Inspiring innovations

Businesses using science in the UK

THE ROYAL SOCIETY

Cover image
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Foreword

The UK's excellent science base supports companies across industrial sectors to innovate, bringing broad benefits for society and supporting economic growth.

The UK has created a world-leading research base, which provides the foundation for new ideas and discoveries, fuelling economic growth, training skilled people and improving productivity. Industry is an integral part of this rich ecosystem, together investing more in research and development than government. In this booklet we present five stories about businesses using science in the UK. Together, they demonstrate the diverse ways in which science inspires innovation, and how this supports businesses to turn new knowledge into benefits for society.

New companies can spring from new discoveries, such as Immunocore, a growing biotechnology company (page 10) that was built from fundamental biological research at Oxford, or Artemis Intelligent Power (page 7) that was founded to commercialise technology that had been developed at the University of Edinburgh. Maintaining links with academia can also support companies as they develop. Artemis was given space and time to grow by the University of Edinburgh.

Relationships between business and academia support innovation in established companies too. GlaxoSmithKline (GSK), who lead the way with university collaborations in the UK[1] are working with the DSTT research consortium to develop new classes of drugs (page 14). Insurance brokers Willis have established a network of links with top academic institutions (page 13), to build scientific expertise about extreme weather events into their business.

Businesses using science to innovate helps the UK to compete on the global stage. Excellent research attracts foreign investment, like Japanese Mitsubishi's investment in Artemis Intelligent Power. It also keeps multinational companies like GSK here, and attracts companies to the UK. Using science also helps businesses to bring in international revenues by developing market-leading products; one eighth of the world's top prescription medicines were developed in the UK.

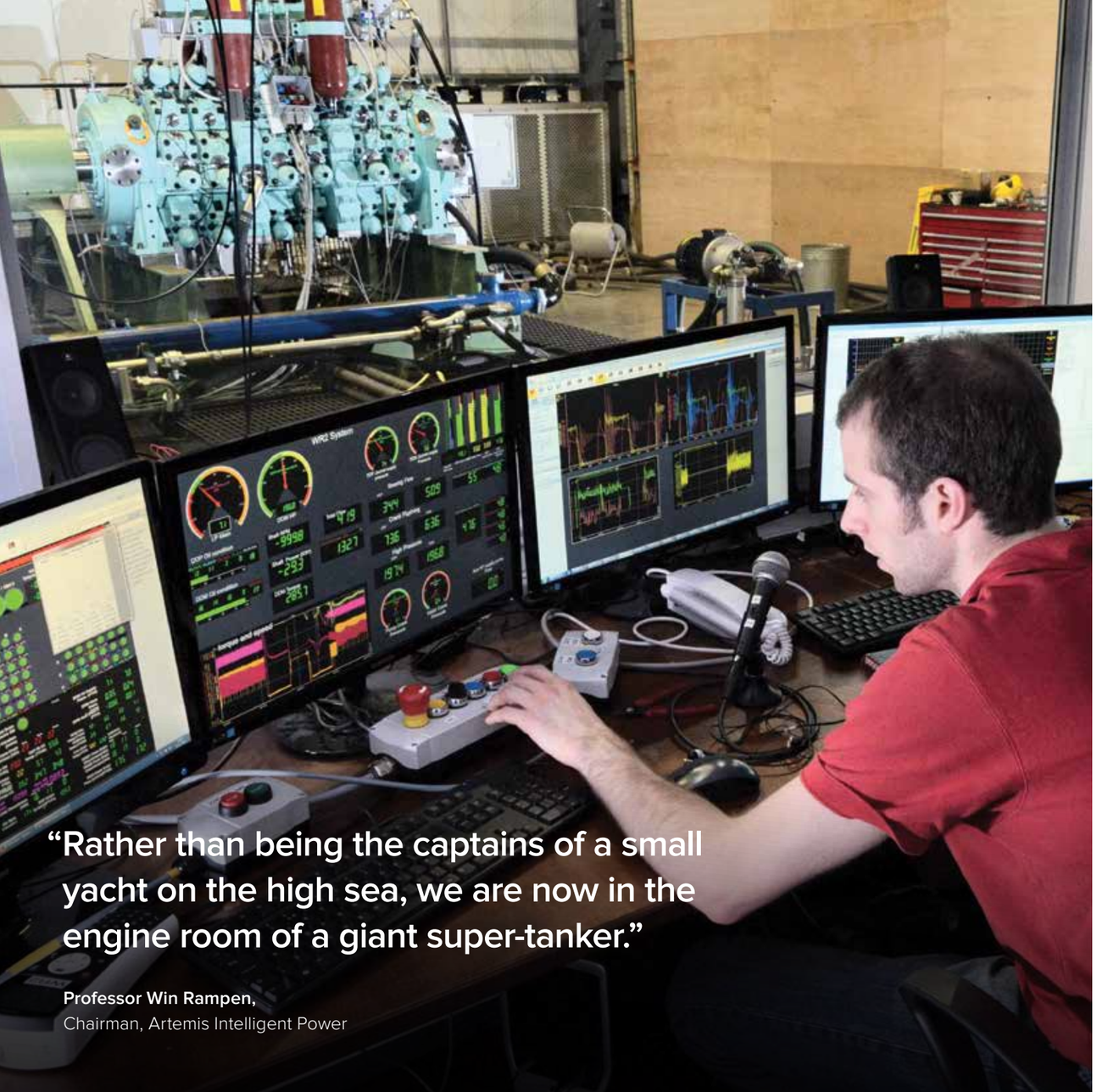
1. Dowling, A. 2015 The Dowling Review of Business-University Research Collaborations, Figure 9. (See http://www.raeng.org.uk/publications/reports/the-dowling-review-of-business-university-research, accessed 9 July 2015)

The UK research and innovation ecosystem that supports all of this is underpinned by public policy and investment. This includes the science budget, but also other funding through Innovate UK, which helped Artemis to grow, or other public bodies like the UK Met Office, which is part of the Willis Research Network.

Together, the stories in this booklet show the benefits of businesses using science in the UK. UK business investment in R&D is relatively low by international standards, and industry should be encouraged to invest more. The UK's excellence in science can inspire companies to innovate, helping us to reap the benefits of research for society.

Sir Paul Nurse
President of the Royal Society

Right



“Rather than being the captains of a small yacht on the high sea, we are now in the engine room of a giant super-tanker.”

Professor Win Rampen,
Chairman, Artemis Intelligent Power

Engineering innovation in offshore power

Artemis Intelligent Power

Artemis Intelligent Power grew out of wave and tidal energy research initially carried out at the University of Edinburgh. In 2010 the SME was acquired by Japan’s Mitsubishi Heavy Industries and through this investment it continues to grow. In 2014 the company’s unique Digital Displacement® hydraulics technology was installed in Scotland’s first offshore wind turbine test facility at Hunterston in North Ayrshire.

The UK is the undisputed global leader in marine energy, with more test devices in UK waters than the rest of the world combined. If properly exploited, offshore power could deliver up to 20 per cent of current UK electricity needs and contribute over £15 billion to the UK economy to 2050.[2]

The technology that Artemis has commercialised started with engineering innovations from the University of Edinburgh’s marine energy group. This work aimed to improve the energy output of wave and wind machines through better power transmission. Their Digital Displacement® hydraulic systems function like a gearbox, but are able to handle irregular power levels more efficiently and can be controlled digitally. As well as wind and marine energy, the technology can be applied to on and off-road vehicles and industrial machinery.

Professor Win Rampen says the company started life in an old university portacabin, as did several other ventures; “the work carried out there was responsible for raising about £200m worth of inward investment” he says. To start with they worked at the University, mostly “under the radar” but having access to tools and students helped them to develop their prototypes.

Artemis was created in 1994, initially licensing their technology to strategic partners for a number of applications including wind turbines. Managing Director Dr Niall Caldwell explains “that income was able to unlock matching funding from the Carbon Trust, Energy Saving Trust, DECC, Innovate UK and the Scottish Government”. They finally left the University in 2008 and in 2010 Mitsubishi Heavy Industries became interested, Dr Caldwell says, due to the wide range of applications for their highly innovative power transmission solution.

Working with Mitsubishi, Artemis, now with 50 employees, is making the largest hydraulic drives in the world. As well as the Hunterston project, Artemis is applying its technology to a 7-megawatt floating turbine being tested off the coast of Fukushima in Japan. Professor Rampen says “the day to day running of Artemis has changed little since we were bought by Mitsubishi, but their investment has given our systems limitless potential. Rather than being the captains of a small yacht on the high sea, we are now in the engine room of a giant super-tanker.”

2. Renewable UK 2015. (See http://www.renewableuk.com/en/renewable-energy/wave-and-tidal, accessed 15 June 2015)

Going underground: computer vision for Crossrail construction

Arup

Set to open in 2018, London's new rail line, Crossrail, is the largest infrastructure project in Europe, comprising 42km of tunnels. The project will increase London's rail capacity by at least 10%, but it has presented numerous engineering challenges. One of these is ensuring the surrounding underground infrastructure is not damaged by construction of the new tunnels. Engineering consultants Arup have been working with the University of Cambridge to improve this monitoring using novel image processing technologies, designed with the University's Centre for Smart Infrastructure and Construction (CSIC).

The CSIC was created in 2010 to work on innovative sensor technologies with the construction industry, which employs around 2 million people and contributes almost £100 billion to the UK economy.[3] Arup Associate Director, Mike Devriendt has been working with CSIC researchers to develop and apply new solutions for complex problems like those found in constructing Crossrail. Together they developed a system that uses 'computer vision' to monitor movement of the tunnels – where tiny changes are detected by analysing individual image pixels.

Their new sensing system has been deployed in the 'smart tunnel project' on which Arup, the CSIC and Crossrail are working together. The system provides real-time monitoring of a 30-metre stretch of the Royal Mail tunnel, which was once used to carry post across London. The century-old, twenty-five metre deep tunnel, now sits directly above the newly constructed Crossrail tunnel under London's Liverpool Street station.

The solution the team provided costs 90% less than traditional methods and has proven itself more effective, as Devriendt explains: "using our method has the advantage of providing more information, as being able to look at images can help to better understand what's going on." The collaboration has benefitted both industry and academia and has led to a key tunnel engineering publication. "We now have a better understanding of the deformation mechanisms that occur in cast iron tunnels," he says.

By testing the system in six locations, including the radioactive tunnels at the CERN particle accelerator in Geneva, Devriendt says, "the team is now confident that we can commercialise the system." Industry partners can licence the new intellectual property.

Arup's strong relationship with the CSIC has provided them with more than project solutions, "the CSIC has also given us access to a network of other companies" says Devriendt. Through the CSIC, Arup has forged several new collaborations, including one with Toshiba to develop an ongoing imaging-based infrastructure monitoring service.

3. Rhodes, C. 2014 The construction industry: statistics and policy, Commons Briefing papers SN01432. (See http://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN01432, accessed 15 June 2015)

"We now have a better understanding of the deformation mechanisms that occur in cast iron tunnels."

Mike Devriendt
AMP Associate Director, Arup

Image

Designing a ‘base paint’ to fight cancer

Immunocore

Immunocore is harnessing the body’s own immune cells to fight cancer. Chief Business Officer Eva-Lotta Allan says that “the company was working on cancer immunotherapies well before it became fashionable.” That work is now paying dividends, with positive results for their first clinical trials recently announced.

The biotechnology underpinning Immunocore is based on the science of founder Dr Bent Jakobsen, who until 2000 led his own research team at Oxford’s Institute of Molecular Medicine. His work in the 1990s led to an initial spin-out company named Avidex, which did much of the early development work. In 2008, Immunocore was created with Avidex’s intellectual property and many of the original scientific team. Since 2008 a total of £32 million has been raised to fund Immunocore’s activities, with further significant income coming from partnerships.

With approximately 150 employees, Immunocore is typical of the SMEs that dominate the UK’s medical biotechnology sector. In 2014, the sector consisted of an estimated 1,000 companies generating turnover of £4.8bn and employing 23,000 people. Over the period 2009-2014, the sector has seen 4.3% annual growth.[4]

Innovative development of Jakobsen’s work led to Immunocore’s biological drugs that recruit T cells in the bloodstream to kill cancer cells. They are known as ImmTACs and are bispecific as they are able to connect to both T cells and cancer cells.

Immunocore’s technology is highly competitive; “there are very few companies that have managed to design similar bispecific drugs yet” says Eva-Lotta Allan. She describes their drugs as a potential ‘base-paint’ cancer treatment. Their low toxicity makes them ideal to be used in combination with other drugs.

Immunocore has secured significant income from partnership deals with leading pharmaceutical companies, who are currently taking a big interest in cancer immunotherapy. But the company is also developing its own drug pipeline and is now running its first clinical trials for a cancer drug which could be on the market in a few years.

The technology has potential for a wide spectrum of cancers and beyond, to treat viral infections and autoimmune diseases. The company continues to be heavily research-led, with ~85% of staff in research roles.

According to Eva-Lotta Allan, many smaller biotech start-ups are quickly acquired by bigger companies, “a common reason why European biotech companies often fail is because they are not optimally funded to expand”. She adds, Immunocore’s ambition is to become a premier global biotechnology company and a leader in the field of cancer immunotherapy.

4. HM Government 2014 Strength and opportunity 2014: the landscape of the medical technology, medical biotechnology, industrial biotechnology and pharmaceutical sectors in the UK: annual update – March 2015. (See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427769/BIS-15-224-BIS-strength-opp-2014.pdf, accessed 15 June 2015)

Image

“There are very few companies that have managed to design similar bispecific drugs yet.”

Eva-Lotta Allan
Chief Business Officer, Immunocore

“The expert input and thought leadership the network provides is going to be crucial in understanding how future weather patterns are changing.”

Stuart Calam
Programme manager, Willis Research Network

Managing insurance risk by modelling windstorms

The Willis Research Network

“Like buses, severe storms in Europe often come together, in twos or threes” says Stuart Calam, Programme Manager of the Willis Research Network (WRN), which was set up in 2006 by leading global risk advisor, insurance and reinsurance broker, the Willis Group.

Before the 2010 European windstorm project, the frequency at which severe weather events occur was not widely understood, so WRN researchers undertook a statistical study to model how these events impact on insurance risk. “The project identified that storms cluster and this has allowed companies to price insurance more accurately – something that has now been integrated into all industry risk models” Calam says.

Willis was persuaded that the sector needed greater academic input after a number of natural disasters, such as the 1999 cyclones, Lothar and Martin, which caused €8.5 billion of insured losses. Stuart Calam explains, “we recognised that our industry was not able to provide the information clients needed to manage their risk and we needed to improve our natural catastrophe modelling.” Drawing on UK excellence in weather modelling, the WRN is now the world’s largest academic collaboration in the financial sector, with a membership of around fifty global research institutions.

Members of the WRN include UK and international universities: Oxford, Exeter, Imperial College, UCL, Reading and Princeton and the network has relationships with bodies such as the Met Office and NASA. The WRN funds 15 multidisciplinary research programmes, looking at a variety of natural hazards such as flooding and hail damage, as well as the largely unmodelled risks of volcanoes and landslides.

The ground-breaking European windstorm project was carried out with Exeter University’s Professor David Stephenson, in collaboration with the UK Met Office. Their statistical modelling showed that clustering is more likely to occur with intense cyclones and provided a method to retro-fit storm clustering into existing risk models. This will lead to better risk management and so reduce some of the huge losses that insurers have faced from extreme weather.

The WRN’s research has been valuable to the whole insurance industry, which is a particularly successful UK sector, employing around 315,000 people and contributing nearly £12bn in tax revenues in 2014.[5]

Stuart Calam says “the expert input and thought leadership the network provides is going to be crucial in understanding how future weather patterns are changing, and what effect this will have on managing risk.” There may be many uncertainties in our current climate, but Willis is certain that its network of leading academics will help it to stay ahead.

5. Association of British Insurers UK insurance key facts 2014.
(See https://www.abi.org.uk/Insurance-and-savings/Industry-data/Key-Facts-2014, accessed 15 June 2015)

Signalling progress: collaborations underpinning drug discovery

GlaxoSmithKline (GSK)

"There isn't a week that goes by without a GSK scientist talking to a scientist at a UK University" says Dr Malcolm Skingle CBE, GSK's Director of Academic Liaison, responsible for the company's collaborations with over 50 UK universities. The strength of the UK's science base means that GSK continues to invest in UK academic research to support its own drug discovery programmes. It now funds more than 300 individual research collaborations, 240 PhD students and more than 155 post-doctoral researchers.

The collaborative relationship between academia and the UK pharmaceutical industry is one of the things that keeps the sector strong. One eighth of the world's top prescription medicines have been developed in the UK and in 2013 the sector directly employed 73,000 people and generated a trade surplus of £3bn.[6]

GSK is the UK's largest pharmaceutical company and in 2014 invested almost £1 billion in R&D in the UK. External collaborations have become a critical component of its R&D strategy. "The scientific challenges are getting bigger and bigger and we know that we won't discover everything inside our own labs. Drug discovery needs a diversity of academic thought and access to new areas of science – the best way to do this is by working together" says Dr Skingle.

An example of this type of collaboration is the Division of Signal Transduction Therapy consortium (DSTT) based at the University of Dundee. The DSTT involves the know-how of 180 Dundee scientists working with GSK and five other global pharmaceutical companies.[7] The consortium focuses on drugs that alter cell signalling pathways. It is when these signalling pathways go wrong that a number of major diseases can occur, including cancer, diabetes, hypertension and Parkinson's disease.

GSK has been part of the DSTT consortium since its 1998 inception and regards it as a model for how academia and the pharmaceutical industry can interact productively. One significant impact of the consortium has been its role in the development of a promising new class of cancer drugs, called kinase inhibitors. They work by blocking cell signalling pathways that have malfunctioned. With underpinning research from Dundee, GSK successfully developed a kinase inhibitor for late-stage skin cancer, approved for use in 2013.

"Our academic partnerships bring benefits to all parties – they bring us insights and expertise from outside the company that truly enable us to progress our own programmes more quickly, and support the students and post-docs involved to build their understanding of drug discovery" says Dr Skingle.

6. Association of the British Pharmaceutical Industry 2014 Delivering value to the UK (See http://www.abpi.org.uk/our-work/library/Documents/delivering_values_dec2014.pdf, accessed 15 June 2015)
7. AstraZeneca, Boehringer Ingelheim, GlaxoSmithKline, Janssen Pharmaceutica NV, Merck-Serono and Pfizer.

"There isn't a week that goes by without a GSK scientist talking to a scientist at a UK University."

Dr Malcolm Skingle CBE
Director of Academic Liaison, GSK

Image

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, as it has been since its foundation in 1660, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities emphasise its commitment to the highest quality science, to curiosity-driven research, and to the development and use of science for the benefit of society. These priorities are:

- Promoting science and its benefits
- Recognising excellence in science
- Supporting outstanding science
- Providing scientific advice for policy
- Fostering international and global cooperation
- Education and public engagement

For further information
The Royal Society
6 – 9 Carlton House Terrace
London SW1Y 5AG

T +44 20 7451 2500
E industry@royalsociety.org
W royalsociety.org

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