application	Overview of the UK opportunity
	<b>Surgery</b>	A technological field primed for growth with the R&D infrastructure in the UK making it an excellent location for investment.
	<b>Long-term care</b>	An aging population in the UK is putting greater pressure on budgets for adult long-term care, presenting an opportunity to sell into in the UK market and/or partner with companies.
	<b>Space</b>	Within the global space sector, the UK is considered to be at the forefront of robotics with a well-established R&D community and thriving small business environment.
	<b>Industry/ Manufacturing</b>	The UK already has world-leading research institutions in robotics and some highly innovative robot companies. However, overall uptake of manufacturing automation in the UK has been slow and it represents a valuable market for new entrants.
	<b>Agriculture</b>	Agri-food is the largest manufacturing sector in the UK and it is seeing a smart farming revolution that is opening the sector to technology innovators.
	<b>Extreme environments and infrastructure</b>	The UK has strong offshore and nuclear industries, along with a dense, mature infrastructure that needs frequent intervention. Robots that operate in these dangerous environments remains a relatively untapped opportunity.
	<b>Urban</b>	The UK's progressive regulatory approach to urban robotics has created one of the strongest test beds for urban autonomous technologies and living labs in cities to test the technologies that will drive urban robotics developments.

# Surgical Robotics

## Overview

The commercial success of the first generation clinical robotic systems has inspired an ever-increasing number of platforms from both commercial and research organisations, resulting in smaller, safer, and smarter devices that aspire to roam the human body and blur the lines of disease prediction and prevention.

Surgical robotics is a market-driven industry in the UK with a focus on cost effectiveness and regulatory standards. Future industry forecasts for UK healthcare are positive and driven by:

- £181m in government support for Leading Edge Healthcare R&D.
- The UK Medical Devices market is forecast to grow at a compound annual rate of 3.7%, reaching £6.3bn in 2023-24.
- The UK's aging population is expected to increase demand for innovative and more efficient methods of surgery.
- Plans to increase funding for the UK National Health Service will increase the propensity of downstream health-care operators to invest in new equipment.

## Opportunities in the UK

- Platforms for performing robotic assistance of specific parts of surgery rather than entire surgical procedures.
- Development of smart, miniaturised, mechatronically enhanced or robotically assisted surgical instruments.
- 3D printing and planning technologies.
- Untethered microrobots.
- Virtual/Augmented Reality for surgery.
- The development of 'intelligent' prosthetics



Sources: Royal College of Surgeons (2018) Future of Surgery <https://futureofsurgery.rcseng.ac.uk/>  
 UK RAS Network (2016) Surgical Robotics: the Next 25 years  
 IBIS World (2018) Medical and Dental Instrument Manufacturing



# The UK government supports leading edge healthcare

## £35m fund for innovation

The Digital Health Technology Catalyst is part of the Leading Edge Healthcare Challenge within the Industrial Strategy. It is a **£35 million fund over four years**. It is open to small and medium sized businesses that partner with at least one other business, academic institution, or research and technology organisation. Projects can span a range of technologies including:

- virtual and augmented reality
- artificial intelligence and machine learning
- use of sensors, internet of things, and networks
- informatics, data analytics and process

To search for open innovations competitions click [HERE](#)

**Surgical robotics is a technological field primed for growth and the R&D infrastructure in the UK makes it an excellent location for R&D investment.**

## The Engineering and Physical Sciences Research Council (EPSRC)

The EPSRC is the main funding body for engineering and physical sciences research in the UK. They have a **£38m portfolio of funded research in robotics** as part of their Healthcare Portfolios research theme.

This allows for collaborations between universities and leading companies in the industry to develop new technologies. Examples include:

- £6.1m for micro-robotics for surgery - Imperial College London with Hansen Medical (US), Intel (US), Karl Storz (Germany).
- £6.1m for surgery enabled by ultrasonics – lead by the University of Glasgow and in collaboration with the universities of Birmingham, Edinburgh, Leeds and Southampton. The Ultrasurge project will partner with companies such as Kuka Robotics (Germany), Dentsply Sirona (US), Shanghai Institute of Ceramics (China).
- £1m for soft robotic technologies for next-generation bio-integrative medical devices – University of Bristol with RIKEN (Japan)



# Key areas for surgical robotics R&D

## 1 Imperial College London Hamlyn Centre

The Hamlyn Centre is at the forefront of research in surgical robotics and works in partnership with major industrial leaders. It has also commercialised their own surgical platforms such as the i-Snake® and Micro-IGES platforms.

## 2 Wellcome EPSRC Centre - Medical Engineering

The Centre combines multi-disciplinary research with medicine and biomedical research. It develops imaging robotics systems that guide ultrasound in foetal and cardiac diagnostic imaging, and image-guided interventions.

## 3 University College London

Undertaking cutting-edge research in surgical robotics and robotic assisted imaging including a £10m project on applying new technologies to fetal surgery (GIFT-Surg).

## 4 University of Surrey

Building on expertise in space robotics the University is researching technology transfer to health innovations. They also provide access to a medical robotics lab.

## 5 Bournemouth University

The Orthopaedic Research Institute are working with Nuffield Health Bournemouth Hospital to undertake the first in-depth analysis of using robotic-assisted technology in hip replacements.

## 6 Bristol Robotics Lab

The Bristol Robotics Lab are developing novel robotic platforms for surgery that are improving patient and surgeon experience. These include fixing broken bones, minimally invasive surgery through sensory exoskeletons, and tumour detection using remote touch.

## 7 Oxford Robotics Institute

ORI is developing Soft Robots and Tactile Sensing Technologies using advanced 3D printing techniques with the objectives to improve capabilities of robotic surgery tools, to achieve intelligent prosthetics and realistic robotic patient simulators.

## 8 University of Sheffield - Insigneo

Insigneo brings together highly respected researchers and clinicians from across the University of Sheffield and Sheffield Teaching Hospitals. Members collaborate across disciplines and with international partners in industry, academia and healthcare.

## 9 University of Leeds

The Institute of Robotics, Autonomous Systems and Sensing includes a focus on surgical robotics and technologies. This includes capsule robots, intelligent surgical instruments, minimally invasive surgery and intelligent training aids.

## 10 University of Dundee

A leader in minimally invasive surgery, image guided therapy and robotics. The School of Medicine's Division of Imaging Science and Technology houses state of the art laboratories for MR guided focused ultrasound technologies, including InMotion robotics.





# Spotlight: Advances in surgical robotics in the UK

## Location helps UK's fastest growing medical devices company

CMR Surgical is one of the UK's leading surgical robotics companies. In 2018 they were listed as the sixth fast-growing company in the UK – and fastest growing medical devices company.

The success of CMR Surgical shows what can happen when innovative ideas, talent and location align. In particular when the global experience of company founders meets an ideal location.

In Cambridge, Europe's largest technology cluster, they found a ready pool of talent capable of tackling the clinical, commercial and technical challenges of surgery.

Established in 2014 the company has secured nearly \$100m dollars in funding with principal shareholders including ABB Technology Ventures, Watrium, LGT, Cambridge Innovation Capital, Zhejiang Silk Road Fund and Escala Capital.

CMR Surgical has grown significantly in the five years since the company was founded, now employing over 300 people. Their technology is expected to be used in hospitals in the UK and continental Europe in the next 12 months, with wider international expansion shortly afterwards as the company completes significant regulatory milestones.

Source: CMR Surgical <https://cmrsurgical.com>

## UK expertise leads an international network of surgical robotics R&D

In 2018 researchers at the University of Glasgow received £6.1m funding from the Engineering and Physical Sciences Research Council to support the 'Surgery enabled by ultrasonics'. Partners in the project included Kuka Roboter (Germany), Dentsply Sirona (US), Shanghai Institute of Ceramics (China).

Working with the Universities of Birmingham, Edinburgh, Leeds and Southampton the project will examine new approaches for using ultrasonic tools in complex, robot-assisted surgery. This will help partners realise the full potential of ultrasonics.

Not only is the project bringing together universities around the country, it is also utilising the skills of experts from different disciplines including engineers, dentists, surgeons, robotics, cell biologists and solid mechanics.

Based on the research findings, the researchers will develop miniaturised ultrasonic tools and tentacle-like robots to enable fast, safe and effective complex surgical procedures.

Source: University of Glasgow [https://www.gla.ac.uk/news/headline\\_621114\\_en.html](https://www.gla.ac.uk/news/headline_621114_en.html)

# Robotics for long-term care

## Overview

long-term care involves health and social support services for people with chronic conditions and disabilities who need care on an ongoing basis. Robotics has been suggested as a way to help improve the quality of long-term care in the UK.

As the aging population places more pressures on existing services a wide range of robotic technologies are in demand, from automated vacuum cleaners to robots resembling humans or animals. This is an emerging market projected to have strong growth over the next 20 years and the UK is well positioned to take advantage of this new technology.

- The UK strengths in AI, sensing and control systems provide ready-made opportunities for collaboration with hardware providers.
- A growing shortage of health and social care workers in the UK can be offset by the use of assistive robots/intelligent furniture.
- Technology is expected to be a theme in the Government's upcoming policy paper on adult social care.

**In 2017 the total number of service robots for personal and domestic use increased by 25% to about 8.5 million units**

## Opportunities in the UK

- Telerobotics - the remote operation of a robot by a healthcare practitioner.
- Robots to assist professional carers to be more efficient, allowing them to focus more on the human-to-human aspects of their work, and reducing the physical demands of caring.
- Robots for Independent Living that provide general assistance around the home, for instance, performing household chores and assuring safety.
- Robots to help people rehabilitate following illness or injury, allowing a more rapid return to health and independent living.
- Therapeutic pet robots to help reduce stress and anxiety.



Sources: Parliamentary Office of Science and Technology (2018) *Robotics in Social Care*  
 UK RAS Network (2017) *Robotics in Social Care*  
 International Federation of Robotics (2018) *World Robotics 2018*



# Funding long-term care robotics research

## £98m to support healthy aging

The Healthy Ageing Challenge Fund is a £98 million investment to stimulate economic growth in the UK by enabling business-led consortia to develop large-scale markets for products and services which maintain people's independence as they age and delay transition into higher levels of care.

Research themes around managing common complaints of aging and living with cognitive impairment would be of relevance to the long-term care robotics sector and possible sources of funding for innovative ideas.

To find out more about the Healthy ageing challenge fund click [HERE](#).

## Transforming community health care

Funding for long-term care robotic solutions is available through the Engineering and Physical Sciences Research Council (EPSRC) healthcare technologies grand challenge, in particular the research themes of Transforming Community Health and Care or Assistive Technology.

This allows for collaborations between universities and leading companies in the industry to develop new technologies. Examples of funding in these area includes:

- Over £1m for a robot training buddy for adults with ASD - Heriot Watt University, University of Glasgow, Aldebaran Robotics/Softbank (France).
- £0.25m for restoring sensation using prosthetic hands – University of Newcastle and Ossur (Iceland).



# Long-term care robotics R&D takes place across the UK

## 1 University of Glasgow

Working with researchers at Heriot-Watt university to develop spoken dialogue systems from robots that can interact with humans to understand complex social situations.

## 2 University of Edinburgh

In collaboration with the design agency IUVO and the Shadow Robot Company have developed two exoskeletons to help people with gait disorders.

## 3 University of Newcastle

Working with Belgian based Ossur to create an artificial leg that can adapt autonomously to the user's changing needs and also provide feedback regarding the state of the limb and prosthesis.

## 4 University of Salford

The Soft Robotics Group develops soft robotic feeding systems for patients who do not have the mobility to feed themselves.

## 5 University of Sheffield

The Sheffield Biomedical Robotics Lab develops bionic and assistive robots that show life-like behaviour and sustained operation in order to achieve long-term adaptive healthcare.

## 6 University of Lincoln

Working with Samsung Electronics to create a framework for training AI conversational agents to operate in different activity domains and across multiple sensory modalities.

## 7 University of Birmingham

Developing robots with the longevity and behavioural robustness necessary to run continuously in dynamic human environments and generate appropriate behaviour in security and care scenarios.

## 8 Aberystwyth University

The Intelligent Robotics Group are examining infant play as the central mechanism for autonomous, self-motivated robots that learn the local physics of their world.

## 9 Cardiff Metropolitan University

The EUREKA Robotics Lab are developing robots for rehabilitation and specialist play robots for children.

## 10 Bristol Robotics Lab

Collaborating with partners in Spain and Switzerland to develop a system that will provide proactive assistance with dressing to people with disabilities.

## 11 Plymouth University

Developing speech and tablet-based interfaces for assistive robots that are able to operate inside and outside the home.

## 12 Imperial College London

Developing robotic rehabilitation tools to help people who have suffered from stroke to improve their hand function.

## 13 Oxford Robotics Institute

Developing highly integrated soft sensing technologies to improve human-robot interaction, teleoperation and integration into smart devices for therapeutic/rehabilitation applications.

## 14 Intelligent Systems Research Centre

Collaborates with user groups to develop of home based technology for the purposes of self-monitoring and self-management of health and well being parameters.





# Spotlight: International links for UK long-term care robotics

## UK facilities link investors with new opportunities

Investing in the UK can tap into facilities that drive collaboration and inspire innovation. When Japanese practical robotics manufacturer TMSUK established their first European office they took advantage of the expertise and facilities they found around Bristol.

The company develops practical robots which are designed to help in the healthcare, mobility and service industries, and set up in Bristol to promote sales of their robotic wheelchair in the UK and develop new research collaborations.

They chose to set up in Future Space, the University Enterprise Zone led by University of Western England Bristol which provides a range of dedicated, shared and co-working offices, labs, workshops, engagement spaces and meeting rooms that connects entrepreneurs and tech innovators with scientists, researchers and graduate talent.

33 companies now operate at Future Space including some of the most innovative robotics companies working across the UK.

Source: Future Space Bristol <https://www.futurespacebristol.co.uk/>

## International partnership drives UK growth

The success of UK social robotics company Consequential Robotics shows the international nature of the next generation of robotics. It is a mix of the best of British and international design and engineering.

In 2017 UK startup Consequential Robotics launched the first of a planned range of companion robots for applications in social care, education and research. Since then almost 100 robots have been shipped to organisations in the UK and worldwide such as Hong Kong, the US and Australia - showing the demand for UK robotics technology.

Their MiRo robot is a fully programmable autonomous robot with six senses, eight degrees of freedom and an innovative brain-inspired operating system and was developed to provide a platform suited for developing companion robots.

These 'pets' have been shown to reduce feelings of loneliness and in one test case, involving the use of robotic dogs in a UK care home, brought increased levels of happiness and comfort.

Source: Consequential Robotics <http://consequentialrobotics.com/>



# Space Robotics

## Overview

Robotics is helping to reduce the cost of space along with enabling more audacious exploration of the solar system and increased use of space to manage the Earth's resources.

The UK is at the forefront of the global 'New Space' revolution and has legislation and investment in place that will see the UK develop its capabilities further. Space robotics is central theme of this growth and investors in the UK benefit from:

- Access to FAIR-SPACE Hub, the UK's national hub for research excellence on space robotics that acts as a single point of entry to innovation.
- A thriving robotics research community that offers UK based companies access to technologies that will make the next step change in space.
- The UK is one of the largest contributors to the ESA robotic Mars lander mission - EXOMARS2020.
- Unique test facilities for space environments.

## Opportunities

- Developing orbital and planetary robots.
- Interoperability between astronaut & robot.
- Autonomous/Intelligent Vehicles, including autonomous mission management, science autonomy, robotic control, navigation or localisation without GPS.
- Robotic Manipulators, including tele-operation, sampling devices, sample transfer and manipulation, rendezvous and docking.
- Novel Locomotion Platforms, including aerobots and climbing robots.
- Robotic Support of Manned Exploration, including human factors, multi-agent collaboration, in-situ resource utilisation.



Sources: UK Space Agency (2017) *Funding for £84 million for artificial intelligence and robotics research and smart energy innovation announced*  
Future AI and Robotics for Space (2018) <https://www.fairspacehub.org/>



# Access the national hub for space robotics

---

## FAIR-SPACE Hub

The FAIR-SPACE Hub is part of the Industrial Strategy Challenge Fund for Robotics for Extreme Environments. This is aimed at increasing the productivity of the nuclear, space, deep mining and offshore energy sectors.

Along with almost £8m funding from government the Hub has been able to secure an additional £1m new research income in 2017/18 and plans to leverage over £2.5m industrial support by 2021.

FAIR-SPACE is a use-inspired research hub which is specifically focussing on solving some of the challenges of the space sector through the use of robotics and artificial intelligence technologies. It has developed a multidisciplinary approach that brings together business and academia to work in partnership to develop solutions and accelerate the commercialisation of these technologies.

## Helping industry and academia to solve challenges

The hub focuses on five cross-cutting research themes underpinning major industry-led challenges:

- Sensing and perception
- Mobility and Mechanisms
- Autonomy and AI
- Human-robot interaction
- System Engineering

Led by university experts across the UK, each research theme brings together academia and industry to answer a set of scientific topics. In the long term, the R&D will achieve long-lived, robust mobility & autonomy for next-generation space robots.





# Space robotics research facilities and test centres

## 1 University of Edinburgh

A FAIR-SPACE partner leading on the Mobility and Mechanisms Theme with universities of Salford and Surrey. Industry partners include Airbus, RACE, KUKA, IIT, CASC-SAAT, NASA-JSC.

## 2 University of Liverpool

A FAIR-SPACE partner leading on the System Engineering Theme with universities of Warwick, Edinburgh and Salford. Industry partners include SSTL, ThalesAS, BAE, STFC-Hartree.

## 3 University of Salford

A FAIR-SPACE partner collaborating on themes including Mobility and Mechanisms, Human-Robot interaction, and System Engineering.

## 4 University of Warwick

A FAIR-SPACE partner collaborating on themes of Sensing and Perception and System Engineering Theme.

## 5 Imperial College London

A FAIR-SPACE partner leading on Human-Robot Interaction Theme with universities of Edinburgh, Liverpool and Salford. Industry partners include Airbus, SSTL, RACE, InTouch, CAS-CSU.

## 6 University of Surrey

A FAIR-SPACE partner leading on Autonomy and AI Theme with universities of Edinburgh and Industry partners include Airbus, BAE, RACE, Intel, RURobots, STFC-Boulby.

## 7 Centre for Aerospace Manufacturing

Based at the University of Nottingham the Centre is developing new solutions for in-space production leveraging existing robotic manufacturing expertise. Partners include Airbus, BAE, GKN, GE, Leonardo, LENA Space, Reaction Engines, and Safran.

## 8 Oxford Robotics Institute

The Oxford Robotics Institute has successfully adapted its software developed for self-driving cars for application on current planetary rovers.

## 9 Rutherford Appleton Laboratory

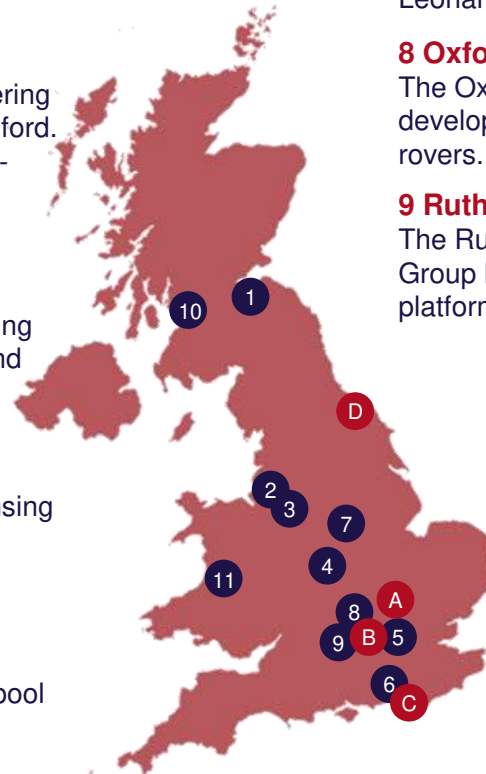
The Rutherford Appleton Laboratory (RAL) Autonomous Systems Group has a long history in developing and prototyping rover platforms especially for field testing and Validation and Verification.

## 10 University of Strathclyde

Strathclyde's Space Mechatronic Systems Technology (SMeSTech) Laboratory provide research expertise and undertakes projects in a wide range of topics, including space robotics for in-orbit satellite services and refuelling.

## 11 Aberystwyth University

The Intelligent Robotics Group have been closely involved with space missions such as Beagle2 and ExoMars Rover. Working on vision-based autonomous sample identification & sample selection with terrain hazard analysis.



### Unique test facilities for space robotics

- A Airbus Mars Yard
- B Harwell Robotics and Autonomy Facility
- C University of Surrey STAR Lab
- D STFC Boulby Underground Lab



# Spotlight: UK Space Agency supports robotics growth

## Leveraging UK space investments

The UK space robotics ecosystem is a mix of national agencies, international players and innovative startups. This creates an exciting dynamic for innovation as shown by the example of MDA and Effective Space Solutions.

In 2018 MDA, an internationally recognised leader in space robotics signed a contract to supply space flight LIDAR and infrared cameras for Effective Space Solutions SPACE DRONE aircraft. These craft will be launched into orbit in 2020, as part of a \$100 million contract with a major regional satellite operator. MDA will execute the project from its newly expanded United Kingdom business.

Effective Space Solutions is a UK based company with an additional R&D centre in Israel. Their fleet of small automated SPACE DRONE spacecraft provide life extension services to operators of satellites that are capable of extending the life of aging satellites by as many as 15 years.

The technology that will enable this mission was developed at the Harwell Campus in the UK, through funding and support from the UK Space Agency. MDA have been able and willing to leverage their technology base to build on these past investments and in turn support emerging companies such as Effective Space Solutions. Everyone is focussed on the larger goal of increasing the UK's capabilities in this growing space sector.

Source: <https://www.prnewswire.com/news-releases/maxar-technologies-md-a-to-provide-mission-critical-sensors-for-the-space-drone-on-orbit-servicing-spacecraft-built-by-uks-effective-space-300682748.html>

## Developing game-changing technology

Researchers in the UK are looking to the future with robotic systems that require less structural mass at launch, making the space market more accessible to new customers. The impact could be similar to the effect CubeSats had on the satellite market, and the UK is well placed to capitalise on this new area thanks to its increasing experience in autonomy, robotics, and space-related technology.

The technology has been developed as part of an activity co-funded by the UK Space Agency. Under this programme a consortium of UK companies developed LARAD, a Lightweight Advanced Robotic Arm Demonstrator to address some of the underlying challenges related to both the design and operation of long arms.

The next phase will use the LARAD technologies to robotically demonstrate the manufacturing and assembly of representative space structures in a laboratory environment. This is being conducted by Airbus and TISICS, a company created from a management buy out of the QinetiQ metal matrix composite business group.

Source: TISICS [https://www.tisics.co.uk/doc/Airbus\\_Robot\\_Arm\\_Poster.pdf](https://www.tisics.co.uk/doc/Airbus_Robot_Arm_Poster.pdf)



# Industrial robotics

## Overview

The UK is home to world-leading research institutions in robotics and some highly innovative robot companies. However, overall uptake of manufacturing automation in the UK has been slow compared to most other developed nations. This creates opportunities in both R&D and selling into the UK manufacturing sector.

The attractiveness of the UK as a location for robotics investment is based on:

- The UK government is investing heavily to increase productivity and robotics is a key technology enabler.
- Funding is available for both R&D and adoption of robotics in industry.
- Many of the technologies essential to the future of automation and robotics have industry leaders in the UK, including silicon chips sensors, AR/VR, AI, power and communications.
- The High Value Manufacturing Catapult Automation Forum brings together expertise from seven national research centres to help manufacturers implement automated systems.
- As one of the top 10 manufacturing industries in the world the UK represents a sizeable market size in need of robotic solutions.

**The value of the collaborative robotics industry is expected to grow to \$1 billion by 2020**

*Source: ABI Research (2015) Collaborative Robotics: state of the market*

## Opportunities

- Robots that can assist with on demand, mass customisation of products and services.
- Manufacturing robots that can move beyond traditional, repetitive (and dangerous) tasks to autonomous activities that require more dexterity.
- Continued integration of Industry 4.0 - linking the real-life factory with virtual reality and data driven services.
- Breakthrough of human-robot collaboration technologies (cobots) that maximises the capabilities of both humans and machines in the production line .
- Simplification of robotic platforms and flexible interfaces suitable for SMEs to programme for different application needs.
- Smart factories.





# Funding the research for the factory of the future

## Made Smarter review includes over £120m support

As part of the UK's Industrial Strategy, an independent review called Made Smarter was conducted to set out a vision for unlocking the potential of Industry 4.0 (including automation and robotics) to increase growth and productivity across the manufacturing sector.

In the October 2018 Budget it was announced that UK government will provide up to **£121 million for Made Smarter to support the transformation of manufacturing through digitally-enabled technologies.**

## Helping SMEs access digital manufacturing

As part of the implementation of the Made Smarter review a pilot study is underway in North West England. Working through five North West Growth Hubs (Greater Manchester, Liverpool, Cumbria, Lancashire, Cheshire and Warrington), the £20m pilot aims to engage with 3,000 local manufacturers and provide intensive support to 600.

Over the next few years, the pilot will test out the most effective ways to engage with manufacturers and encourage them to adopt technologies such as artificial intelligence, virtual reality, IoT and sensors, 3D printing and robotics.

## The Engineering and Physical Sciences Research Council (EPSRC)

The EPSRC Manufacturing the Future research theme aims to improve collaboration between world-leading manufacturing research and industry partners. This is achieved through investing in growth areas, accelerating the impact of research by promoting collaboration and fostering a research community.

EPSRC has a **£8.5m portfolio of funded research in robotics** as part of this research theme. Examples include:

- £2m for Autonomous Inspection in Manufacturing & Remanufacturing – University of Strathclyde with KUKA Robotics UK, Spirit AeroSystems (US) and Los Alamos National Laboratory (US).
- £2m for Robotic disassembly technology as a key enabler of autonomous remanufacturing – University of Birmingham with SAIC Motor UK Technical Centre and Caterpillar Limited.
- £0.2m to develop a 3D metal printing system based on large scale flexible robotics and welding technology – Cranfield University with Airbus Defence and Space (Germany) and FMC Technologies (US).



# Centre of Excellence for industrial robotics

## 1 Northern Ireland Technology Centre (NITC), QUB

An innovation centre at Queens University Belfast with a 50-year track record of collaborating with industry to increase their understanding and implementation of robotic technology into their manufacturing operations. Key strengths include; digital manufacturing, parallel kinematic machining, advanced assembly and cost modelling

## 2 & 8 Manufacturing Technology Centre (MTC)

Develops and proves innovative manufacturing processes and technologies in an agile, low risk environment, in partnership with industry, academia and other institutions. MTC specialises in technologies such as advanced assembly and attracts members from global manufacturing companies.

## 3 Virtual Engineering Centre (VEC)

The Autonomous and Intelligent Systems team within VEC provides a framework for integrating, testing and evaluating performance of autonomous systems through simulation of virtual prototypes and their environments, enabling de-risking, assessment of new concepts and support for certifications

## 4 Advanced Manufacturing Research Centre

A network of world-leading research and innovation centres working with advanced manufacturing companies of any size around the globe. Their Integrated Manufacturing Group specialises in developing robotic systems for low-volume, high value markets like aerospace, where robots have to carry out significantly more complex and variable tasks with greater accuracy.

## 5 National Centre for Food Manufacturing

Working with the University of Lincoln, Industrial partners OAL, and selected industry end users, the centre is developing a robotic flexible food manufacturing system with potential to unlock further robotics and automation approaches across the sector.

## 6 Institute for Advanced Manufacturing

Industrial robotics centre at the University of Nottingham. Home of the national experimental test bed and technology demonstrator in digital and informatics-enabled aerospace manufacturing.

## 7 Intelligent Automation Centre

Based at Loughborough University, the Centre undertakes research to create intelligent automation solutions that deliver breakthroughs in productivity, agility, efficiency and resilience.

## 9 Warwick Manufacturing Group (WMG)

The Automation Systems Group focuses on R&D related to manufacturing digitalisation and Industry 4.0, impacting on and supporting the lifecycle of automation in industry today and in the future.

## 10 TWI

Provides impartial expert advice related to engineering, materials and joining technologies. Provides advice to potential users who may be considering the introduction of robots in their manufacturing operations.

## 11 Bristol Robotics Lab

Helps businesses and entrepreneurs embrace the concept of Industry 4.0 through training, prototyping, demonstrating how automation can improve manufacturing processes, and validating innovations.

## 11 National Composites Centre

Working with companies to explore the frontiers of robotics, sensors, data analytics, machine learning and more to create innovative solutions to composite manufacturing processes.

## 12 Advanced Forming Research Centre

The AFRC has expertise in automated inspection, hosting an impressive selection of equipment that businesses can access, including robots to assist with hot forming and forming capability, and materials capability.





# Spotlight: Industrial robotics developments

---

## Delivering savings through research

The experience of BAE systems shows how working with Centres of Excellence in the UK can deliver bottom-line savings for companies. They worked with the Advanced Manufacturing Research Centre (AMRC) in Sheffield to enable robots to accurately machine holes in composite aircraft components.

The robotic countersinking technology was developed through collaborative research, led by the AMRC and involving KUKA Systems UK. It involved the use of multiple robots to automatically handle composite components and then countersink high tolerance pre-drilled fastener holes.

For BAE Systems the research has helped to mature the robotic countersinking technology from concept to full scale production demonstrator, de-risking along the way. It has now been installed at BAE Systems, where it will be used to processes a wide range of composite components for military aircraft.

Working with the AMRC is forecast to save BAE Systems millions of pounds in capital and operational costs over the coming years.

Source: AMRC <https://www.amrc.co.uk/case-studies/amrc-s-robot-research-cuts-the-cost-of-producing-aircraft-components-for-bae-systems>

## Cobots are a high growth sector

As the UK manufacturing sector evolves to make greater use of digital solutions and robotics it is creating a market for innovative companies to flourish.

The story of Reeco Automation is an example of how firms in the UK are benefitting from the growth in demand for collaborative robots or cobots. In the last three years the company has doubled its workforce thanks to this increasing demand.

Based in Wales, Reeco provides customers with eight different cobot solutions including screw and bolt fixing, pick and place, riveting, dispensing, polishing, electronics and gluing. By using cobots to carry out a range of tasks, employees can be freed up to work on more important tasks requiring human intervention.

Reeco Automation has managed to secure a number of high-profile customers including Ford, Rolls Royce, Honeywell and Unilever. It also formed a successful working relationship with Danish based Universal Robots, one of the leading manufacturers of cobots.

Source: Reeco Automation <https://www.reeco.co.uk/>



# Spotlight: international companies investing in UK

---

## Comau expands in the UK

Italy-based Comau is a leading company in the industrial automation field, combining innovative engineering solutions with easy-to use, open automation and enabling technologies. The company has been based in the UK since 1991 and in 2017 expanded into new facilities following strong growth in demand from UK customers.

Comau specialises in working with customers to build up small systems, which can then be transformed into full Automation Solutions. Leveraging simultaneous engineering studies and the latest Virtual Commissioning technologies the company is helping UK companies develop their capabilities in Industry 4.0.

The expansion marked an important step for the company in the direction to be always closer to their customers and shows companies are investing to meet increasing demand in the UK.

## Electroimpact works with Centres of Excellence

US-based Electroimpact is the largest integrator of aircraft assembly lines in the world who specialise in the integration of automation and tooling into synergistic production solutions.

Their UK plant based in Flintshire, North Wales, has begun installation of two advanced automated robotic fibre placement systems for Airbus in Spain in support of its Ariane 6 rocket program.

The company who have experience in creating accurate robots for the aerospace industry will also be delivering a large CNC based drilling system to Bombardier Aerospace in Northern Ireland as they expand their production of A220.

The success of Electroimpact in the UK is also thanks to collaboration with a number of centres of excellence including the Advanced Manufacturing Research Centre in Sheffield and the National Composites Centre in Bristol.

Source: <https://www.comau.com/en/media/news/2017/06/newopeninguk>

Source: Welsh Government

# Agriculture Robotics

## Overview

Agri-food is the largest manufacturing sector in the UK. It supports a food chain that generates over £108bn per year, with 3.9m employees in a truly international industry that exports £20bn of UK manufactured goods.

Farming 4.0 is the evolution of precision agriculture to the advent of small smart machines that take advantage of IoT to conduct more complex tasks. The future for agriculture robotic solutions is forecast to evolve from servicing only large, flat farms to smaller farms and tasks.

Advantages of investing in the UK include:

- Existing experience in precision farming.
- A culture of agri-tech companies working closely with farmers.
- The UK has a strong Agri-food robotics R&D community and there opportunities for innovators who can help commercialise the expertise.
- The UK has a number of agri-tech innovation centres that allow for real-life testing of new ideas.

**In 2018 the amount of funding raised globally by agri-tech start-ups reached more than \$16.9bn**

*Source: AG Funder (2018) AgriFood Tech Investing Report*

## Opportunities

- Developing field robots that can assist workers.
- Robotics for Livestock that can perform tasks such as removing animal waste, carrying foodstuff, milking, and health monitoring.
- Integration of autonomous systems technologies into existing farm operational equipment such as tractors.
- Self organising robotic systems to plant, fertilise, spray and harvest crops including complex dextrous operations.
- Robotic applications to augment worker productivity.
- Collaboration between the robotics community and industry practitioners. For example, breeding crops using robotic phenotyping to develop fruits which are easy to see and pick by robots.
- Robotics for food manufacturing and processing.
- Further refinement of technologies in sensing, manipulation and soft robotics.







# Supporting agriculture robotics research

## £90m for transforming food production

The UK government has committed up to £90m to help businesses, researchers and industry to transform all aspects of the food production chain. This support is linked to the UK's Industrial Strategy and includes a number of strands:

- **Challenge platform networks** to bring together businesses, farmers and academics to collaborate on research projects.
- An **Innovation Accelerator Fund** to accelerate the commercial potential of new technologies.
- **Demonstrator Funding** for projects that show how innovative agri-tech ideas can be applied in real-world settings.
- **International Research Support** to identify and accelerate shared international priorities and help build export opportunities for pioneering agricultural-technologies and innovations overseas.

## Driving agricultural innovation

In 2019 the government announced an investment of £6.3m to create the first global centre of excellence for agri-robotics in the UK. Based at the University of Lincoln, the centre will meet increasing global demand in the agricultural industry to use robotics, autonomy and artificial intelligence.

The UK is also home to four Agri-Tech Centres designed to allow industry to work with leading UK researchers and innovators. Crucially, the centres aim to address challenges that no one part of the sector can address alone. Two of these centres are of particular interest for companies working in robotics:

**Agri-EPI** (Engineering, Precision and Innovation Centre) is the UK lead centre for the adoption of precision agriculture and engineering technology. It is involved in progressing cutting-edge sensing and imaging technologies, robotics and autonomous vehicles to create a new understanding of production efficiency. More than 70 organisations from across the agri-food supply chain have already collaborated with the centre to deliver precision agriculture solutions.

**Agrimetrics** represents the UK's biggest investment in agrifood data collection and connection. It delivers bespoke professional services to help companies build their own data resource and pioneers the adoption of new data technologies.

Sources: UK Research and Innovation, Transforming food production  
<https://www.ukri.org/innovation/industrial-strategy-challenge-fund/transforming-food-production/>  
UK Research and Innovation, New fund to boost excellent research at 13 universities  
<https://www.ukri.org/news/new-fund-boost-research-at-13-universities/>

# Facilities to develop agriculture robotics

## 1 Lincoln Agri-Robotics

The UK's first global Centre of Excellence in agri-robotics research was created at the University of Lincoln in June 2019. Lincoln Agri-Robotics will be a major new research centre bringing together world-leading expertise in robotics, artificial intelligence and agriculture, based on the site of the University's working farm.

## 2 National Centre for Precision Farming (NCPF)

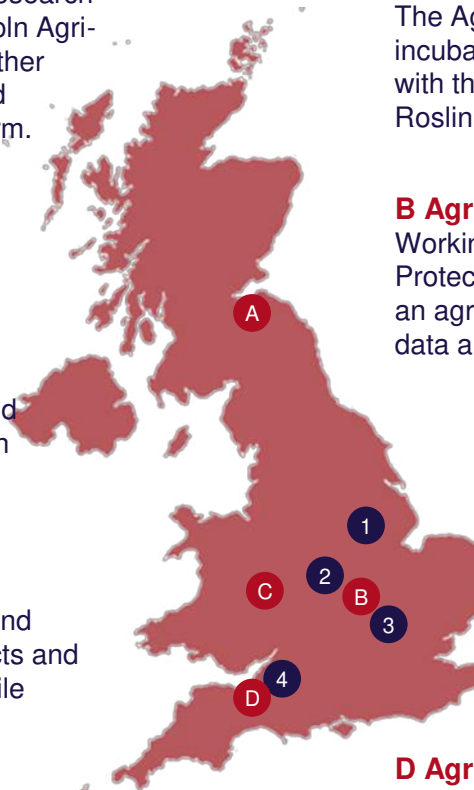
Based at the Agricultural Engineering Innovation Centre at Harper Adams University, the NCPF facilitates the knowledge exchange required to bring "smart" agricultural machinery into wider and more productive use. Harper Adams is home of the 'Hands Free Hectare' project that is testing future swarm vehicle logistics, fleet management and navigation. The project is in partnership with the UK division of Australian precision agriculture specialist FarmScan AG.

## 3 Rothamsted Research

A world-leading, non-profit research centre that focuses on strategic agricultural science. Their Agricultural Research and Innovation Accelerator (AgRIA) develops innovative products and practices incorporating technologies such as sensors, mobile phones, robotics, imaging and spectroscopy.

## 4 Bristol Robotics Lab

Bristol Robotics Laboratory (BRL) is the most comprehensive academic centre for multi-disciplinary robotics research in the UK. The lab works with established companies and entrepreneurs on a number of agriculture related projects including machine vision of animal health and autonomous farm vehicles.



## A Agri-EPI Hub - Edinburgh

The Agri-EPI head office provides R&D facilities, business incubation and meeting facilities. The Centre provides close links with the Centre of Innovation Excellence in Livestock and the Roslin Institute for animal health.

## B Agri-EPI - Hub Cranfield

Working with Cranfield University and CHAP (Crop Health & Protection) the centre provides facilities for testing vehicle sensors, an agri-informatics data hub and access to Digital Globe satellite data and UAV platforms.

## C Agri-EPI Hub - Midlands Innovation Hub

A centre that allows scientists and engineers to work alongside farmers in participatory workshops. The Centre is collaborating closely with Harper Adams University on increasing automation and integrating 5G technology in agriculture.

## D Agri-EPI Hub - South West Dairy Development Centre

The Centre provides a platform to test and demonstrate new and emerging technologies in dairy farming. Facilities include three GEA DairyRobot R9500, state-of-the-art demonstration facilities with visitor access and high-speed connectivity to exploit the benefits of remote access (including a 5G rural testbed).



# Spotlight: Entrepreneurial agricultural robotics in the UK

## UK agri-tech innovators are in demand

Small Robot Company is one example of the innovation happening in British farming, supported by collaboration between investors, farmers and innovators.

In 2019 Small Robot Company, a British agri-tech start-up for sustainable farming, announced that it achieved its Crowdcube equity crowdfunding funding target of £500,000 within minutes of its launch.

The company harnesses the power and precision of robots and Artificial Intelligence to improve the way that food is produced and minimise chemical usage. It will make farms more profitable, and increase yield and efficiency, through using small robots instead of tractors. Its farmbots Tom, Dick and Harry will plant, feed and weed arable crops autonomously, with minimal waste.

A prototype robot is already developed and in field trials on 20 farms across the UK. This prototype embodies all the core technology needed for farmbots including autonomy, geolocation, obstacle avoidance, navigation and the ability to accurately position objects on a map within 2 centimetres.

Source: Small Robotics Company <https://www.smallrobotcompany.com/>

## Building on academic expertise

Successful UK companies are building on the enormous progress in academia in the fields of computer vision, semantic image understanding and robot-control policies. It shows how the strong Agri-food robotics R&D community in the UK can hold the key to many potential robotic solutions in agriculture.

Dogtooth is a Cambridge-based technology startup building state-of-the-art intelligent robots for soft fruit picking. Currently focussed on strawberries, the company is developing robots that can navigate autonomously down polytunnels, find ripe strawberries, carefully pick them, perform a visual inspection and place those suitable for sale in a punnet.

Unlike other similar robots in the industry, Dogtooth's robotic solution snips the strawberries by the stem. By leaving a little of the stem attached with the fruit, the self-life of the fruit is extended, which benefits farmers and traders in the long run. This picking method is going to be the main driving factor for increased adoption of this novel solution.

The company has raised close to £6m in funding and is highlighting the UK as a location for innovation in agri-tech.

Source: <https://www.cambridgeindependent.co.uk/business/how-dogtooth-technologies-intelligent-robots-are-mastering-strawberry-picking-9050467/>



# Spotlight: Foreign investors focus on UK

---

## International technology transfer

In 2018 Indian-based TAFE, the world's third largest tractor manufacturing company in terms of volume, became the first business to take up residence in the Agri-EPI Centre Newport Hub, as part of a major collaborative research and development project with Harper Adams University.

Research will be focused on agriculture, engineering and technology development programmes on autonomous farming and energy efficient implements, Unmanned Aerial Systems (UAS) and sensor technologies.

The investment will provide TAFE with opportunities for developing a range of advanced training skills, learning and the promotion of international technology transfer and exchange.

## Partnership with Chinese drone manufacturer

China-based XAG are one of the largest agricultural drone and robot companies in the world. They recently formed a partnership with the National Centre for Precision Farming to develop localised drone and robotic solutions which suit the UK and European farmers.

In addition, they are working with the Centre and Harper-Adams University to develop AI technologies and ground-based robots to free farmer's hands.

The university are also playing a role in helping XAG to overcome UK legislation on the use of drones for crop spraying by working with relevant authorities, such as the Civil Aviation Authority, to enable trials for the first time in the country.

Source: <https://www.harper-adams.ac.uk/news/203264/harper-adams-university-and-global-tractor-manufacturer-tafe-enter-into-collaboration-for-new-agriepi-centre-project>

Source: <https://www.harper-adams.ac.uk/news/203279/xag-and-harper-adams-university-partnership>

# Robots for extreme environments and infrastructure

## Overview

The ability of robots to operate in extreme environments, whether for routine or emergency tasks, remains a relatively untapped area in the UK. There is considerable potential for investors to take advantage of the strong research base in the UK and a growing demand for the technologies.

Reasons for this potential in the UK include:

- The UK has a dense, mature infrastructure that needs frequent intervention with tasks ideally suited for robotics.
- The National Nuclear Laboratory provides technology transfer facilities to move from research to full-scale demonstrator.
- The UK has a thriving £7.5bn Subsea industry that covers oil & gas, defence, oceanology and marine renewables, including offshore wind, wave and tidal.
- There has been a strong programme of R&D funding based around the nuclear decommissioning sector with opportunities to expand into other utilities and heavy engineering.
- The number and severity of natural disasters is increasing globally and it is clear that robotic solutions will play an increasingly important role in future disaster relief and resilience.
- The UK has a strong network of active research universities conducting genuinely world-class basic research in areas such as sensor technology, MEMS devices, battery technology and AI.

**The UK has committed £60bn to infrastructure investment up to 2028**

## Opportunities

- Autonomous robots to maintain infrastructure.
- Autonomous robots with the ability to perform underwater and underground inspection and repair.
- Robots to remove disruption from infrastructure inspection.
- Inspection and repair in extreme environments such off-shore wind, petrochemical installations and nuclear plants.
- Search and rescue for emergency response.
- Observation and maintenance using Unmanned Air Vehicles and Autonomous Underwater Vehicles.



Sources: Infrastructure and Projects Authority (2016) National Infrastructure Delivery Plan 2016-2021  
Subsea UK <https://www.subseauk.com/>



# Supporting robotics in extreme environments/infrastructure

## Supporting Robots for a safer world

The UK Government is providing up to £93m to industry and researchers to de-risk research and innovation in advanced robotics and create a safer working world. This Robotics for a Safer World research theme allows businesses to obtain grants for collaborative innovation projects or to test and prove their ideas in real-world extreme environments. Examples of funding provided so far include:

- £16.5m awarded to over 70 businesses, 13 universities and 10 research organisations.
- £3 million for 17 demonstrator feasibility studies.
- £4.3 million for the Natural Environment Research Council (NERC) to fund five research projects at the National Oceanography Centre (NOC), and the universities of Exeter and Southampton to develop sensors capable of working in the ocean's extreme conditions.

## Supporting testing and validation

The **Offshore Renewable Energy Catapult** is UK's leading technology innovation and research centre for offshore renewable energy. Their test and validation facilities provide representative environments to help prove, demonstrate and accelerate the commercialisation of new robotics technologies, increasing investor confidence and bringing their benefits to the market more quickly.

The Catapult has helped innovators like Rovco, Modus Seabed Intervention and Perceptual Robotics take their technologies closer to full commercialisation.

## Research Hubs for Robotics

As part of the Robotics for a Safer World research theme, the Engineering and Physical Sciences Research Council (EPSRC) will manage new Research Hubs developing robotic solutions to enable safer working environments in the areas of off-shore energy, nuclear energy and space.

The benefits of these hubs for UK research include:

- Cross disciplinary opportunities for UK robotics R&D which were not previously available.
- Opportunities to nurture talent in large-scale hubs.
- Collaborations with industry and international partners.
- Opportunities to expand solutions into other industries.

More information on these hubs is provided on the next slide.



# Research Hubs for Robotics and extreme environments

## Offshore Robotics for Certification of Assets (ORCA)

The ORCA Hub is a £36M programme aimed at addressing the offshore energy industry's vision for a completely autonomous offshore energy field.

Led by the Edinburgh Centre for Robotics (Heriot-Watt University and the University of Edinburgh), in collaboration with Imperial College London and the Universities of Oxford and Liverpool, ORCA Hub brings together internationally leading experts with over 30 industry partners to create a multi-disciplinary consortium.

The Hub is focussed around four key work themes:

- Mapping, Surveying and Inspection
- Planning, Control and Manipulation
- Intelligent Human-Robot Interaction
- Robot and Asset Self-Certification.

[Website](#)

## Robotics and AI in nuclear (RAIN)

The RAIN initiative has been created to develop advanced robotics and artificial intelligence for future nuclear operations. Their adoption has the potential to completely transform the nuclear industry.

The RAIN Hub brings together eight teams of robotic and nuclear engineering experts from the Universities of Manchester (project lead), Lancaster, Oxford, Liverpool, Sheffield, Bristol, Nottingham and RACE (Robotics and Remote Applications in Challenging Environments). They are joined by industry partners such as EDF Energy, AWE and Rolls Royce and international partners in US and Japan.

The overall objectives are to lower costs within the nuclear industry, reduce timescales, reduce risk, improve safety, promote remote inspection and reduce the chances of human exposure to radiation and other hazards.

[Website](#)

## National Centre for Nuclear Robotics (NCNR)

NCNR is a £42m programme to develop new ways to tackle legacy nuclear waste. It brings together experts in robotics, AI, sensors, radiation, and resilient embedded systems.

The NCNR is a collaborative project involving international experts from 8 UK universities and 30+ partners from the nuclear industry. Partners include universities from Birmingham, Bristol, Edinburgh, Lancaster, Essex, Lincoln, West of England and Queen Mary University London.

Key research areas include:

- Characterisation of waste
- Waste handling
- Cell decommissioning
- Underwater interventions
- UAV based site monitoring.

[Website](#)



# Extreme environments and infrastructure R&D facilities

## 1 The Oil & Gas Technology Centre

The Centre invests in and supports ambitious technology developers to help take their new solutions to the oil and gas markets. Currently working on a number of robotic ventures.

## 2 Heriot-Watt University

As part of the Edinburgh Centre for Robotics the university is involved in a number of projects including the development of remote inspection and repair technologies to inspect offshore wind farms.

## 3 University of Leeds

Developing search and rescue robotic systems combining small agile ground robots with multirotor type aircraft.

## 4 University of Manchester

The Robotics for Extreme Environments Laboratory (REEL) in West Cumbria contains state-of-the-art robotics technology that has been delivering solutions to the Sellafield nuclear site and local nuclear supply chain.

## 5 University of Nottingham

The Machining and Condition Monitoring team are developing fundamentally novel, miniaturised robotic systems, such as walking hexapod and continuum robot, for inspection, maintenance and repair operations in challenging environments (e.g. aero-engines, nuclear).

## 6 University of Warwick

The Warwick Mobile Robotics groups encourages undergraduate and postgraduate students to develop robotic solutions. Based within the Warwick International Manufacturing Centre the group has developed search and rescue platforms and unmanned aerial inspection vehicles for nuclear power stations.

## 7 London South Bank University

The University Robotics Centre develops intelligent automated and robotic systems for the non-destructive testing and inspection of large critical infrastructure. They develop wall climbing, swimming, pipe crawling and mobile robots for the nuclear, petrochemical, energy and aviation industries.

## 8 Oxford Robotics Institute

Developing robots with legs and arms and an autonomous locomotion to enable current technology to be used in industrial scenarios, especially in hazardous environments that are primarily built for humans.

## 8 Remote Applications in Challenging Environments

The UK Atomic Energy Authority's centre for remote applications in challenging environments. A global leader in fusion remote operations and maintenance that works with 13 universities and more than 100 companies.

## 9 University of Southampton

Developing a long range Unmanned Air Vehicle (UAV), which delivers a light Autonomous Underwater Vehicle (AUV) to a predetermined location. Providing the opportunity of deployment in remote and inaccessible places.

## 10 Marine Robotics Innovation Centre

A £3.5bn centre featuring specialist testing and engineering facilities. The Centre hosts a community of innovative companies developing technology for platforms, components and sub-systems for robotics oceanographic research.

## 11 Bristol Robotics Lab

Working on the safe dismantling of all of the nuclear assets that are currently scheduled for decommissioning in the UK. Around £42m in research funding for extreme environment robotics.







# Spotlight: Collaboration develops the next robot solutions

## Cross-industry partnership for subsea innovation

In a first of its kind collaboration the UK defence and oil and gas industries are coming together to develop advanced underwater technologies. Subsea UK and its technology arm, the National Subsea Research Initiative (NSRI), have joined forces with the UK Defence Solutions Centre (UKDSC) to accelerate the development of underwater robotics, unmanned operations, sensors and other technological and digital innovations.

Following the signing of a memorandum of understanding in 2019, a cross sector innovation framework has been developed and is backed by government funding and industry investment, extending the organisations involved to include Innovate UK and the Oil and Gas Technology Centre (OGTC) to support the development of the technologies.

Four areas have been identified in the framework as key to unlocking progress on creating the most advanced and sophisticated systems for use by the defence sector, the oil and gas industry and other underwater sectors in the wider 'Blue Economy. These include; sensors and data, power and communications, deployment and operations.

This partnership will allow for knowledge to be shared between two well developed industries and further develop the potential of the undersea autonomous robots.

Source: <https://www.subseauk.com/10433/defence-and-subsea-sectors-join-forces-to-accelerate-development-of-underwater-autonomous-operations-to-unlock-uk-competitiveness>

## National Nuclear Laboratory

Established in 2008, the National Nuclear Laboratory (NNL) brought together the UK's nuclear research and development capability into one organisation. A key role for NNL is working with end-users to identify and prioritise decommissioning challenges which could be solved with robotic technology.

Collaboration is an essential part of NNL's success. They help to translate fundamental research into real-life solutions for industry and provide access to novel robotic technologies that facilitates the transfer of successful research to nuclear active facilities.

These facilities provide flexible space and equipment that acts as a link between the small-scale, low Technology Readiness Level robotics research already ongoing at research institutes (TRL 1-4), and full-scale demonstrator facilities to progress technology up to TRL level 9.

The National Nuclear Laboratory has six sites across the UK with a Central Laboratory that is the most modern and advanced facility of its kind in the world. It works with supply chain partners across these sites to develop robotic technology that is suitable for the nuclear industry.

Source: <https://www.nnl.co.uk/>



# Spotlight: New technologies for extreme environment

## Unmanned aerial systems ready for UK rescue

The Royal National Lifeboat Institution (RNLI) provides 24-hour rescue services around the coast of the UK and Ireland, along with flood rescue teams inland. The service has a proud history of embracing new technology, from cork lifeboats in the 1800's to new unmanned aerial systems for the 21<sup>st</sup> Century.

In 2018 they worked with industry partners including Lockheed Martin UK, Scisys and the University of Bath to test a variety of drones of different scenarios. The benefit of unmanned aerial systems to lifesaving is likely to be huge. From finding people and delivering life-preserving equipment to those in the water to reducing risk to rescuers by giving them an idea of the conditions at the rescue scene in advance.

The results of the pilot project show there is a market for this type of technology in the UK. Findings from the project concluded:

- There is an appetite from manufacturers and operators of unmanned aerial systems (UAS) to improve their products through better understanding the search and rescue environment.
- The technology is mature enough to benefit localised operations, in particular to help rescue teams communicate in areas where terrain makes radio communication difficult.

## UK robotic solutions are in demand globally

Following the Fukushima earthquake and tsunami in 2011, two companies in the UK secured critical contracts from Japan to design and build a world-first remotely operated robotic system to sample the fuel debris within the reactors. The companies show the mix of established global players and innovative startups that are active in the UK robotics industry for extreme environments.

Veolia Nuclear Solutions has supported the Fukushima cleanup effort by designing or delivering multiple customized robotic and remote systems to inspect, repair, sample and ultimately retrieve damaged fuel. As part of this project that have taken advantage of facilities in the UK such as the Remote Applications in Challenging Environments (RACE) to host a full scale reactor mock-up that will be used for functional testing and training.

Createc is an innovative UK startup, founded in 2010 that is working on sensor based solutions to measure the radiation levels in areas that are unsafe for humans. This includes a drone that flies over the contamination zone and uses sensors to locate and quantify hazardous radiation sources.

# Urban robotics

## Overview

Urban robotics provides the opportunity to extend new technologies into many of the functions of a city. These can include energy, transportation, logistics, planning, emergency response, policing, health, social care, construction and maintenance.

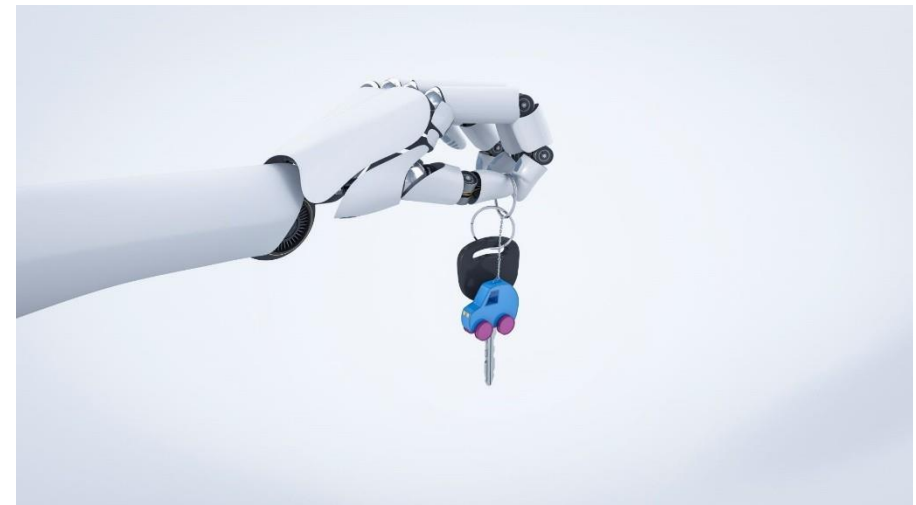
The testing and application of these technologies in real world settings is essential to the future development of urban robotics. The UK has progressive legislation and facilities that will accelerate the development and commercialisation of these technologies.

Advantages for innovators and investors in the UK include:

- The British Standards Institute has created a set of standards for smart city technologies to reduce barriers to systems integration.
- Living Labs across the country operate as open innovation environments where developers in transport, automotive and technology sectors work together.
- The Greenwich Living lab provides a real-world test bed in a complex mega-city environment.
- The Connected Places Catapult supports businesses working in mobility services and the built environment.
- Government investment of £150m to make the UK the world's most effective Connected and Autonomous Vehicle testing ecosystem.

## Opportunities

- Cloud connected robots enabling real time monitoring and physical corrective measures for optimal use of resources.
- Networked intelligent robotics for high variety tasks.
- 3D vision for navigation and identification in robots.
- Natural Language processing for social robots.
- Urban security and emergency response.
- Robotic health services.
- Robotics for offsite construction (Flying Factories).
- Urban maintenance.
- Unmanned Aerial Vehicles and Connected and Autonomous Vehicles.





# Support for urban robotics research

## A number of routes to support

As part of the UK's Industrial Strategy there are a number of avenues of support that are available for different aspects of urban robotics.

- The **Industrial Strategy Challenge Fund Robotics Challenge** aims to develop robots to take people out of dangerous work environments. Primarily aimed at offshore, nuclear and space sectors, the Fund also provides opportunities in urban settings. For example, the UK Government has invested £26.6 million to build micro robots that can help repair the UK's vast underground pipe network.
- As part of the **Transforming Construction** Challenge, £170m for government will be matched by £250m from industry to create new construction processes and techniques.
- £500m in funding from government through the **Centre for Connected and Autonomous Vehicles** and industry to develop and test CAV technologies.

## Linking industry to academia and cities

The **Connected Places Catapult** operates in the space between industry, academia and government. They work on Advanced Urban Services around housing, construction and urban mobility – all areas with robotic solutions. Services for business include business facilitation, industry forums, market research, and hackathons. They also work with cities and regulators to lower the barriers to real-world testing.

## The Engineering and Physical Sciences Research Council (EPSRC)

The EPSRC supports a number of projects relevant to urban robotics. These allow companies to work with universities in the UK to develop new technologies. Recent examples include:

- £4.2m to develop autonomous and dynamically responsive infrastructure maintenance using robots – University of Leeds with Balfour Beatty Group, National Grid, Elgin and Scoutek.
- £1.2m to develop the world's first collective multi-robot building manufacturing system – University of Central London with Buro Happold, Arup Group,; Cementation Skanska, and KUKA Robotics.
- £1.5m for emergency flood planning and management using unmanned aerial systems – University of Exeter with Tata Consultancy.

# Urban robotics research and test beds

## 1 Smart Environments Research Group – Ulster University

Dedicated facilities and expertise for undertaking research in smart environments including a robotics laboratory to investigate the development of autonomous robotics within home based settings.

## 2 University of Leeds

Leading a pioneering £4.2m national infrastructure research project to create self-repairing cities. Working with Leeds City Council to ensure that the robots are thoroughly tested before being trialled in a safe and responsible manner in Leeds.

## 3 University of Sheffield Urban Institute

An international centre researching how cities are responding to the challenges and opportunities of intensified urbanisation and resource constraint. A key research theme is Urban Automation and Robotics.

## 4 Horiba Mira

Europe's foremost "City Circuit" for the development of autonomous and connected vehicles. Helps organisations to define, design, build, validate and test their connected and autonomous vehicle solutions.

## 5 Warwick Manufacturing Group (WMG)

Providing a multidisciplinary approach to autonomous vehicle testing, including cooperative driving systems, connectivity, human factors and verification and validation.

## 6 Bristol Robotics Lab

Developing technologies to address the challenge of aerial robotics in urban environments. Also working on four connected autonomous vehicle projects.

## 7 Millbrook test facility

Forged a unique partnership with the UK Atomic Energy Authority to use the secure roads at Culham Science Centre to bridge the gap between track testing and deployment on public roads.



### Living Labs for real life testing

- A** Edinburgh
- B** Newcastle Helix
- C** West Midlands
- D** Milton Keynes
- E** Greenwich

## 8 Oxford Robotics Institute

The Cyber Physical System Lab lead a multi-centre project to safeguard and transform current operation protocols of fire and flood emergency teams by providing sensing, situation awareness, cognitive assistance and mobile autonomy capabilities.

## 9 Imperial College London

Centre for Infrastructure Robotics Ecosystems integrates expertise in robotics, sensor networks, AI, data science, business innovation and environmental policy. Their Aerial Robotics Lab is developing an aerial robotic construction systems and drones that will patrol buildings to identify and fix minor problems.

## 10 University College London

Technology and creative campus in East London where architects, engineers, and computer scientists work side-by-side with nearby entrepreneurs,. Includes a 2,000 sq m robotics and advanced prototyping space.

## 11 University of Sussex

The Centre for Computational Neuroscience and Robotics conducts Biologically-Inspired Engineering, including a £3m project to create a computationally and energy-efficient autonomous flying robot.

## 12 Construction Scotland Innovation Centre

Industry-led centre links together businesses, university experts and public sector providers to deliver transformational change in construction. Offers a range of product development, manufacturing, robotics and visualisation equipment.



# Spotlight: Commercialisation of urban robotics

---

## Access to funding helps international expansion

Companies in the UK benefit from access to a vibrant venture capital funding ecosystem. As the leading country for robotics startups in Europe, innovators find plenty of investor interest in this sector.

In 2019 UK robotics startup Q-Bot raised £3m in funding that will be used to increase its workforce, expand the technology portfolio and begin international expansion.

Their technology is being used to transform processes across the construction sector. By combining robotics, AI and building expertise Q-Bot have been able to disrupt traditional practices and improve energy efficiency in cities without major disruption.

Q-Bot has introduced the first affordable and fully accredited solution for the insulation of existing timber floors. Their robot applies insulation in situ to the underside of the suspended floor.

Source: <https://placetech.net/news/q-bot-raises-3m-for-international-expansion/>

## From living Lab to commercialisation

In 2018 Milton Keynes completed one of the world's largest trials of free roaming autonomous vehicles (pods) for last mile journeys. The trial demonstrated the UK's ability to develop and test advanced autonomous technology that works in a live public environment.

The pods were built by UK-based experts Aurrigo, a division of RDM Group who have been supplying products and services to the Automotive Industry since 1993. The Milton Keynes success is an example of how UK companies are expanding their expertise into testing future autonomous solutions.

Mile Garner, Sales and Marketing Director at Aurrigo, said: "The trial in Milton Keynes has proved we have advanced autonomous technology that works in a live public environment and pods that can provide that crucial first and last mile transport solution for towns and cities throughout the world."

The potential in this area is huge and Aurrigo are projecting increases in turnover that could reach £100m over the next three years.

Source: <https://ts.catapult.org.uk/news-events-gallery/news/pods-provide-a-first-last-mile-solution-in-milton-keynes/>



# Spotlight: robotic solutions for the changing city

## Micro maintenance robots can save £5bn

At the end of 2018, the Government made a £26.6 million investment in micro robots which are being designed to help repair the vast underground pipe network while reducing disruptive roadworks across the country.

Scientists from 4 British universities (Sheffield, Leeds, Birmingham and Bristol) will use £7 million of the government investment to develop the 1 cm-long robotic devices that can detect and repair damaged gas, water, and sewage pipes. The robots will be supported by in-pipe sensors and will work by delivering a near real-time map of the underground infrastructure network while navigating it. They will also be able to detect simple defects without human intervention.

The project demonstrates the strong business case for supporting investment in maintenance robots. Traffic closures and disruption to businesses of these roadworks is estimated to amount to more than £5 billion.

Source: <https://www.gov.uk/government/news/robots-to-fix-underground-pipes-and-help-cut-roadworks>:

## A safe space for unmanned aircraft testing

The NBEC Consortium is a collaboration between academia and industry that allows new aerial robot solutions to be integrated and tested to accelerate leading edge research and create a blueprint for UK drone and unmanned aircraft activities.

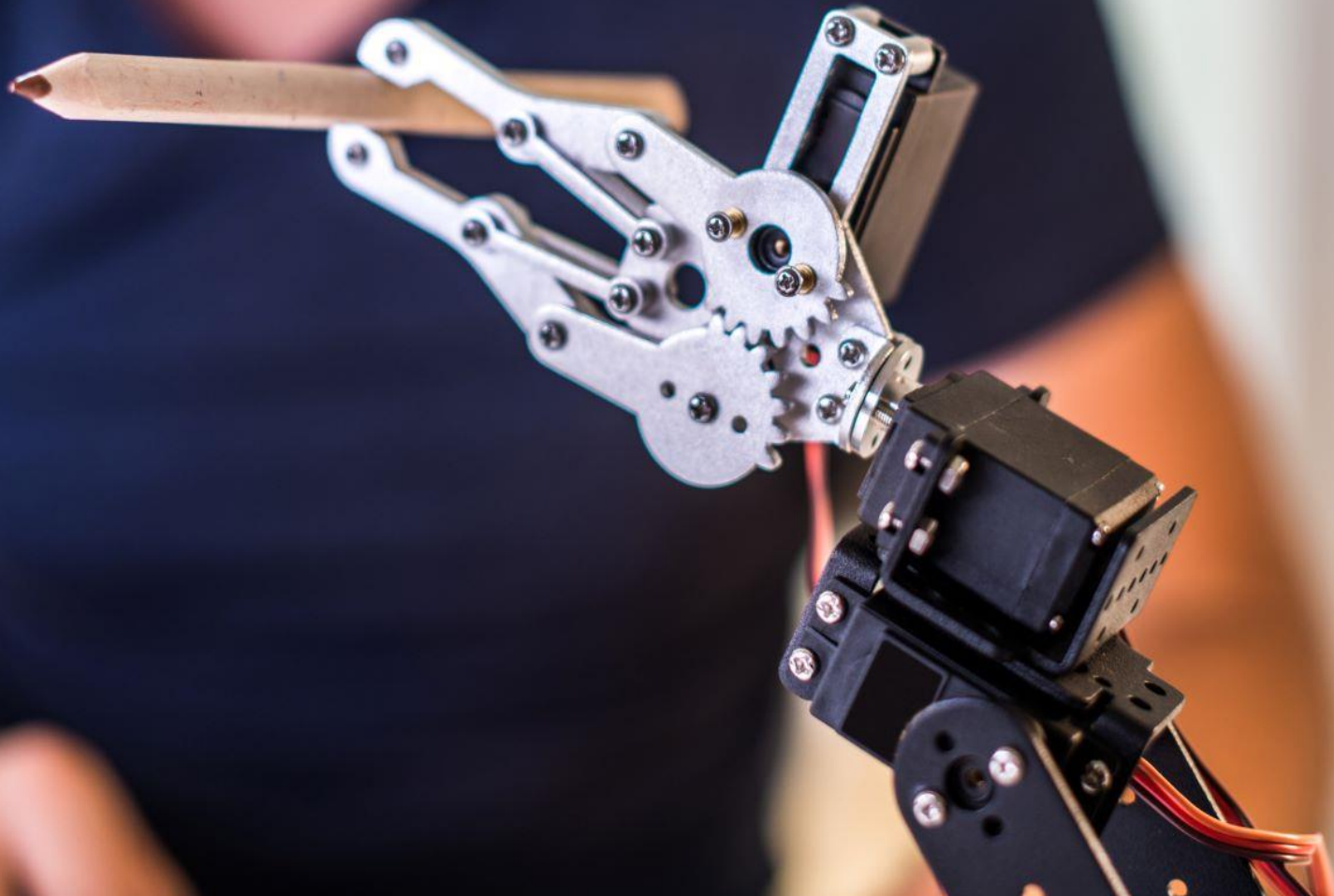
Regulations currently require drones to operate within visual line of sight of the operator at all times but the new consortium will be able to fly within a corridor beyond visual line of sight (BVLOS) by having their locations tracked and thus safely fly in the same airspace as manned aircraft.

The potential of the corridor to validate the operations of unmanned aerial vehicles makes it central to delivering future robot solutions in urban areas.

The Consortium is a mix of research expertise with industry leaders such as Thales and global connectivity players such as Vodafone. The project will operate within the Civil Aviation Authority's (CAA) sandbox initiative that provides a capability for users to work with the CAA to test and trial innovative solutions in a safe environment. In particular solutions that do not fit within the existing scope of regulations, permissions, and exemptions.

Source: <https://limemicro.com/news/vodafone-joins-nbec-consortium-for-4g-5g-cellular-drone-tracking-and-identification-demonstrations/>

**A rich and diverse ecosystem in the UK**





# The UK can support a strong robotics supply chain

## Supporting a robotics supply chain

The UK can provide access to a strong robotics supply chain that will support the forecast growth in demand. The breadth of the potential supply chain in the UK is demonstrated by the 3,800 companies and 114,000 employees active in industries supplying the UK robotics supply chain.

These include companies working in products such as: motors, grippers, actuators, sensors, LIDAR, cameras, communications, and energy storage and management.

In addition the UK is home to a number of experienced software companies, systems integrators and consultants who assist companies in all areas of automation and robotics.

The value of the UK supply chain was demonstrated by the acquisition of UK based Delcam by Autodesk of California in 2018. The deal provided Autodesk with an opportunity to expand into more manufacturing sectors through the existing expertise of Delcam.

## Supporting the robotics supply chain

Companies working in the robotics supply chain also benefit from a number of facilities across the UK such as:

- Sensor City in Liverpool that enables industry and academic partners in a range of sectors to translate their innovative sensor concepts into commercially viable solutions.
- The UK Battery Industrialisation Centre is an £108m facility designed to turn the best ideas into commercial reality. When it opens in 2020 it will be an open-access facility where organisations can undertake collaborative projects including funded research, development activities, and scale-up programmes. This will have wider spillover benefits for energy storage and management of robots.





# Useful Networks for robotics

---

## UKRAS Network

The EPSRC UK Robotics and Autonomous Systems (RAS) Network was established in March 2015 with the aim of bringing together academic centres of excellence, industry, government funding bodies and charities to strategically grow the UK-RAS research base. The networks acts as a portal to interface with industry and deliver technological advances. The network includes 28 universities working in robotics research.

[More information](#)

## The Robotics & Artificial Intelligence Special Interest Group

Special Interest Groups are Knowledge Transfer Networks run by Innovate UK. They are time-bound activities across a wide range of specialist areas to connect and catalyse people and activities to achieve specific knowledge transfer and innovation outcomes. The Robotics & Artificial Intelligence Special Interest Group provides UK RAI innovators with the chance to connect, access markets and showcase their capability. Connect through their [Linkedin Group](#)

## National Robotics Network

The National Robotics Network is an open network of industry and academic professionals from across the UK interested in robotics and autonomous systems. They organise meetings, events and networking opportunities for industry stakeholders interested in taking up robotic solutions.

[More information](#)

## British Automation and Robot Association (BARA)

BARA promotes the use of, and assists in the development of Industrial Robots and Automation in British industry. It provides strong support to assist with the growth of the automation sector in the UK, as well as having a presence overseas at the International Federation of Robotics. BARA also provides training, events and publications for the UK robotics industry.

[More information](#)

## Zenzic

Zenzic brings together government, academia, innovators and developers to facilitate and support the UK's emerging connected and autonomous vehicle sector. Government and industry have committed an initial £100 million through Zenzic to develop a coordinated national platform of CAV testing infrastructure.

[More information](#)

## Subsea UK

Subsea UK is the industry body and focal point for the entire British subsea industry and aims to increase business opportunities at home and abroad for the sector. They act for the whole supply chain bringing together operators, contractors, suppliers and people in the industry. Subsea UK was established by the industry and acts on behalf of the industry.

[More information](#)

# DIT support

---

Through our bank of knowledge, specialists expertise and extensive networks DIT can help identify and leverage potential opportunities, both for trade and investment.

The services we provide to overseas companies include:

- **Accessing market opportunities:** helping international companies assess market opportunities in the UK
- **Access and introductions to the right people:** working with every UK government department to support access to a vast network of industry experts
- **Setting up in the UK:** we provide a range of support from applying for visas and entry to the UK to set up procedures, to the UK tax system and site selection
- **Bespoke market research:** compiling in-depth factual reports including market entry support, research and development collaborations and cost analysis
- **On-going government support:** continued support after your business is established in the UK, providing assistance on expansion and representing your interests in government
- **Entrepreneurial assistance** through a network of mentors to help make a commercial success of early stage companies





Department for  
International Trade

[gov.uk/dit](https://www.gov.uk/dit)

This information has been prepared by the Department for International Trade (DIT), and suppliers of DIT, for general informational purposes only. This information is not intended to amount to advice on which you should rely. Although DIT and its suppliers makes reasonable efforts to ensure the accuracy of any information provided, neither DIT nor any of its suppliers makes any representations, warranties or guarantees, whether express or implied, that any information supplied is accurate, complete or up-to-date. Accordingly, you must obtain professional or specialist advice before taking, or refraining from, any action on the basis of this information.

Neither DIT nor any of its suppliers accepts any responsibility for updating this information in light of subsequent events or for any other reason. This information does not constitute a recommendation or endorsement by DIT or any of its suppliers.

To the fullest extent permitted by law, neither DIT nor any of its suppliers accepts or assumes any responsibility or liability to any reader of this information for any loss or damage, whether in contract, tort (including negligence), breach of statutory duty, or otherwise, even if foreseeable, arising under or in connection with the use of or reliance on this information including, but not limited to, loss of profits, sales, business, or revenue, business interruption, loss of business opportunity, goodwill or reputation, or any indirect or consequential loss or damage. Should any such reader choose to rely on this information, then they do so at their own risk.

DIT is the owner, or the licensee, of all intellectual property rights in this information and DIT reserves all rights in this information.