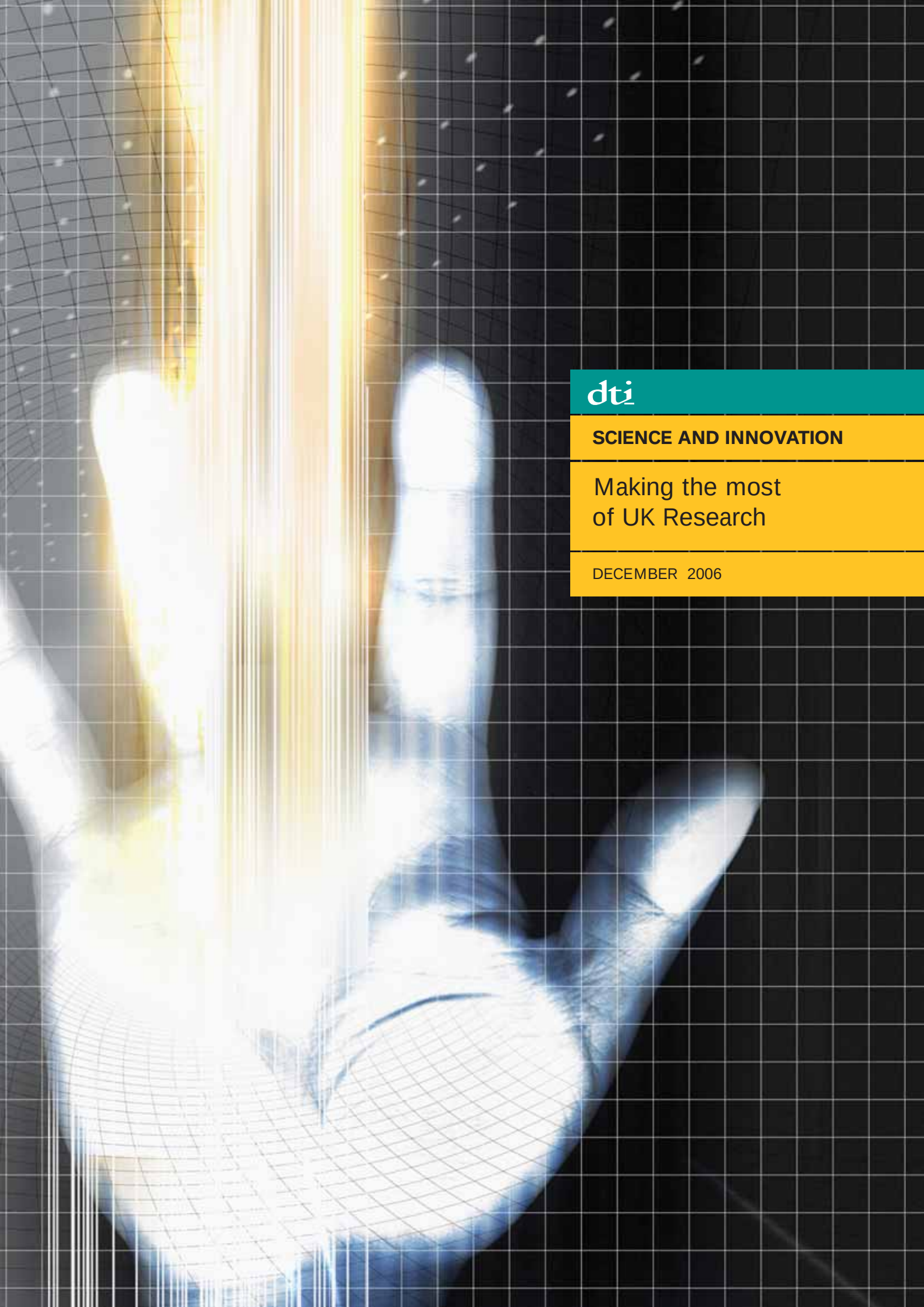

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SCIENCE AND INNOVATION

# Making the most of UK Research

DECEMBER 2006

Cover: *‘Reaching out to science’*

# Contents

# Case Studies

# Foreword

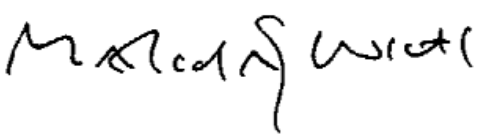
The way we create wealth is changing. Knowledge-based businesses account for over half the job growth in the UK during the past two decades. The Government aims to ensure that the living standards of UK citizens continue to improve. The best way to achieve this is to increase the amount of output each person produces, that is, to increase productivity. Therefore, it is vital that we continue to innovate and devise new and more productive ways of working.

Continued investment in research and development is essential to the future of this country. The Government is therefore determined to make the UK one of the best places in the world for science and innovation. The Government has set ambitious goals for the future in a 10-year forward looking *Science and Innovation Investment Framework 2004-2014*. We aim to secure the UK's leading place among the major European countries and substantially close the gap between the UK and the USA, the best performing, major innovation-driven economy.

It is also vital for UK business and our quality of life that innovative ideas make it beyond the drawing board and become successful products and services. We must become better at ensuring that the knowledge generated in our research institutions is transferred to where it can have the greatest beneficial impact on our economy.

Within a modern, knowledge driven economy, knowledge transfer is about transferring good ideas, research results and skills between universities, other research organisations, business and the wider community to enable innovative new products and services to be developed. Our mission is to make the most of the UK investment in science, engineering and technology.

This publication highlights examples of knowledge transfer in action. It illustrates some of the many ways in which science and innovation have contributed to our way of life.



Malcolm Wicks
Minister of State for Science and Innovation

# Introduction

In July 2004, the Government set out its long-term ambitions for the UK's science and technology in the *Science and Innovation Investment Framework 2004-2014*. The research community reacted enthusiastically to the Framework and welcomed the Government's long-term commitment to invest in science and innovation. The vision outlined in that document builds on activities that already exercise many businesses and academics - to improve the capacity of the research base to engage with business.

> "With the right long-term decisions, Britain can lead in some of the fastest growing and highest value added sectors - city and business services, education and health, creative and science based industries - once small, now one third of our economy and exports, soon a much higher share of jobs and wealth"
>
> Gordon Brown, March 2006

This publication demonstrates, through a selection of examples:

- how the academic community and businesses in the UK have worked together,
- how they have risen to new challenges, and
- how they have been able to build upon each others' strengths to produce new and innovative products and services that have a significant impact on the UK's economy.

The collaboration between researchers and business takes many forms, including;

- the people who emerge from our excellent research base
- greater responsiveness of the research base to the needs of the economy, and
- increased business investment and collaboration.

> "Britain will only have a competitive edge if we develop world leadership in the most technologically intensive and science based industries and services."
>
> Gordon Brown, February 2005

# The Research Councils

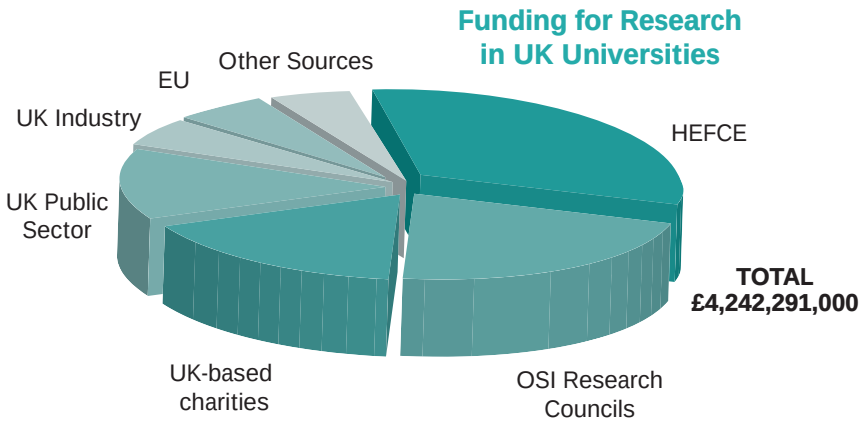
Much of the Government's investment in research is channelled through the Research Councils to support science at UK universities and research institutes. There are eight Research Councils, established under Royal Charter. The Department of Trade and Industry is responsible for funding and governance of the Councils, supported by the Director General of Science and Innovation, Sir Keith O'Nions, in the Office of Science and Innovation.

Council members are appointed by the Secretary of State for Trade and Industry.

**The UK Research Councils are:**

- Arts and Humanities Research Council (AHRC)
- Biotechnology & Biological Sciences Research Council (BBSRC)
- Council for the Central Laboratory of the Research Councils (CCLRC)
- Engineering & Physical Sciences Research Council (EPSRC)
- Economic & Social Research Council (ESRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Particle Physics & Astronomy Research Council (PPARC)

Collectively the Research Councils are major funders of research in UK universities. Information about the Research Councils and their activities can be found on the Research Councils UK (RCUK) website: www.rcuk.ac.uk



# Research Excellence

An assessment of research outputs showed that the UK's science base is second only to that of the US on most scientific indicators (PSA target metrics for the UK research base, OSI, December 2005). In fact, it could be argued that the UK exceeds the US's performance when measured on a per capita basis.

With 1 per cent of the world's population, the UK produces 5 per cent of its science, publishes over 12 per cent of all cited papers and almost 13 per cent of those with the highest impact. The UK is second to none in terms of the productivity measures of papers published and citations per researcher. Our research strengths are broadly based, ranking second in the world in eight of ten broad research disciplines.

The increasing need for scientific excellence and skilled people with research training makes it imperative to put higher education institutions and public sector research laboratories on a long-term financially sustainable footing if this ranking is to be maintained. Without this our higher education institutions (HEIs) cannot maintain their ability to deliver cutting edge research.

## Saving lives

### Archaeology Deciphered

In the process of deciphering ancient writing tablets from Hadrian's wall, archaeologists funded by the Arts and Humanities Research Council developed a new way to read them. This technique is also useful in medical imaging, such as mammography.

### Blood pressure & heart disease

The Medical Research Council first found the link between high blood pressure and heart disease. Further research showed that aspirin and warfarin helped prevent heart attacks and strokes.

### Volcano warning

Hazard warning and crisis management were executed through the British Geological Survey during the Montserrat volcano crisis in 1997, saving the lives around 4600 people.

| Research Field | World ranking | Trend 95-04 | Examples of economic and social impact: |
|---|---|---|---|
| Bioscience | 2 | ↑ | In the 1970s, UK researchers, supported by the forerunner of the BBSRC, developed environmentally friendlier insecticides.Today, these compounds account for 17 per cent of global insecticide sales – a market worth more than $7 billion per annum. |
| Environmental | 2 | ↑ | The hole in the ozone layer was discovered by a team from the British Antarctic Survey, a part of the Natural Environment Research Council. |
| Social science | 2 | ↑ | Evidence from the National Child Development Study (NCDS) and the 1970 British Cohort Study (BCS70) helped put the warning about smoking in pregnancy on cigarette packets. |
| Business | 2 | ↑ | Research from the Economic and Social Research Council contributed to the auction of the 3G mobile phone spectrum raising £20 billion more than forecast. |
| Clinical | 2 | ↔ | Medical Research Council research means that four in five children with leukaemia now recover, compared with only one in five 25 years ago. |
| Pre-clinical | 2 | ↔ | Researchers have developed models to help understand the causes of human Down Syndrome. |
| Humanities | 2 | NEW | Funded by the Arts and Humanities Research Council, scientists researching touch sensitive interfaces have enabled artists and designers to get the best use from computer-aided design software. |
| Mathematics | 2 | ↔ | Mathematical modelling from EPSRC research helps drivers to avoid congestion and traffic lights respond automatically to traffic volume. |
| Physical | 3 | ↔ | The World Wide Web arose from physicists needing to share huge volumes of data. The Internet has a substantial effect on the UK economy with UK online shopping growing by 27.5 per cent in 2004. |
| Engineering | 4 | ↔ | New materials for aircraft are more efficient, more reliable and cheaper. Aircraft maintenance has improved and costs have fallen. |

Long term, stable investment is required to nurture and capitalise upon research excellence. As the examples in this review illustrate, the benefits of research are often unpredictable. They flow not just from a single research project, but from knowledge accumulated, often over long periods.

CASE STUDIES

# Magnetic Resonance Imaging (MRI)

MRI allows the creation of detailed images of the internal structures of the body, to assist with the diagnosis of conditions such as multiple sclerosis and Alzheimer's disease.

Sir Peter Mansfield, working at the University of Nottingham and funded by the Medical Research Council, carried out important research that enabled the rapid production of images.

## What is it?

MRI uses a combination of very strong magnets and radio waves to produce high-resolution images of the opaque interior of the body. The technology allows doctors to diagnose, and treat, patients more rapidly and more effectively.

MRI is, in many ways, the ideal medical imaging technique. It can identify all kinds of tissue, poses no health risks and has no limit to the number of images that can safely be taken. Patients require no preparation and there is no recovery time.

While it can image most parts of the body, MRI is most commonly used to examine the brain, where X-rays cannot distinguish

details or structures and surgery is regarded as too dangerous. As an emergency medical tool, MRI can quickly detect and diagnose strokes, allowing immediate treatment, thereby limiting damage and promoting recovery.

Through such techniques as functional MRI, known as fMRI, researchers are able to see the "action" within the brain, imaging the effects of thought processes and showing how the brain responds to stimuli and manages emotion.

Designed through collaboration between the University of Nottingham and EMI, the British medical instruments firm, full-body MRI scanners were first introduced to hospitals in the early 1990s. With more than 20,000 scanners around the world, performing more than 60 million scans every year, MRI is now a standard diagnostic tool in many hospitals, improving treatment, cutting waiting times and saving lives.

# RESEARCH EXCELLENCE

## The science

The basic science behind the MRI arose from research funded by the Particle Physics & Astronomy Research Council. MRI creates images using the magnetic properties of the simplest of all atoms - hydrogen, which make up nearly two-thirds of the atoms in the human body. Hydrogen atoms are in all parts of the body, concentrated in water and fatty tissue.

An MRI machine is constructed from very powerful magnets, around 60,000 times the strength of the Earth's magnetic field. The patient lies in this strong magnetic field which aligns the body's hydrogen atoms parallel to the magnetic field. A short pulse of radio waves “nudges” the atoms away from this alignment. When the pulse stops, the atoms realign to the field, emitting more radio waves. Analysis of these radio waves can determine the precise nature of the environment of the atoms. Using a magnetic field that varies in a carefully controlled way, an MRI machine can divide the body up into regions about 1-mm across and can measure the properties of the tissue in each of these regions.

Researchers at the University of Nottingham, devised mathematical methods to rapidly analyse the emitted radio waves and create three-dimensional images of the body. The MRI instrument can distinguish between all types of tissue, allowing detailed imaging of organs such as the brain, to tell the difference between healthy and cancerous tissue.

## MRI TIMELINE

**1945**

First magnetic resonance measurements are taken of a solid

**1950**

Invention of pulsed magnetic resonance

**1959**

J R Singer at AT&T Bell Labs proposes MRI as a blood-flow measurer

**1971**

Paul Lauterbur devises a way to create magnetic resonance images

**1973**

Lauterbur produces the first magnetic resonance image

Peter Mansfield at the University of Nottingham publishes a method to construct images quickly

## Today

Scientists are working towards advanced MRI scanners that can produce real-time images of internal organs. Other advancements in MRI centre on their use during surgery, to give doctors and surgeons a constantly updated, three-dimensional "map" of the patient they are treating. One way of accomplishing this is to fit robotic arms on the inside of the MRI machine. Guided by doctors via remote control, these can take tissue samples for medical testing from precisely the right point on a tumour.

Currently doctors working from a static MRI image cannot be sure that they have collected tissue from the tumour rather than surrounding material. They often take several samples to be sure. This new method would speed up the process and cause less distress to patients.

## Future developments

New developments in MRI involve combining it with other medical imaging techniques, such as computerised tomography (CT) and positron emission tomography (PET). Exploiting MRI's extremely high resolution and great sensitivity, and using the ability of the other techniques to image fast-moving processes, the new combined machine can image almost any system in the body.

Based on information supplied by the Institute of Physics: www.iop.org

**1976**

Mansfield produces the first magnetic resonance image of a body part

**1980**

The first useful image of a patient in a hospital is taken

**1986**

Technological advances mean that it takes less than 5 seconds to obtain an image

**1990**

Full-body MRI scanners are introduced into hospitals

**1993**

Functional MRI is developed, enabling the brain to be imaged in great detail

**2002**

20,000 MRI machines exist in the world and 60 million examinations are performed

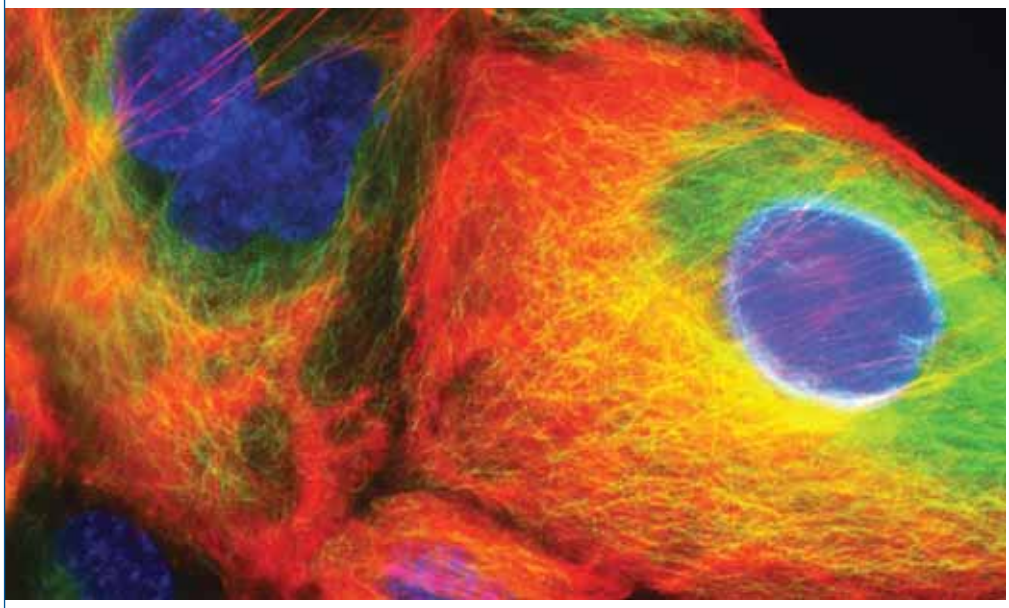
CASE STUDIES

# Cancer Treatment

- Cancer causes a quarter of all deaths annually in the UK
- Modern physics research is a key component of the medical care given to people with cancer
- Modern treatments have developed from techniques used to study subatomic particles

## Impact of Cancer

More people die from cancer in the UK than from any other disease. One in three people will be diagnosed with a form of cancer at some point in their lifetime.



Since 1950, the number of deaths from causes such as heart disease and strokes has declined steeply, whereas the number of people killed by cancer has remained about the same. Though the number of people contracting cancer increases each year, advances in treatment mean that mortality rates are falling.

Physics research is a key component of the medical care given to people with cancer. Enabling early diagnoses and quick, effective and often painless treatment, medical physics aids this reduction of mortality rates for many different kinds of cancer.

Many recent advances in medical physics come not from within medical physics itself but from such distant fields as astronomy and high-energy particle physics, where research has yielded medical imaging techniques, such as computerised tomography (CT) and positron emission tomography (PET), which can follow chemicals around the body, to monitor blood flow and to see how effective drugs are.

Both of these techniques rely on extremely sensitive detectors that were originally designed for looking at stars. Astrophysics has also resulted in methods of non-invasive cancer detection, such as selected ion flow tube mass spectrometry (SIFT).

Techniques for imaging tumours use the same principles and technology as those for imaging stars. Many modern cancer treatments have their origins in physics laboratories. From initial detection and diagnosis to treatment and recovery, research in physics is the driving force behind modern cancer care.

# RESEARCH EXCELLENCE

## The science

Modern methods of detecting, imaging and treating tumours inside the human body exploit a knowledge of atoms and radiation acquired from studies of subatomic particles.

Imaging techniques such as PET rely on the principle that when matter and antimatter meet they will annihilate each other with the emission of energy. Injecting cancer patients with drugs attached to compounds that will emit antimatter allows scientists to follow their progress around the body by following the energy trail, thus seeing how effective the treatment is. By a similar mechanism, PET can monitor the body, finding regions where blood flow is unusually high and that could be home to tumours.

CT scanning, invented by Godfrey Hounsfield at EMI Laboratories, is an advanced technique that takes X-ray images sequentially from different directions. Computers then combine these to produce three-dimensional images, resulting in much more sensitive CT scans that can detect more kinds of tissue than conventional X-ray techniques.

Techniques devised to control experiments at particle accelerators have produced technology to direct beams of high-energy particles and radiation accurately. When combined with advanced imaging techniques such as CT these particle beams can also be used to target and destroy tumours.

## CANCER TREATMENT TIMELINE

**1961**
First treatment of cancer patients with beams of subatomic particles.

**1963**
Allan Cormack of South Africa devises a method for computerised tomography scanning.

**1969**
Godfrey Hounsfield creates the CT scanner at EMI Laboratories, UK.

**1973**
Michael Phelps and Edward Hoffman take the first PET image.

**1974**
First commercial PET machine is built.

Experiments have shown that some radioactive particles, once emitted from source, will travel a known distance before they stop and release their energy. Knowing how far these particles will travel through the body, radiographers can target cancerous growths, tuning the particles to deposit all of their energy at that site while causing minimal damage to healthy tissue. Following treatment a further CT scan can monitor progress.

New techniques for detecting specific types of cancer continue to be developed. These include SIFT. Developed at the University of Birmingham to analyse the results of astrophysics experiments, SIFT was designed to detect extremely low concentrations of gases. It is now being applied to the study of the subtle changes in the chemical composition of the breath of patients with certain kinds of cancer.

Based on information supplied by the Institute of Physics: www.iop.org

**1975**

CT scanners are introduced in hospitals.

**1980**

First clinically useful magnetic resonance image.

**1990**

National breast cancer screening campaign starts in the UK.

**1995**

Cancer Research UK develops CHART, a technique for giving radiotherapy in many small doses.

**2002**

Mortality rate of breast cancer is down by 15 per cent on 1994 levels.

**Today**

Scientists are working on non-invasive cancer tests, such as the breath test, SIFT.

CASE STUDIES

# The World Wide Web

A tool developed to help scientists to navigate mountains of data has changed the world, and just about everything that we do in it.

- Tim Berners-Lee, a British scientist, invented the Web while working at the European Organization for Nuclear Research (CERN), which is partly funded by the UK
- More than £540 million was spent purchasing goods online in the UK in 2004, and over £1 billion in 2005
- The Web dramatically improves global communication and collaboration

## What is it?

When we talk about the Internet we speak of the network itself - the infrastructure, the millions of computers communicating with one another and distributed all over the globe. To access this network, to view the information it contains, we use the World Wide Web.

The Web allows us to search the vast quantities of information stored on computers around the world and to view this as easily as pages in a magazine. Before the invention of the Web, the Internet and the information on it was hard to get at and was the preserve

of the military and academics. Information could only be seen by downloading individual files onto the user's computer. The Web allows users all over the world easy and uncomplicated access to a world of knowledge.

While the Internet wasn't so much invented as built, a natural progression of the increasing number of computers in the 1960s and 1970s, the World Wide Web was sparked off by one man, Tim Berners-Lee. The key to the Web are lines of computer code which can produce “hyperlinks” between information held on millions of different computers all over the world.

The hyperlinks between distant computers form a web-like structure, hence the name. Every page on the Web has its own unique address: the hyperlinks allow users to view these pages and to hop between them, something that has come to be known as “surfing the Net”.

Originally conceived as a means of transferring and searching through the vast quantities of scientific data produced by large European labs, the World Wide Web has developed into a true tool of the people. It extends into every field of commerce and reaches into every country. The Web has given people the ability to share knowledge across borders and across continents, to trade with distant customers as easily as they trade with their neighbours. The World Wide Web has changed the world, making it smaller by the ease of access to knowledge while making it bigger by showing just how much is out there.

## The science

The first real computer network was constructed in 1969. It allowed the transfer of files between users and introduced “packet switching”. This enabled multiple systems to communicate with each other through a single communication link by assembling data into “packets” and sending them down the wires. The technology was robust but not versatile and by the early 1980s others had devised a new means of networking. The Internet, as it became known, was used predominantly by academics and the military and, with its continuing growth, was becoming cumbersome and difficult to use; its sheer size meant that it was difficult to organise and find information.

Berners-Lee, while working at the European synchrotron at CERN, invented the system that solved this problem. In 1980, he wrote the two key pieces of code that allowed the Internet to prosper, the hypertext markup language (HTML) and the uniform resource locator (URL).

HTML is a means of embedding codes into a simple text file, to define the structure of the document and include links to other documents on the network. This file can then be read by other machines which can recreate the original page, including the links to other pages. These “hyperlinks” are the strands of the web. They allow pages to be linked no matter where the actual data are stored.

A URL is a simple means of specifying the location of a page or document in one title which includes a computer name, a file path and a protocol with which to retrieve the file from that machine. These allow the rapid transfer of files, forming the basis of the first Web browser - Berners-Lee's own WorldWideWeb.

### Distributed

Complex problems can be analysed by computers across the world that would otherwise be idle. Programs similar to screensavers can use the computer's power to analyse data while the owner is not using the machine. The computer transmits the data back to the originator via the Web. Scientists at Oxford

## WEB TIMELINE

**1969**

First computer network, ARPANET, is constructed.

**1980**

Tim Berners-Lee, working at CERN, writes a routine to make searching his computer easier. He invents the terms URL and HTML.

**1989**

Berners-Lee invents the World Wide Web, allowing scientists and military personnel all over the world to communicate information quickly and effectively.

**1991**

Internet usage reaches 600,000 people.

**1992**

Mosaic Web browser is invented, which, using hyperlinks, can present web pages as if they are pages from a magazine.

**1993**

World Wide Web accounts for only 1 per cent of Internet traffic.


University have used the technique to aid the search for a cure for cancer. The more computers involved, the quicker the analysis.

## Future developments

The UK is to be a major contributor to a Europe-wide initiative to develop and implement an advanced global-computing network, designed to analyse, process and distribute massive amounts of data far in excess of that possible by current World Wide Web standards. Known as the DATAGRID, and regarded as the precursor to the next-generation Internet, it will revolutionise our ability to access and manipulate vast amounts of information.

Based on information supplied by the Institute of Physics: www.iop.org

**1994**
Internet introduced into homes through the "web-in-a-box.

**1995**
eBay and Amazon launched.

**1996**
40 million users of the Web.

**1998**
100 million people online.

**1999**
150 million people online.

**2001**
550 trillion documents accessible on the Web contained within 1 trillion web pages.

**2005**
More than £1 billion spent online in the UK in one year.

**TODAY**
UK works to develop the DATAGRID regarded as the precursor to the next-generation internet.

CASE STUDIES

# Creating financial sustainability

To ensure that the UK has the best facilities in which to conduct world-class research, the Government launched the Science Research Investment Fund (SRIF) to address previous long-term under-investment in research infrastructure. Since its launch in 2002, SRIF has allocated over £2.5 billion for the restoration and replacement of a significant proportion of university research facilities. It has enabled research to continue in areas where there is the ability and potential to deliver with a satisfactory "well-found laboratory" in place.

SRIF funding in the UK's four nations is channeled to universities through local funding bodies:

- Department of Education, Northern Ireland
- Higher Education Funding Council for England (HEFCE)
- Higher Education Funding Council for Wales (HEFCW)
- Scottish Funding Council (SFC)

More recently, the Government has begun to invest in the long term financial stability of the research base. Until quite recently, many universities did not know the full economic cost of the research they carried out, so they could not be sure that their income covered the cost of their research. To address this situation, the Government has committed itself to a major reform of public funding of research. It is working to ensure that:

- Universities (and research institutes) understand the cost of the research that they do.
- Over time, changing the basis of Research Council funding so that research is funded at full economic cost. Since September 2005, all proposals to the Research Councils have been submitted on the basis of the recovery of 80 per cent of the full economic cost of the research.
- Requiring all Government departments to fund research at full economic cost and encouraging (and supporting) other major funders (e.g. charities) towards this goal.

# Powertrain and Vehicle Research Centre

## University of Bath

Future car engines will emit considerably lower levels of harmful emissions and will have superior fuel consumption. As a result of a large capital investment, the University of Bath has built state-of the-art technology research facilities, the Powertrain and Vehicle Research Centre in the Department of Mechanical Engineering, where researchers can analyse passenger car engines for performance and emissions in controlled environments that replicate on-road conditions.

Dr Horst Schulte, Chief Engineer of GlobalDiesel Research and Advanced Engineering at the Ford Motor Company, described the new facility in an address at the university:

> *"Recently you have developed your new automotive research facility, the Powertrain and Vehicle Research Centre, and the University of Bath must now rate as one of the leading centres for automotive power train research in Europe."*

Researchers utilising these new facilities have won grants totalling over £3 million, strengthening existing industry partnerships and enabling new alliances in the US, UK and Europe.

Part of this work is contributing to a DTI sponsored programme. The project, led by the Ford Motor Company and British Petroleum, is addressing how best to formulate the lubrication oil used in engines.

Previous work suggests that better lubrication oil could improve fuel consumption by 5 per cent. This will result in cleaner more fuel friendly vehicles.

## RESEARCH EXCELLENCE

Professor Gary Hawley, Director of the Powertrain and Vehicle Research Centre, says that *"this recent success has enabled researchers to continue to develop thecutting-edge expertise, which is required by the automotive industry, in such a way that we are able to offer a 'brand' of excellence that is well known throughout the UK and this is gathering notice world-wide."*

Bath University, Powertrain and Vehicle Research Centre: www.pvrc.co.uk

# Aston Academy of Life Sciences

## Aston University

The Aston Academy of Life Sciences (AALS) is a uniquely equipped medical facility offering diagnostic and surgical services for eye care and brain imaging in a research led environment. AALS, a wholly owned company of Aston University, is registered by the Healthcare Commission as an Independent Day Hospital. In keeping with the university's mission statement, the academy aims to be recognised as an international centre of excellence inresearch and clinical care.

The custom built academy fuses academic research and private medical care. Located on the university's campus, a major focus of activity is new treatments in cataract, refractive surgery, macular degeneration and diabetic eye disease.

To meet this end, the facilities include two large ophthalmic operating theatres, three different refractive laser operating systems, eight specialist consulting rooms, medical and biochemistry wet laboratories and a wide range of state-of-the-art diagnostic and therapeutic technologies. The facility also houses a functional Magnetic Resonance Imaging (fMRI) suite for the investigation of musculoskeletal and sports injury, as well as advanced neuroscience research.

Most of the funding for the £10 million project came from Advantage West Midlands, the local regional development agency, and the Government's SRIF programme.

Aston University: www.aston.ac.uk/
Aston Academy of Life Sciences: www.astonacademy.co.uk

CASE STUDIES

# Earth Systems Research Facility

## University of Wales, Aberystwyth

An award of more than half a million pounds from the Government's SRIF programme enabled the creation of a new, world-class Earth Systems Research Facility (ESRF) at the Institute of Geography and Earth Sciences (IGES), University of Wales, Aberystwyth.

The ESRF is housed in five units:

### Land-Atmosphere Observation Unit

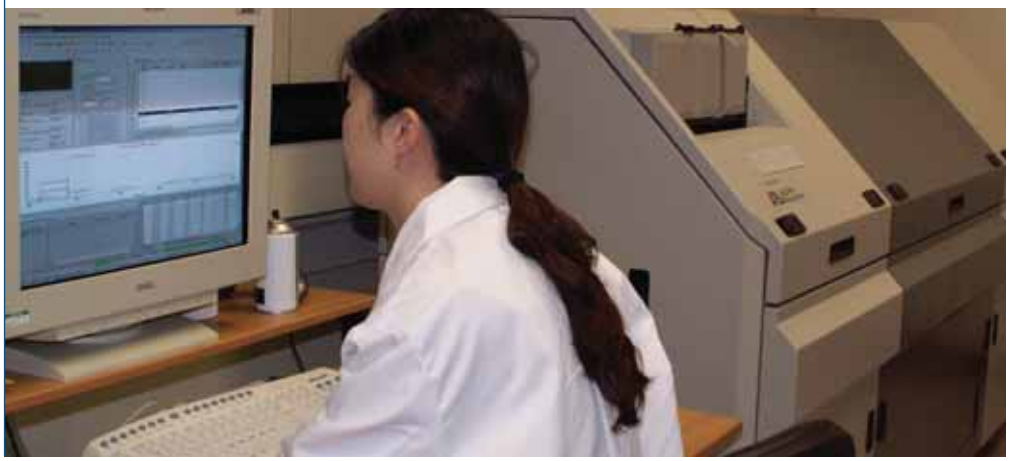
A new field-based unit that measures the flows of water, energy, radiation and greenhouse gases at the interfaces between water, land and atmosphere, and the related biogeochemical and physical properties of land surfaces, water surfaces and the lower atmosphere. This new unit provides IGES with a land surface observation and global change impact detection capability that is unique to the UK.

### Field Data Acquisition and Monitoring Unit

This new unit facilitates mobile and in situ environmental measurement, high-resolution topographic survey, sampling and element flux measurements of near-surface waters and sediments.

### Physical Analysis Unit

Devoted to the analysis of the physical properties of sediments and soils, including sediment-based dating techniques and frozen material, this is was an existing unit in IGES, and SRIF funds were used to purchase new equipment and carry out laboratory refurbishment.



### Geochemical Analysis Unit

Undertakes element analysis of inorganic components within water, ice, snow, sediment, soil, plant and animal material. This is an existing unit within the institute, and SRIF funding was used to replace obsolete equipment, to buy new equipment and to carry out much needed laboratory refurbishment. These investments have produced, for the first time, a fully integrated suite of laboratories, which have greatly increased the speed of sample throughput as well as improving the range and quality of element analyses.

### Environmental Modelling Unit

Before the SRIF investment, the unit provided only mapping and numerical modelling support for projects in physical geography and Earth science. ESRF significantly extends the capability of the unit to integrate and analyse remote sensing data, and to capitalise on research opportunities arising from the recent increase in data from new airborne and space borne sensors.

Staffing of these units includes a broad range of experience from MSc and PhD students to Postdoctoral Research Fellows to experienced academic staff. The ESRF has very strong interdisciplinary and multidisciplinary elements.

The overarching theme of research within the ESRF is the study of material flux through Earth systems. This is linked to spatial modelling and prediction of the consequences of environmental change at varying scales and timeframes.

Without this investment, the institute's capacity to continue to undertake international level research would have been severely, and probably permanently, undermined. The SRIF award significantly enhanced the institute's success rate in applications for research grants.

The new research facility has raised the analytical capability of IGES to a high international standard and enhances its ability to undertake world-class research in understanding past, present day and future fluxes of materials in Earth systems. ESRF has allowed institute staff to engage as teams in national and

## RESEARCH EXCELLENCE

multinational Earth-systems projects and helped them to bid competitively for research grants and contracts from national and international organisations including the Welsh Assembly Government, Countryside Council for Wales, Environment Agency, DEFRA, NERC, EPSRC,The Royal Society, EU and industry.

The ESRF has facilitated collaboration with many other universities in the UK and overseas. In addition, it prompted the development of a major new multidisciplinary project between the Universities of Wales Aberystwyth and Bangor entitled *'Catchment to Coast'*, which aims to establish a new Welsh Centre for Catchment and Coastal Research. The equipment at the facility has been put to good use by other departments at Aberystwyth, by other universities and commercial enterprises.

ESRF has also provided the equipment base for four new MSc courses that the institute launched in September 2004.

The Welsh economy has benefited directly from ESRF with an increased science capacity devoted to understanding its climate, managing its water supply and land use, and controlling pollution from agricultural, industrial, domestic and mining sources. An example of this is a major project, co-funded by the devolved administration, British Geological Survey, Countryside Council for Wales and Environment Agency, that seeks to improve the modelling of flood risk in Wales.

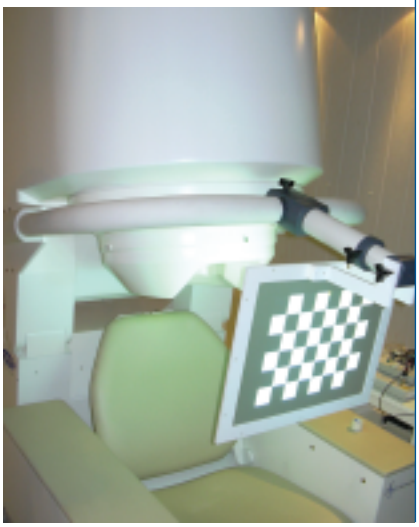
University of Wales, Aberystwyth: www.aber.ac.uk

# Cardiff University Brain Imaging and Repair Centre

## Cardiff University

An investment of over £8m from the SRIF fund enabled the establishment of state-of-the-art imaging facilities at the Cardiff University Brain Imaging Centre (CUBRIC). Officially opened by Sir Peter Mansfield, a pioneer in the development of Magnetic Resonance Imaging (see Medical Scanning, p8), in March 2006, the centre will transform the understanding of normal and damaged brain function, as well as informing the treatment of brain impairments, such as head injury, stroke, dementia and schizophrenia.

Housed in a new purpose-built building, CUBRIC will enable psychologists and brain specialists to gain a better understanding of how the brain works and what happens when people suffer from brain injury and other disorders of the brain. CUBRIC is one of few centres in the UK to combine Functional Magnetic Resonance Imaging (fMRI) and magnetoencephalography solely for research. The facility will benefit the whole scientific community in the UK.



Cardiff University: www.cardiff.ac.uk
CUBRIC: www.cf.ac.uk/psych/cubric

CASE STUDIES

# Biopharmaceuticals

The world market for biopharmaceuticals is worth over £26 billion per annum with more than 160 products approved for use in the USA and Europe, and several hundred in the pipeline. Biopharmaceuticals are available to treat conditions, including cystic fibrosis, Crohn's disease, haemophilia, anaemia, multiple sclerosis and cancers. None of this would be possible without basic bioscience stemming from research conducted at the University of Cambridge more than fifty years ago.

## The science and its application

Every process in the body, from digestion, to defending against disease relies on proteins. Each protein's structure is encoded in the DNA (genes) which are a common language across all living organisms. With modern bioscience, copies of human genes can be transferred into bacteria and other cells so that large quantities of highly purified human proteins can be made and used as biopharmaceuticals.

## Microbes as protein factories

Relatively simple biopharmaceuticals are produced in bacteria or other microbes which are easy to grow quickly and in bulk, and which accept easily 'foreign' DNA. An example of a 'simple' protein is, Human Growth Hormone (Somatotrophin), which became available in 1985, before which the only source was cadavers. The risk of passing on Creutzfeldt Jacobs Disease led to this practice being banned and the hormone made in bacteria provided a safe alternative.

Similarly, heparin which prevents deep vein thrombosis after surgery and helps angina suffers is being replaced as the drug of choice by Hirudin which occurs in medicinal leeches and can be made in yeast cells.

BIOPHARMACEUTICALS TIMELINE

**1953**

Structure of DNA published by Watson and Crick, Cambridge (Nobel Prize for medicine 1962).

**1955**

Frederick Sanger at Cambridge discovers the protein sequence of insulin for which he received the Nobel Prize for Chemistry in 1958.

**1965**

Mobile loops of DNA (bacterial plasmids) identified and classified. Later used to insert foreign DNA into bacteria.

**1966**

Genetic code cracked - to identify proteins. This opens the way to rational modification of protein structure (Nobel Prize for medicine awarded to Holley, Khorana and Nirenberg, 1968).

**1971**

Discovery of restriction enzymes that cut DNA at a specific site.

**1972**

'Foreign' DNA (in the form a plasmid) introduced to E. coli bacteria through the process of transformation.

## Biopharmaceuticals from mammalian cells

Not all biopharmaceuticals can be produced by microbial cells. Many proteins depend for their function on the addition of chains of sugar molecules (glycosylation), which doesn't occur in microbes. So scientists produce the biopharmaceuticals in cultures of mammalian cells instead.

This technology is used to produce Erythropoietin (EPO), a human protein that regulates red blood cell production and is an effective treatment for anaemia. EPO was first purified in 1977, and is now cultured and grown on an industrial scale.

## Harnessing the power of antibodies

Antibodies are an important class of proteins that are the cornerstone of our immune system. They have unique abilities to recognise and bind to specific targets or cell types, tumour cells for example. In 1975 researchers in Cambridge discovered how to make cells that produce only a single type of antibody - called monoclonal antibodies which have a huge range of uses, including therapeutics.

The first monoclonal antibody approved for medical use in the UK was Rituximab in 1998. It is used to treat Non-Hodgkins lymphoma (a cancer that affects part of the immune system) and works by specifically binding to cancerous white blood cells. In 2004 global sales of Rituximab were more than £800 million.

## The future

The biopharmaceutical market has grown from nothing to a multi-billion dollar global market in three decades. The drugs have saved millions of lives and UK bioscience has played, and will continue to play, a key role in this success story.

Biotechnology and Biological Sciences Research Council:
www.bbsrc.ac.uk

### 1977

First human gene works successfully in E. coli bacteria.

### 1989

Researchers at the Roslin Institute in Scotland inserted a gene for a human protein into mammalian cells in such a way that the animals produce large quantities of pure protein in their milk.

### 1995

First monoclonal antibody approved for cancer treatment (Edrecolomab approved by German regulatory bodies).

### 1998

Rituximab is first monoclonal antibody licensed to treat cancer in the UK.

### 2005

More recently, Roslin Institute research has demonstrated that a humanised anti-cancer antibody can be produced in significant quantities in hens'eggs.

### TODAY

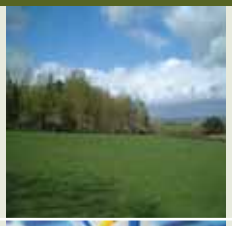
Biopharmaceutical global market is worth over £26 billion. More than 12% of all prescriptions written by doctors are for biopharmaceuticals

# Greater responsiveness to the needs of the economy

To capitalise effectively on strengths of the science base, between 1997 and 2004 the Government invested over £500 million in programmes to support the exchange of knowledge between business and the research base. This investment is already starting to bear fruit but indicators suggest that the full impact of these programmes will take several years to become apparent.

We have seen a steady increase in the number of patents filed by universities (1,300 in 2003-04) and income from licensing intellectual property (£38 million for 2003-04). Income from business through consultancy contracts has also steadily increased, exceeding £210 million in 2003-04. In the past three years alone, 25 spin outs from UK universities have floated on the stock market with a combined value of £1.5bn.

## Responding to the needs of the economy



### Woods against floods

Research from the Natural Environment Research Council shows that newly planted woods can play a key role in halting floods that could devastate towns in the UK. Small strips of trees in grasslands can hold vast amounts of water that would otherwise run down hills and surge along rivers

### DNA fingerprints

Understanding the biology of DNA has led to new ”fingerprinting” technologies. These have many uses including forensic science, testing for family relationships and disease diagnosis.

### R&D tax credits

The World Bank uses findings from research funded by the Economic and Social Research Council to advise governments around the world on R&D tax credits.

£164 million of the third round of the Government's Higher Education Innovation Fund was allocated by formula to all higher education institutions in England over two years. The move to a formula marks the coming of age of knowledge transfer as a core activity - it provides a more predictable stream of funding, reduces the burden of having to bid competitively and ensures that every HEI in England has an opportunity to develop the knowledge transfer agenda.

It is widely recognised that the UK's broad base of public sector laboratories and research facilities is a further asset that has much to offer the UK economy. This is a diverse community of institutions including Research Council Institutes, Government Laboratories, NHS Trusts and major museums. Since 2001, the Government has provided over £50 million to support these establishments in commercialising the intellectual property generated by their research.

To assess the impact of these and other measures, the Government has begun to collect data on the interactions of universities and public laboratories with business and the wider community. The Higher Education-Business & Community Interaction Survey has run annually since the academic year 1999-2000. The Higher Education Funding Council for England (HEFCE) collects the data as part of each university's annual return and provides an overview of how interaction between the higher education and business sectors has developed in the six years since the first survey. A similar survey covering the public laboratories was launched in 2004 and was run again a year later.

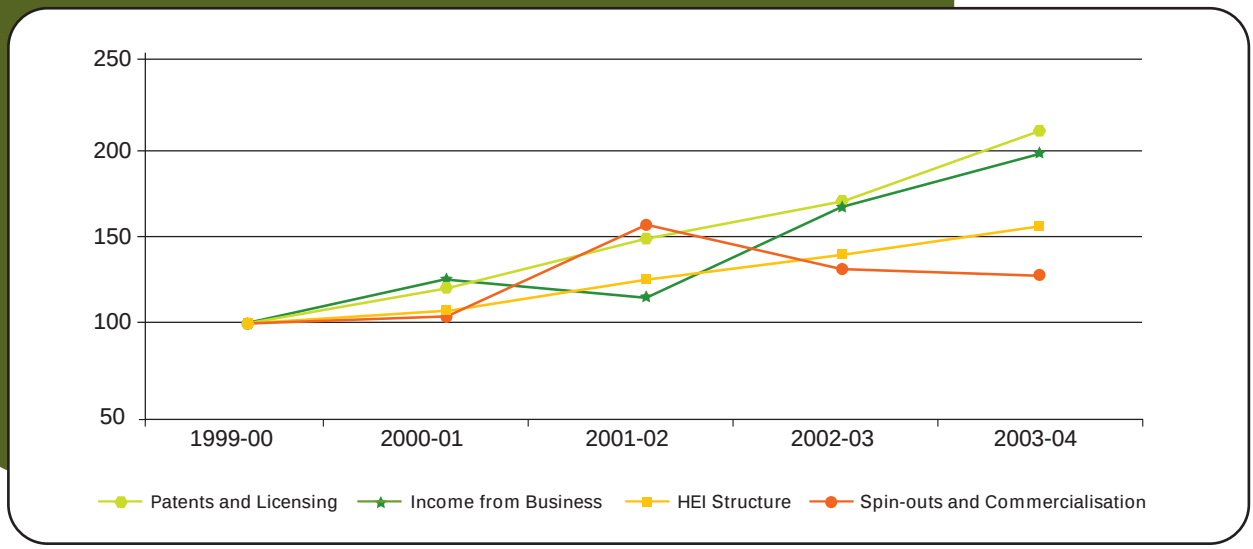
## OSI Knowledge Transfer Indicators

| | 1999-00 | 2003-04 | Change over period % |
|---|---|---|---|
| Business representatives on governing bodies (per cent) | **35** | **34** | **-** |
| Full time equivalent staff working with business | **1,268** | **2,706** | **+113** |
| Contract research income from business (£ million) | **242.19** | **286.76** | **+18** |
| Consultancy income (£million) | **76.2** | **210.87** | **+176** |
| Number of new UK patent applications | **705** | **1308** | **+86** |
| Number of UK patents granted | **188** | **463** | **+146** |
| Number of licences and options executed | **581** | **1202** | **+107** |
| Gross income from IP (£ million) | **23.30** | **38.23** | **+64** |
| Number of spin-outs (wholly or partially owned) | **187** | **167** | **-11** |

## GREATER RESPONSIVENESS TO THE NEEDS OF THE ECONOMY

The trends shown in the chart below suggest growing maturity in the interaction between business and universities. The number of spin-outs has been falling year-on-year since 2001-02 while patents licensing and income from business have grown over the same period.

### OSI Knowledge Transfer Indicators




It is still rather early to draw conclusions from these trends but it may well be that universities are being more selective in their choice of spin-out companies and are seeking alternative channels of business engagement where they are more appropriate.

# Mobile phone technology

According to Ofcom, the UK has 61million mobile phones in use. Many features of today's mobile phones are the products of basic research funded by the Engineering and Physical Sciences Research Council.

## Mobile battery technology

Mobile phones use rechargeable batteries which were developed from the results of research undertaken at the University of Oxford. Further research at the University of St Andrews led to a new family of batteries which are cheaper, safer and store more charge.

## Displays

Mobile phone displays are based on liquid crystals (LCD), originally from the University of Hull. More recent performance improvements in LCDs are based on research at the University of Dundee.

An alternative to LCDs are light-emitting polymers (P-OLEDS), first discovered at the University of Cambridge. This research underpinned the UK start-up company Cambridge Display Technology . The company believes that these displays will be more power-efficient, thinner, lighter and brighter than LCDs. They continue the search for further performance improvements in collaboration with the research base.

Engineering and Physical Sciences Research Council: www.epsrc.ac.uk/default.htm

## Partnerships between business and universities

| | |
|---|---|
| Midlands Medici | An expansion of Medici, an earlier Higher Education Innovation Fund project, embeds an enterprise culture in academic departments through an innovative hands-on training programme for academic staff in entrepreneurship, technology transfer and business processes. The programme focuses on four subject areas; bio-medical, healthcare, creative industries and technology. |
| SETsquared | Four universities - Bath, Bristol, Southampton and Surrey - work as a Partnership to deliver the whole range of their academic enterprise agenda, from enterprise education for students and staff, through licensing of intellectual property, spin-out company creation and support for high technology spin-in companies from the local community, to collaboration with established corporations and small and medium enterprises. A Partnership Board, including four pro-vice chancellors together with representatives from industry and a management team of the University enterprise directors runs the SETsquared Partnership. The Partnership has grown over five years and offers a comprehensive and strategic approach to maximise the universities' impact on the UK economy. |
| Contact KE | Contact: The Knowledge Exchange works with businesses in the West Midlands to identify their needs and then matches them with the most suitable university expertise. Where businesses can benefit from an existing business support programme the Contact KE team will use its extensive connections. The regional Contact KE team works with national and regional partners to identify, disseminate and evaluate best practice in all areas of knowledge transfer between higher education and business. |
| Combined Universities in Cornwall | Part of a coherent business support strategy across the higher education sector in Cornwall. There is a particular focus on incubation support, linking new pre-incubation facilities at University College Falmouth with the Knowledge Spa incubation facility at the Peninsula Medical School, Treliske. This project, funded by the Higher Education Innovation Fund, builds upon existing business support activity in art, design and media, establishing a new 3D design bureau, additional art/design projects, a professional writing centre, and employability support for graduating artists. The environmental and Earth sciences sector is supported with mentoring, R&D support, and environmental projects. |

| | |
|---|---|
| Proof of Concept - Universities working together | This fund, co-ordinated by Imperial College London, including Oxford, Cambridge and University College London, was established to develop technologies prior to licence and spin-out and to explore the commercial potential of technology based propositions. Benefits of collaboration are: information on all submitted projects shared across partners opening up possibilities to 'bundle' technologies; shared contacts for managers, investors and licensees; cross-participation in decision making. Partnership will disseminate learning through UNICO, the University Companies Association. "Imperial Innovations also secured further funding with a consortium of Imperial Innovations, University College, the Royal College of Art and the London Institute. This consortium was able to draw on best practice already developed and a number of projects were co-funded across both consortia. Imperial Innovations managed both programs and is in the process of extending the London based consortium to a wider set of partners. From Imperial's proof of concept projects alone 5 new companies have been formed and funded. |
| Knowledge Capital Universities - Manchester | This knowledge transfer collaboration brings together Manchester Metropolitan, the University of Manchester and Salford University to support the 'Knowledge Capital' prospectus. Development projects will improve access to research expertise within the HEIs. Business development work will help with sharing of commercialisation expertise; additional support for Knowledge Transfer Partnerships; feasibility and pilot work within the city; academic inward investment; cultural industries; area regeneration. And skills initiatives will improve development of entrepreneurial talent. |
| Universities for the North East | Building on their collaborative Knowledge House service to business which was described as "global best practice" in a recent OECD report, this partnership between the Universities of Durham, Newcastle, Northumbria, Sunderland and Teesside, will address and meet needs of business in areas including: consultancy, contract research, support for new business, graduate placements and employment training – all in support of economic regeneration through innovation and enterprise." |
| South East Knowledge Exchange for Product Development | This Knowledge Exchange (KE) project, involving the Universities of Portsmouth and Brighton and Buckingham Chilterns University College, will focus on the product design and manufacturing sectors across the South East region as well as providing access to the skills and services available to improve product design for a range of clients. The KE will provide advice guidance, consultancy and signposting to the partners' centres of excellence. Activity will include: improved problem identification, school and further education college taster days, best practice benchmarking, access to prototyping equipment. |

CASE STUDIES

# MEDICI
## Creating Enterprise in Universities
University of Birmingham

The Medici programme was designed to foster a climate of entrepreneurship, particularly in relation to research with commercial applications in biomedicine, technology and creative industries.

Medici's main objectives are to embed entrepreneurial attitudes and activities across research disciplines, while raising the commercial awareness of academic and post-doctoral staff. Medici has organised workshops and seminars to realise these aims and to help researchers and their parent institutions in generating income from consultancy, industrial and collaborative research, and in commercialisation of their research through patenting, licensing and spin-outs.

The Medici programme is funded through a joint HEIF award to the 16 partner universities, with Birmingham taking the role as lead partner. A total of 94 fellowships have been made available throughout the consortium, most within the biomedical area, though there have also been awards pertaining to technology and the creative industries.

Medici Fellows identify and develop a personal portfolio of commercial projects. To help them in identifying appropriate projects, they attend a taught course in business, commercialisation and intellectual property issues. This is enhanced by entrepreneurship and innovation training. It includes familiarisation with IP issues and company formation, together with advice on business planning and operation. Fellows work in close liaison with mentors who provide extensive support at all stages of the process throughout the year. A further unique feature of the programme is that Medici provides personal development programmes that help fellows to develop skills which will be useful to them whether they remain or return to an academic career.

Since its inception, Medici has been responsible for the formation of 14 spin-out companies, filing of 40 patents, forging of 17 licences, 147 disclosures to the technology transfer office and 656 contacts with academics. Of the former fellows, 44 per cent have gone on to pursue an academic career, 22 per cent have moved into technology transfer roles at higher education institutions and 34 per cent have moved into other areas including industry, spin-out companies and consultancy.

Medici: www.midlandsmedici.org

CASE STUDIES

# Monica Healthcare: a Medici Fellowship

University of Nottingham

The aim of Monica Healthcare Ltd is to develop products to monitor the heart rates of both mother and foetus for long periods as a means of identifying the need for clinical intervention in high-risk births.

There are around 65,000 high-risk births in the UK every year, with many more in both developed and developing countries worldwide.

The technology Monica is developing is based on IP built up over 15 years by the School of Electrical and Electronic Engineering of the University of Nottingham. The group's research has focussed on the tiny electrical signals generated by the foetal heartbeat and other electrophysiological events, present on the maternal abdomen. This resulted in development of the Care2000 prototypes which have led to the current OB24 device (pictured below.

Ultimately, this technology will enable GPs and midwives to assess more accurately the condition of the unborn child in high-risk pregnancies, leading to more successful vaginal delivery and more optimal timing of caesarean intervention. It exploits patented technology developed by the University of Nottingham. Dr Carl Barratt, a former Medici Fellow, has been at the forefront of the establishment of the company.

Monica Healthcare Ltd:
www.monicahealthcare.co.uk

# Oxford University Begbroke Science Park

## Where Industry and Science Meet

"Turning the best ideas into jobs and prosperity is vital to our economics success. Developments such as this one at Begbroke are key to this process." *Lord Sainsbury*

Begbroke Science Park is a pioneering development for Oxford University. It provides a stimulating environment where spin out companies can prosper, where applied science and worlds class scientists can thrive, and where companies can take advantage of the on site analytical and research services.

On site, we have a number of high tech companies, a Centre for Innovation and Enterprise and a range of. associated University activities.

The Centre for Innovation and Enterprise opened in July 2006 and reached 50% occupancy in less than 3 months. Arranged over two floors, the Centre offers a mix of offices, with or without wet or dry laboratories, and serviced with all that companies require for start-up. This includes a professional reception service, meeting rooms, high speed internet and telecommunications, flexible agreements, and plenty of networking opportunities. Two of the tenant companies arose from Oxford University's Chemistry Department, Oxford Nanolabs and Oxford Medical Diagnostics. Other tenants include APEM, Chiralabs, CrystalMaker Software, Kirkhouse Trust, Rochford Medical and WheelRight. The Centre is owned and managed by Oxford University. www.cie.ox.ac.uk. Other companies on site include Oxonica and OGT.

**University activities on site include :-**

The Department of Materials which houses the Oxford Materials Characterisation Service, a clean room facility and a suite of world beating microscopes.

## GREATER RESPONSIVENESS TO THE NEEDS OF THE ECONOMY

**Begspoke Science Pack**

Oxford University's Knowledge Transfer Partnership Office works with companies and relevant academics to identify company specific research projects. These projects are undertaken by University scientists, working inside the company for the life of the project. The scientist and the company additionally benefit from academic mentoring.
http://www.begbroke.ox.ac.uk/research/ktp.php

The Oxford Enterprise Fellowship scheme also operates from Begbroke. This scheme supports scientists moving out of academia in to Knowledge and Technology Transfer and so translates academic innovation to commercial reality. The scheme offers three different fellowships:- Technology – helps fellows to commercialise their own innovations. Business – fellows assist others to exploit their IP. Knowledge – fellows develop new, cross technology courses and other knowledge transfer initiatives.

The successes from the Enterprise Fellowship Scheme are numerous. Tiancun Xiao founded Oxford Catalysts which floated in May 2006 for £15m. Terry Sachlos founded TEOX which won the first Wellcome Trust University Translation Award and won the 2005 Oxford Business Plan Competition, Stephen Bell established AlchemOX which has successfully licensed its technology, Jamie Patterson established EyKona Technologies Ltd, Wolfgang Denzer founded Oxford Medical Diagnostics, John Laczik founded Oxford Optics, and John Topping founded MfN. The Enterprise Fellowship scheme has also supported RF Sensors and ASFUSON, as well as putting in place 4 new CPD courses (one on grid science, and two on climate modeling and one on nanotechnology) and developing two CD resources climate basics
http://www.begbroke.ox.ac.uk/learning/climate_basics.php and Nanotechnology basics
http://www.begbroke.ox.ac.uk/learning/nano_basics.php.

To deliver all of this, the Begbroke team works closely with many partners. Inside the University these include Isis Innovation, Continuing Professional Development, the Said Business School and the many science departments themselves.

Enquiries for occupation of the CIE or for doing research in the IAT with Oxford University scientists, should be made to enquiries@begbroke.ox.ac.uk

# International Centre for Computer Games and Virtual Entertainment

## University of Abertay, Dundee

The University of Abertay, Dundee is a centre of excellence in teaching, research and knowledge transfer related to computer games. The International Centre for Computer Games and Virtual Entertainment (IC CAVE) hosts commercial computer games and digital entertainment projects which develop solutions to problems facing the games industry. The DTI has entrusted IC CAVE to lead technology fact finding missions to North America, Asia and Europe.


Interdisciplinary groups of psychologists, mathematicians and human factors specialists are studying how greater realism can be embedded in commercial games and training simulations. Work with health authorities and games training companies, for example, is applying expertise in mathematical modelling to the development of greater realism in health related training applications.

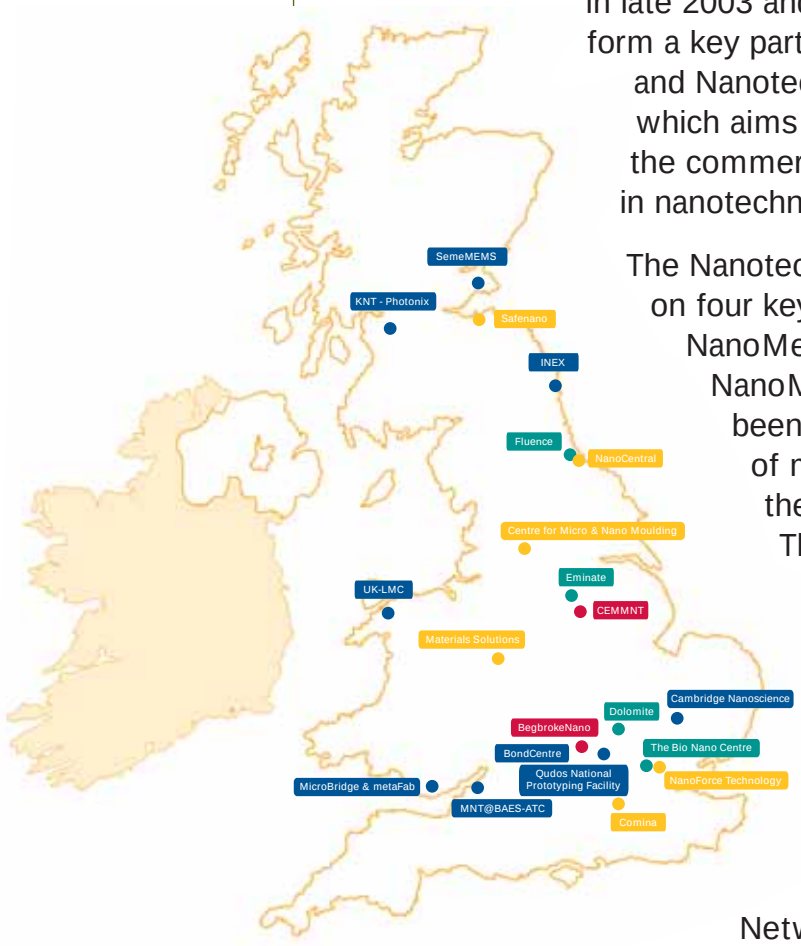
Research into the use of games for learning has led to the formation of a start-up company, ADD Knowledge Ltd, to develop console based learning games to aid home study by primary school children. Further knowledge transfer is achieved through Dare to be Digital, Abertay's international games development competition for students and graduates.

IC CAVE, University of Abertay: www.iccave.com

CASE STUDIES

# The UK Micro and Nanotechnology Network (MNT)

In 2002, the Taylor Report, New Dimensions for Manufacturing: A UK Strategy for Nanotechnology, recommended that a network be formed in the UK to promote and drive micro and nanotechnology. The Regional Development Agencies (RDAs) and Devolved Administrations (DAs) came together to form a single body to drive this network forward. This group provided funding, matched by the DTI. The UK MNT Network was launched in late 2003 and its Nanotechnology Centres form a key part of the DTI's £90 million Micro and Nanotechnology Manufacturing Initiative, which aims to assist the exploitation of the commercial potential of developments in nanotechnology.




The Nanotechnology Centres focus on four key areas: NanoFabrication, NanoMetrology, NanoMedicine and NanoMaterials and their goal has been to drive the commercial use of micro and nanotechnology for the economic benefit of the UK. Through the cooperation of all of the RDAs and DAs its remit is to engage on a strategic national basis. No other approach could have delivered such an organisation with successful delivery mechanisms.

A major role for the UK MNT Network has been to help oversee the creation of the DTI funded Capital Projects network. These facilities, based around the country, offer open access to capital equipment and assets. As the map shows, these are spread throughout the country and offer appropriate services for each region. Through working together the RDAs and DAs have ensured that there is no unnecessary duplication and that as wide a range of commercial activity has been covered as is possible for the UK.

UK MNT: www.mntnetwork.com

# Emerging technologies in the South East


In 2005, the South East Science and Engineering Technology Advisory Council (SESETAC) approved funding for regional development of 'Emerging Technologies'. In the first instance, £2 million was allocated to fund a single nanotechnology related project.

Following the strategic direction and regional strengths, an open regional competition was held for a project that would bring nanomaterials based products towards the marketplace. The winning project was a consortium led by QinetiQ Nanomaterials and Brunel University with four other partners. Its goal is to develop commercial nanoparticles with anti viral properties and to use these in products such as facemasks.

Assistance from the South East England Development Agency (SEEDA) has been crucial. The project call required a clear exploitation path for existing research, which encouraged partnerships to be balanced between research and commercial needs to successfully bid for the funds. In addition to the winning bid, partners in other proposals continue to work together.

Without SEEDA funding such a programme would not have gone forward: the individual small and medium business partners would not have been able to afford the project. Further assistance in developing the project's supply chain will be provided by some of the funding being reserved for "Proof of principle" work packages for SME suppliers.

SEEDA:
www.seeda.co.uk

CASE STUDIES

# Isis Innovation

Isis Innovation, Oxford's technology transfer company, was created in 1988 to commercialise the products of the university's research. Isis provides researchers with commercial advice, funds patent applications and negotiates exploitation and spin-out company agreements. Isis manages over 400 patent application families and since 1997 has assisted in the formation of 52 university spin-out companies.

One such company, VASTox plc, was formed to exploit research into new, sophisticated techniques of drug discovery. The company floated on the stock exchange in October 2004 valued at £42 million.

In April 2005, Isis was also appointed to support the transfer of technology from the four wholly owned research centres of the Natural Environment Research Council. Isis will work with NERC to increase licensing and create spin-out companies.

Oxford University: www.ox.ac.uk
Isis Innovations: www.isis-innovation.com

# Andor Technologies plc

Andor Technologies was founded in 1989 by members of the School of Physics in Queen's University Belfast. They found that the cameras available to them were inadequate for their research projects. So they set about developing their own. After using these for various imaging and spectroscopic applications, the physicists found that researchers, both in other departments at Queen's University, and other universities were asking for cameras.

Andor was incorporated in 1989, to exploit this advanced camera equipment. In 2002, the company won Top Exporter award at Invest Northern Ireland's Exporter of the Year Awards. In December 2004, it floated on the Alternative Investment Market of the London Stock Exchange, with a market capitalisation of £23 million.

The main business of Andor remains the development and manufacture of high performance digital cameras for academic and business research. The company is constantly improving its products and bringing new and innovative technologies to the market place.

The company is still based in Belfast at a purpose-built 50,000 sq. ft facility. The premises include state of the art optical, electronic and mechanical workshops, a 3000 sq. ft clean room, vacuum and electronic processing facilities. It is now the fastest growing company manufacturing high performance digital cameras, with customers in over 40 countries and more than 160 staff.

http://www.andor.com

CASE STUDIES

# Novel treatment for allergies

- Between 100 and 150 million people worldwide suffer from asthma
- Novel natural pharmaceuticals are being developed from tick saliva to treat allergic conditions.
- Further developments show promise for using tick saliva to treat heart attacks and autoimmune diseases.

## What is it?

Leeches were used in the past to treat illness, now research at Natural Environment Research Council's (NERC) Centre for Ecology and Hydrology (CEH), Oxford, is identifying novel natural pharmaceuticals developed from tick saliva that can help to treat a variety of inflammatory, allergic and auto-immune conditions. In 1998 NERC's first spin out company, Evolutec, was set up to develop and exploit basic research undertaken at CEH Oxford into tick saliva for medical and healthcare applications.

Significant numbers of people develop allergies to substances in food and the environment; asthma and hay fever are common reactions. The World Health Organization estimates that between 100 and 150 million people worldwide suffer from asthma, and 180,000 die from it annually. Hay fever affects more than 115 million people worldwide. Between a third and half of people are genetically predisposed to develop Immunoglobulin E antibody (IgE) to common environmental allergens that cause histamines to be released into the surrounding tissue resulting in familiar allergic reactions.

In 2002, the market for inflammatory, allergy and auto-immune diseases was $42 billion. These include rhinitis ($6.6 billion), asthma and Chronic Obstructive Pulmonary Disease ($11.1 billion) and psoriasis ($0.6 billion). It is believed that several of the major therapeutic areas are potential markets for Evolutec's lead product.

## The science

Professor Pat Nuttall, Director of CEH, wanted to know why ticks were so good at transmitting diseases to their hosts. When a tick bites its host, it pumps a multitude of molecules into the skin to prevent the host from launching an immune reaction. This means that any viruses in the tick's saliva can cause infection, whilst the immune system has been suppressed.

In trying to isolate the factors in tick saliva that help disease transmission, Professor Nuttall and her colleague, Dr Guido Paesen, discovered a tick protein, named rEV131, that binds to histamine, inactivating it. Histamine triggers a number of inflammatory responses, for example reactions of asthma and hay fever.

During an allergic reaction, the immune system attempts to protect the body by producing IgE antibodies that specifically target the allergen that comes in contact with the body. The antibodies then cause certain cells in the body to release chemicals into the bloodstream. One of the chemicals released into the bloodstream is histamine, which then acts upon a person's eyes, throat, lungs, nose, and digestive tract. The body will trigger the antibody response any time the allergens are in contact with the body.

A traditional antihistamine drug selectively targets only one of the four histamine-receptors in the body, and only the activities of histamine mediated by this receptor are blocked. The tick protein is a broader-spectrum drug; by sequestering the histamine itself it suppresses the activities mediated by all histamine receptors, rather than just one.

Professor Nuttall realised that the tick protein had commercial potential, and, with the backing of 3i, the London-based venture capital group, Evolutec was established as NERC's first spin-out company.

Evolutec's lead product has shown success in trials for treating hay fever, and for inflammation post-cataract surgery. In February 2005, the company signed an agreement with Cambrex Bio Science Baltimore, Inc. to manufacture the histamine-binding protein and undertake trials to confirm its effectiveness, monitor side effects,

compare it to commonly used treatments, and collect information that will allow the drug or treatment to be used safely.

Positive pre-clinical data has also been generated for treatment of asthma and acute respiratory distress syndrome, a severe injury of the lungs, with the additional benefit of providing new insights into the underlying causes of asthma. The trials could lead to the development of drugs to treat these common human diseases.

Evolutec was admitted to the Alternative Investment Market of the London Stock Exchange on 2 August 2004, raising £5.1 million net of expenses. On admission, the market capitalisation was estimated at £12.7 million.

## EVOLUTEC TIMELINE

**1873**

Charles Blackley proved that grass pollen was the cause of hay fever.

**1911**

Sir Henry Dale discovers histamine, a substance released during an allergic reaction which causes running nose, sneezing and itching, and narrows the airways in the lungs.

**1921**

Kustner & Prausnitz undertake an experiment to test Prausnitz's theory that that the blood of allergic individuals contained a substance that acts with allergens to cause an allergic reaction. This is now known as the Prausnitz-Kustner reaction or passive transfer.

**1933**

Antihistamines were discovered and first generation treatments developed. Bovet won the 1957 Nobel Prize for Medicine for his contribution.

**1967**

Researchers in the USA, and Sweden independently identify the nature of the antibody discovered by Prausnitz and Kustner. The antibody, named immunoglobulin, or IgE, causes histamines to be released into the surrounding tissue resulting in allergic reactions.

## The future

The tick protein is only one of a number of compounds for which Evolutec has granted patents or patents applications. Some of these show promise as treatments for heart attacks and autoimmune diseases.

Other candidates for commercialisation include vaccines that will protect animals from ticks and tick-borne diseases. Evolutec's expertise has led to a partnership with Merial, one of the world's leading animal healthcare companies, to evaluate anti-tick vaccines in animals. Positive trial results would enable Evolutec to pursue the potential of the same technology in the human vaccine area where preclinical work has shown potential against tick borne encephalitis, a human viral infectious disease affecting the central nervous system.

CEH is exploring the possibility of establishing a further spin-out company to take forward its research into potential products from tick saliva and other bloodsucking arthropods, and extending its product development pipeline.

NERC: www.nerc.ac.uk

**1995**

CEH undertakes experiments to identify the components of tick saliva that allow transmission of diseases to their hosts in collaboration with the Institute of Zoology in Bratislava.

**1996**

Histamine-binding protein found in tick saliva that inactivates histamine, preventing allergic reactions. CEH establish Vacs for Life to explore the commercial potential.

**1998**

A tick cement protein is discovered with potential for use in vaccine development. Vacs of Life becomes Evolutec, and with the backing of 3i, is established as CEH's first spin-out company.

**2003**

Evolutec / Merial partnership launched to develop anti-tick vaccines in animals.

**2004**

Evolutec admitted to the Alternative Investment Market of the London Stock Exchange.

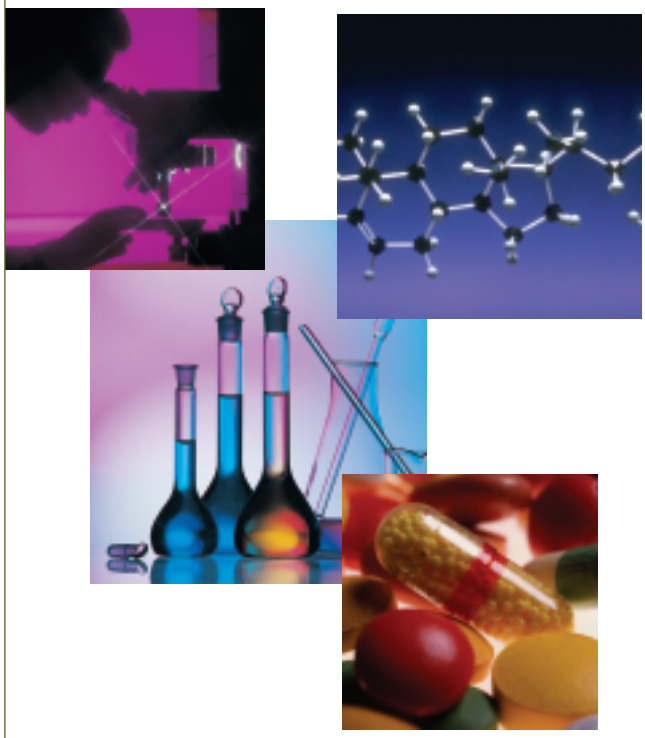
**2005**

Evolutec sign an agreement with Cambrex for the manufacture of its lead compound. Evolutec announce a fundraising of £10 million to be fully underwritten by Robert W. Baird.

CASE STUDIES

# The Sulis Seedcorn Fund

The Sulis Seedcorn Fund, currently worth £9 million, was established in December 1999 as a partnership between the Universities of Bath and Bristol. The partners provided the fund with an initial investment of £1.25 million and there were further contributions of £1.30 million from The Wellcome Trust and £2.45 million from the DTI. In July 2002, the University of Southampton joined the fund, contributing £1 million and the DTI awarded a further £3 million.



The partners created the fund to fill the gap between research funding and commercial venture capital. It offers a source of finance to the academic communities of the partner universities. The fund provides 'seed' stage investment capital to enable potential businesses to evaluate their potential, refine their concepts and ensure effective commercialisation.

The fund aims to invest in a balanced portfolio, split between the establishment of spin-out companies and IPR/licensing projects. The fund aims to become self sustaining with returns from investments and income from licensing royalties generating funds for new projects.

Since 2001, Sulis has invested in 23 spin-out companies and has given assistance and advice in commercialising over a dozen other projects based on academic research generated within and owned by the Universities of Bath, Bristol and Southampton.

Sulis Seedcorn Fund: www.bath.ac.uk/sulis-innovation

# Social Science
# Informing government policies

## Changing attitudes within society

Tools such as the Census, the Labour Force Survey, the General Household Survey and the National On-line Manpower Information Service (NOMIS) help policy makers to understand changing social conditions and the impact that policy initiatives can have on them. Research in the social sciences underpinned some of the government's most successful recent initiatives, such as the Sure Start initiative and the New Deal programme.

### *Environment*

Government housing policy has been heavily influenced by environmental research carried out by Sir Peter Hall of University College London. The UK will require accommodation for an additional 4.4 million households by 2016. He argued for planned, strategic provision for greenfield housing in sustainable urban clusters along selected major transport corridors radiating from London.

As a result of this research the Government developed a policy of sustainable greenfield development on selected transport corridors in southern England. The policy document, Sustainable Communities (2003), produced by the Office of the Deputy Prime Minister largely accepted the case for this development in three major corridors (M1/A6, M11 and A2/M2 Thames Gateway).

## GREATER RESPONSIVENESS TO THE NEEDS OF THE ECONOMY

### *Unemployment*

Two decades ago, many people considered high unemployment inevitable, seeing it either as a product of technology or as a result of a growing work force. However, a model developed by three economists in the 1980s, identifying the causes and cures of unemployment, inspired the thinking behind the New Deal in Britain: it also influenced the employment policies of other countries.

In identifying the key supply-side influences, two general points became clear:

- a bigger labour force does not of itself increase unemployment, jobs do respond, so that unemployment cannot be blamed for example on immigration;
- higher productivity does not increase unemployment - technology is not the main problem. Research on vacancies showed that the UK was failing to mobilise the unemployed to fill the jobs available,

and that high inflation resulted from unfilled vacancies.

This ‘mobilisation failure’ was traced to changes in the way unemployed people were treated at benefit offices and job centres. During the 1990s, this analysis of the causes and cures of unemployment was increasingly accepted by European policy makers. In the European countries that adopted this approach - Denmark, Holland and Britain - unemployment fell sharply from 1993. In those countries that did not - France, Germany and Belgium - unemployment levels remain high.

British Academy: www.britac.ac.uk

# Insecticide-treated mosquito nets

## Medical Research Council and Biotechnology and Biological Sciences Research Council

*Insecticide-treated mosquito nets have revolutionised malaria prevention, and have the potential to save millions of lives.*

Nets treated with biodegradable insecticides protect people from malaria in two ways: by physically preventing malaria-carrying mosquitoes reaching the skin; and by killing the mosquito when it lands on the net. The Medical Research Council (MRC) Laboratories in The Gambia first demonstrated in 1984 that the nets actually work in reducing malaria in a real life setting. Later MRC studies showed that insecticide-treated mosquito nets reduced deaths in children under five years old 63 per cent.

Mosquito nets treated with insecticide (DDT) were used during the Second World War but DDT was also toxic to people. In the 1970s, research funded by the BBSRC led to the discovery of a whole new class of insecticides based on naturally occurring compounds in a type of daisy. These new insecticides, called synthetic pyrethroids, are more environmentally friendly and much less toxic. In the 1980s when synthetic pyrethroids came on to the market, the use of treated nets could be reconsidered. Treated nets are cheaper and more effective than spraying insecticide: treating a family's nets needs only about one sixth as much insecticide as indoor residual spraying of their house. Also, nets can be re-impregnated.

The MRC's work triggered large-scale trials in northern Ghana, Kenya and The Gambia. This led the Tropical Diseases Research Programme of the UN, World Bank and World Health Organization (WHO) to fund research to improve methods for treating nets with insecticide. Since 1998, insecticide treated nets have been used in the WHO's Global Malaria Programme.

This aims for 80 per cent of people in Africa at risk of malaria to be using treated nets by 2010.

The WHO estimates that malaria causes over a million deaths a year, the vast majority of them children.

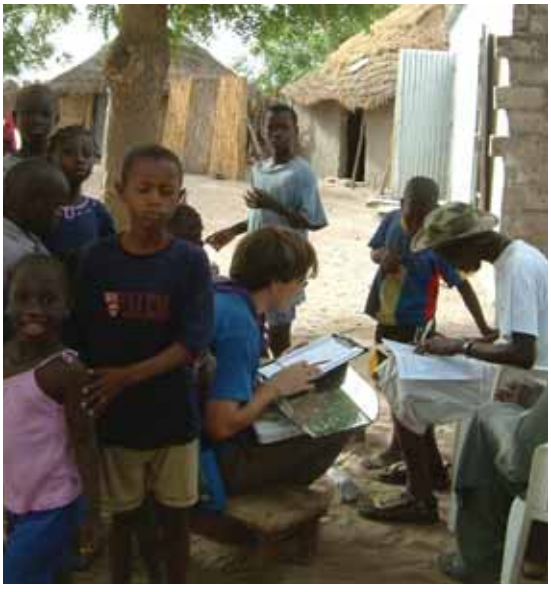
## GREATER RESPONSIVENESS TO THE NEEDS OF THE ECONOMY

In Vietnam, insecticide-treated nets were introduced in 1991 and gradually took over from spraying. Consequently, deaths from malaria were virtually eradicated there by 2003. Treated nets have both a personal protection effect to the individual user and a community wide effect because occupied nets act as baited traps for mosquitoes. Nets reduce personal net bites by 69 per cent. For other people sleeping in the vicinity of treated nets, even if they do not have their own nets, risk from bites decreases by 75 per cent.

Research has shown that donation, rather than selling, is the best way of distributing nets to poor families in African villages. When net donation was combined with a measles vaccination campaign in Zambia, the use of nets increased from 17 to 80 per cent. Now there are programmes all over Africa linking vaccination campaigns and free nets.

The costs of providing treated nets for 1000 people for one year, including annual replacement, cost of insecticide, labour cost and transport, is £540. This is less than half of the cost of spraying. The cost of free nets, including insecticide, labour and transport, for the 350 million people in lowland tropical Africa is £189 million a year. This is 17 per cent of the amount spent on ‘de-fleaing’ cats in Europe and the US.

Malaria's direct and indirect costs have been shown to be a major constraint to economic development. Annual economic growth between 1965 and 1990 in countries with severe malaria averaged 0.4 per cent of GDP per capita, compared with 2.3 per cent in the rest of the world. Malaria prevention is therefore of interest not just to the developing countries themselves, but also to the developed world.



Medical Research Council: www.mrc.ac.uk
Biotechnology & Biological Sciences research Council: www.bbsrc.ac.uk

# Smart Infrastructure

## Cambridge-MIT Institute

The Smart Infrastructure Knowledge Integration Community of the Cambridge-MIT Institute works with industrial partners to develop and test innovative new sensor systems to monitor, and to help prevent defects in, water mains, tube tunnels, road and railway embankments and building foundations.

In one large-scale field trial, the researchers developed, installed and evaluated a prototype sensor system at King's Cross to monitor movement of the existing Thameslink Tunnel during construction nearby of part of the Channel Tunnel Rail Link. The sensor system, operating alongside a variety of other systems, measured minute changes of shape of the tunnel, demonstrating sensitive and low-cost monitoring of vital infrastructure.

The Cambridge-MIT Institute: www.cambridge-mit.org

CASE STUDIES

# Thames Barrier

## Proudman Oceanographic Laboratory

Conceived after disastrous floods in eastern England killed over 300 people in 1953, the Thames Barrier protects London from storm surges and flooding from the sea. Between its first use in 1982 and Oct 2004 the Thames Barrier was closed 54 times to forestall potential flooding. With global warming causing rising sea levels and the threat of increased storminess, the barrier is likely to be deployed more often in the future.

The barrier controller takes the decision to close the floodgates, informed by the best science and sophisticated computer analysis from the Proudman Oceanographic Laboratory of the Natural Environment Research Council. The laboratory has developed and maintains tide and surge models that run on the Meteorological Office computer.

A severe flood in London today could paralyse the Tube system, damage fresh water and sewage systems, and disrupt power, gas, telephone and data services. Thousands of homes, shops, factories and businesses would be affected. It could take months to get back to normal.

The financial cost of such a flood would be enormous. The Environment Agency, which runs the Thames Barrier, estimates that the bill could be over £30 billion, on top of the massive impact in human suffering and potential loss of life. London's economy contributes over 17 per cent of the UK's GDP and is comparable in size to that of Sweden and Russia. A major flood would have a devastating effect on our economy.

NERC: www.nerc.ac.uk

# Imaging chair for children

## Royal Victoria Infirmary

With the assistance of NHS Innovations North, the Regional Medical Physics Department (RMPD) at the Royal Victoria Infirmary, Newcastle Upon Tyne NHS Trust developed the paediatric imaging chair. The chair solved problems encountered by staff in keeping children as still as possible during kidney scans.

The prototype chair took nearly two years to develop. NHS Innovations North began identifying licensees in 2002, negotiating a licence agreement with Bright Technologies in 2004. In its first year of trade, 12 paediatric imaging chairs have been sold, and interest continues to increase.

### The problem

It is essential that children remain as still as possible during kidney scans to obtain good quality images. Adult positioning chairs are currently used in hospitals. However, there was no facility for positioning babies and children during scans. In many cases, staff had to hold children down during scans, which was stressful for the staff and the patient.

### The solution

Robert Beckwith of the RMPD developed the paediatric imaging chair. NHS Innovations North were invited to assist with the development of the project in May 2002. Design, production and evaluation of the chair took around two years with trials at the Royal Victoria.

The imaging chair is designed to make children feel comfortable and at ease during scanning. The construction allows the chair to move around easily without disturbing the patient. A harness holds the child comfortably in a specific position and prevents the child from moving around or trying to get out.

The chair was recently exhibited at the British Nuclear Society Event in Brighton where the Medical Physics Department at the Infirmary received an 'Ammy' Award from Amersham Health for *'Achievement in Nuclear Medicine'.*

### Benefits to the NHS

Following the licence agreement negotiated with Bright Technologies in March 2004, the first royalties for the Trust were received in June 2005.

Use of the chair within the NHS has improved the procedure for both the staff and the patients. It has enabled staff to produce good quality scanning images without intimidating or frightening young patients. The procedure has become far less traumatic for the patient, and as fewer scans have to taken, the process is more efficient, saving a great deal of time.

NHS Innovations North: www.nhsinnovationsnorth.org.uk

# Promoting healthy eating

## Hammersmith Hospital

A new laboratory service at the Hammersmith Hospital will enable researchers in nutrition to measure the glycaemic index (GI) of foodstuffs. The GI is a measure of how quickly a carbohydrate gets into a person's blood as sugar. The higher the GI, the less healthy the carbohydrate. Only a small number of laboratories around the world can offer these sorts of tests.

The system will:

- promote the consumption of healthier foods
- provide rapid GI results to industry in the formulation of new food products, as other food constituents can affect the GI value of a carbohydrate
- provide information to diabetics, as slowly absorbed carbohydrates can help to even out blood glucose levels for sufferers of this disease.

### Development

The facility at the Hammersmith Hospital is one of only four laboratories in the world that perform this diagnostic. Commercial organisations have accessed the expertise in the laboratory on an ad hoc basis over a number of years.

The development of specialised services is being coordinated at the Hammersmith Hospital with executive board approval and support. Services can be provided to both the public and the private sector. The business plan is completed and is being assessed by the PFI unit of the Department of Health.

CASE STUDIES

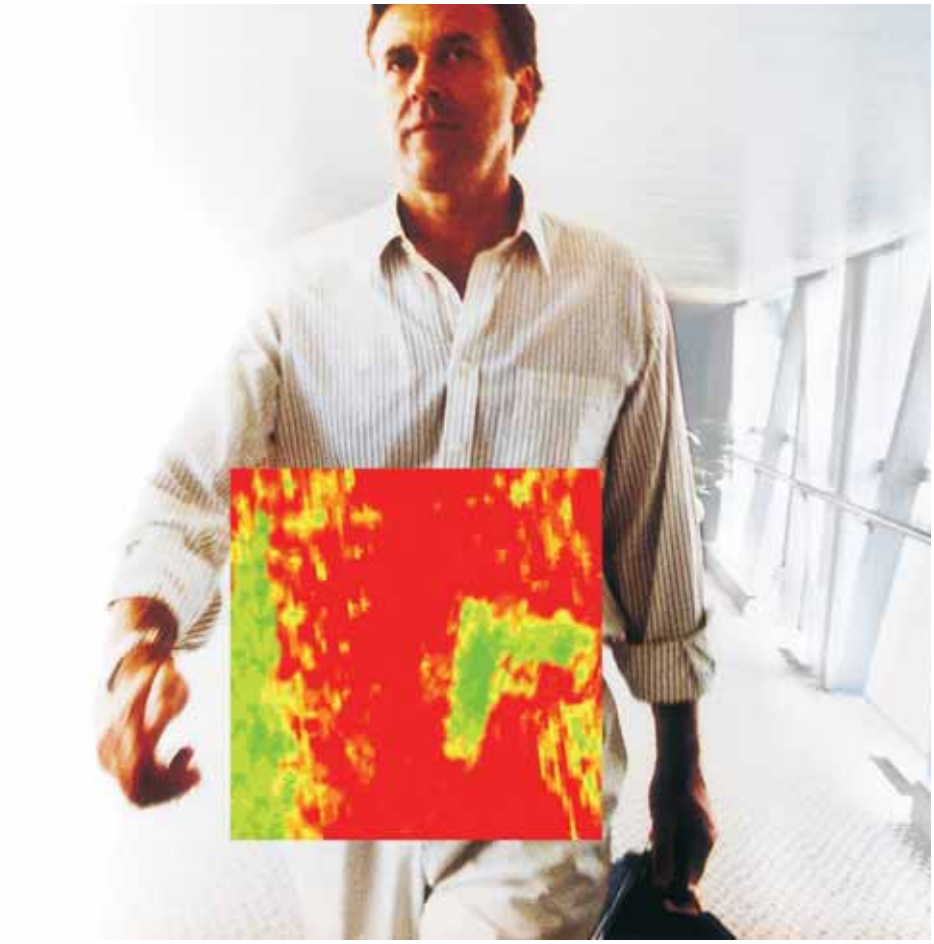
# Terahertz imaging

## Rutherford Appleton Laboratory

Terahertz imaging is an established analytical technique used to monitor planets. With the Particle Physics and Astronomy Research Council, the European Space Agency funded a consortium to develop commercial applications for this technology. The main focus has been the security market - the technology can image hidden guns and explosives.

Founded in 2004 as a spin-out from the Rutherford Appleton Laboratory with DTI support, ThruVision Ltd is testing an imaging system for security screening applications at a number of high profile locations worldwide.

www.thruvision.com



# TTURA

Eight Inch Ltd
Enterprise Works
Beach Road
Newhaven
East Sussex
BN9 0BX

There are currently 16,000 commercial and public bottle bank sites in the UK which is set to increase as the public increases its recycling efforts. The principal outlet for this returned glass is back to the furnace to make new glass. However UK manufacturing is predominately clear glass, whereas half the glass collected in bottle banks is green.

TTURA is a stylish, durable and environmentally friendly material which is made up of thousands of chunks/fragments of recycled glass (typically 85 per cent). These can be coloured or clear or both, and are bonded together with a specially developed solvent free resin. Once these have been mixed and poured into bespoke moulds, the TTURA is allowed to cure before being diamond polished in the same way as marble and granite.

TTURA was developed by Gary Nicholson, a furniture/industrial designer while he was running an environmental research programme at one of the UK's leading university research centres. The original research was supported by the Arts and Humanities Research Council. The company, Eight Inch, was spun out to utilise the versatility of TTURA, providing an alternative to quarried stone.

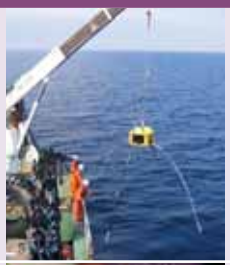
Ttura: www.eightinch.co.uk
Arts and Humanities Research Council: www.ahrc.ac.uk

# Increased business investment and engagement

As part of its goal to make the UK one of the most innovative and competitive economies, the Government wishes to improve the engagement of business with the research base.

However, R&D alone does not capture the full range of innovation. As the OECD noted in 2005, the UK's strengths in knowledge intensive services and creative industries - where indicators such as R&D spend are less likely to pick up innovation - probably means the UK's innovation performance is understated.

## Working with business



### Offshore Hydrocarbon Mapping Ltd (OHM)

OHM grew out of research at the UK's National Oceanography Centre, Southampton and is world leader in controlled source electromagnetic (CSEM) surveying, data processing and data interpretation for the offshore oil industry. CSEM is increasingly being recognised as a valuable method of de-risking the oil and gas exploration process and creating multi-million pound value for clients.

### Wolfson Microelectronics

Wolfson, which span out of Edinburgh University in 1984 and went public in 2002, is a global leader in the supply of high performance microchips. Wolfson's chips are found in PDAs and digital music players, most notably the Apple iPod.

### Pfizer in the UK

Pfizer makes a significant contribution to the UK science base through its own R&D activities and collaborations. In 2005, the company invested more than £550 million in its UK R&D activities, the majority of which were conducted by scientists at its European R&D headquarters in Sandwich, Kent. Pfizer is also involved in several high profile collaborations. These include The Pain Clinical Research Hub (PCRH) with King's College Hospital and King's College London, which is seeking to advance medical knowledge of pain and develop new treatments, The Pfizer Institute of Pharmaceutical Materials Science at Cambridge University and, in conjunction with GlaxoSmithKline, AstraZeneca and The British Pharmacology Society, the Integrative Pharmacology Fund to support pharmacology, physiology and toxicology research in UK universities.

The Government has supported several initiatives to help business to increase engagement with the research base. These include:

- The R&D tax credit, against which nearly 22,000 claims have been made since it was introduced in 2000. Almost £1.8 billion of support has been claimed, just under £1 billion by small and medium enterprises.

- The UK wide Technology Programme, led by the DTI and overseen by the business-led Technology Strategy Board, stimulates knowledge transfer (KT), leveraging the scale and scope of KT support offered by Government Departments, Regional Development Agencies and the Devolved Administrations and Research Councils. It keeps a focus on the potential for UK exploitation and the global nature of much KT. Over £420 million has been allocated to over 600 Collaborative Research & Development projects worth £900 million since 2004 and 20 Knowledge Transfer Networks (KTNs) have been set up to accelerate the rate of technology transfer into UK business.
  The Technology Strategy: www.dti.gov.uk/innovation/technologystrategy
  Knowledge Transfer Networks: www.ktnetworks.co.uk

- Knowledge Transfer Partnerships (KTPs) enable graduates to work in a firm to introduce new processes/services/product development in partnership with a suitable university, college or research organisation. The DTI spends £18 million pa leveraging £12 million from other public sector and £54 million from business.

The Office of Science and Innovation is also developing cross-sectoral Innovation Platforms, working with other Government departments and key stakeholders to explore opportunities for British business to address key challenges that face society. Two pilots have been launched in Intelligent Transport Systems and Services and Network Security.

As well as the collaborations established through the Government funded programmes, many companies have developed links and partnerships to take advantage of the skills and knowledge offered by higher education and other public sector research.

These collaborations take many forms, including research partnerships, continuing training and development programmes for established workers and incubation and support for new companies taking their first steps.

CASE STUDIES

# Authentix Limited

University of York

Authentix Limited brokered a Knowledge Transfer Partnership (KTP) with the University of York to develop a novel method for detecting levels of security markers in fuels using a rapid, automated and reliable test that can be carried out in the field.

Illicit trading of fuel is a global problem, costing governments and industry billions of pounds annually in lost tax revenues and sales. Whilst current technology allows fuel testing to be conducted in the laboratory, a rapid field test would reduce costs and increase market accessibility.

The KTP project delivered a functioning field test kit and the IP generated, two patents filed and one in preparation, demonstrate to customers and investors that the company invests in new technologies and solutions with a direct commercial driver. The success of the first project has led the company to invest in a follow-on KTP project with two associates and to commit more funds to knowledge enhancement.

Knowledge Transfer Partnerships: www.ktponline.org.uk
Authentix Ltd: www.authentix.com

# Supporting business improvement

## De Montfort University

De Montfort University operates a successful and extensive Knowledge Transfer Partnership (KTP) programme aligned to the R&D needs of business. The university's research and expertise focuses on real world problems and solutions and is ideally placed to meet the needs of SMEs in high value markets such as telemetry, holography, mobile communication and technology-based creative industries. De Montfort University has successfully developed 60 KTP projects. An experienced team is in place, developing demand within the business community and providing support for grant applications and project management.

Through the transfer of real-world research into the business community, De Montfort addresses the KTP mission to "strengthen the competitiveness, wealth creation and economic performance of the UK".

The university currently manages 16 projects worth approximately £1.6 million in total. It aims to develop a sustainable portfolio of at least 20 in the next year.

In accordance with the university's research competencies, the KTPs are delivered primarily in high growth technology and engineering sectors, responding to both national and regional market requirements. Nearly 75 per cent of the university's KTPs are within the East Midlands region.

### Benefits to business

The overall benefits of the KTP programme are well documented. De Montfort University's KTPs typically have a high return on the

grant funding. A five to one return on investment is not uncommon. This reflects the focused and managed nature of projects.

Examples of KTPs focused on product innovation include:
- High performance holographic reflective material - providing both product performance and cost reduction benefits
- Mobile telephone integration with vehicle and plant security systems - providing product functionality benefits
- Visual information and stock management systems on distributed mobile communication technology - providing product functionality benefits
- Flexible radar-reflective materials, - providing new markets for an SME client

Business-critical knowledge and skills are developed and embedded in client SMEs, with many graduates employed by the client after the grant ends. Academic links are often retained through other knowledge transfer mechanisms, such as consultancy.

### Benefits to the university

The KTP programme provides a number of benefits to the university:
- Funding for staff and facilities
- Contributions to the Research Assessment Exercise profile through grants and publications - each KTP yields on average one refereed paper
- KTPs facilitate long-term relationships between academics and business, leading to the continuous exchange of knowledge for both parties. Knowledge of current business needs and practices is fed back into the curriculum - for example, through teaching materials, student projects and placements - and into research through the identification of the next challenge!
- Further opportunities for knowledge transfer or research collaboration often result
- KTP graduates often register for a higher degree as part of the project

### Barriers

The perceived barriers to the development and scaling up of KTP programme are:
- Some SME clients perceive high administrative burdens and long decision times
- Some types of SME that could benefit from the programme are

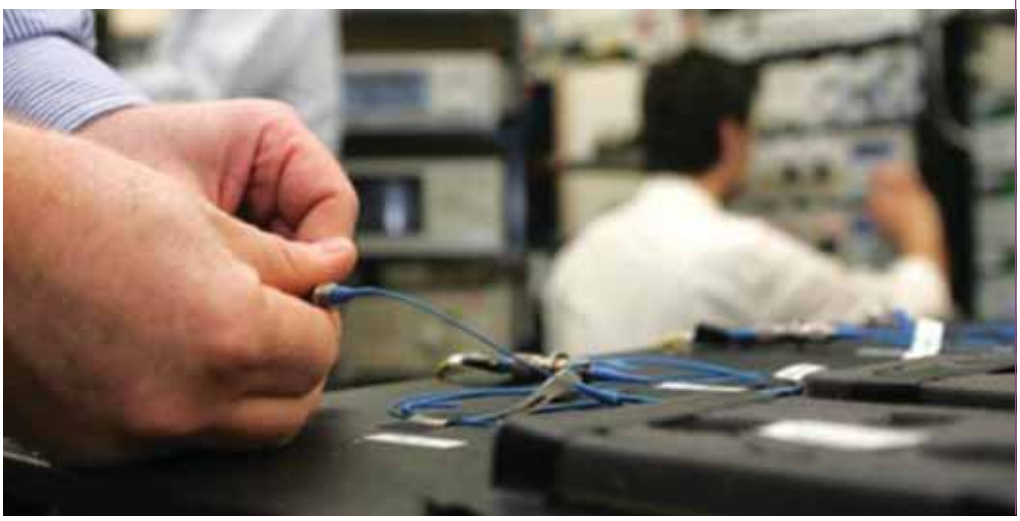
ineligible, owing to the requirements on financial performance and graduate support. Typically very small and recent start-ups find it difficult to qualify
- Difficulties in recruiting suitably qualified graduates - particularly in engineering disciplines
- Converting leads and interest into KTP applications

### Overcoming barriers

The KTP team at DMU is experienced and has identified potential solutions to some of these barriers. Potential mitigation strategies include:

- Additional marketing to promote the business-friendly nature of KTPs to the business community, and the local support available through centralised university KTP teams
- New financial and graduate support models could mitigate or spread the risk of engaging very small and new businesses. Additional assessment criteria based on the local knowledge of the KTP teams could also mitigate the risks
- Additional funding to allow KTPs to attract suitable graduates in line with commercial salaries
- Additional managerial resources to support the development of more in-depth KTP propositions for potential SME clients

De Montfort University:
www.dmu.ac.uk/partnerships/consultancy/innovation_centre/kt/index.jsp



CASE STUDIES

# Advanced Manufacturing Research Centre

University of Sheffield

The internationally acclaimed Advanced Manufacturing Research Centre (AMRC) at the University of Sheffield, a partnership with Boeing, is a £45 million collaboration between world leaders in the aerospace supply chain, key Government offices and international academic institutions. This world-class facility is dedicated to developing innovative solutions for materials forming, metal working and castings to ensure that manufacturing in the UK remains competitive.

As manufacturers switch from metals to composite materials, it will be critical to accelerate the introduction of materials and processes while reducing costs. The AMRC is meeting this challenge by creating a £15 million Composite and Advanced Materials Technology Centre (CAMTeC). CAMTeC will enable engineers to develop composite manufacturing solutions for companies to strategically position themselves in the new generation aerospace value-chain market.

Boeing has R&D relationships with several universities in the UK, including Cambridge, Cranfield and Sheffield. Each concentrates on specific areas of work, such as advanced information, aeronautics and manufacturing technologies. With each of these partners, Boeing aims to gain competitive advantage, not only for itself, but also for its suppliers in the UK.

University of Sheffield:
www.amrc.co.uk

# London Biotechnology Network

The business organisation London First formed the London Biotechnology Network in June 2000, in response to the need for a co-ordinated approach to biotechnology development in London.

It is the largest regional biotechnology organisation in the UK, with some 800 member organisations. London's biotechnology sector is derived from the enormous research activity centred around the large concentration of medical schools, teaching hospitals and medical research organisations. London is indisputably the financial capital of Europe and access to funding is a major attraction for biotechnology companies.

A major part of the network's acitivity is in developing new incubator and laboratory facilities for biotechnology companies. The London BioScience Innovation Centre is now open next to the Royal Veterinary College, in Camden, and houses a number of companies. There are plans to develop five other projects in new space in Central and West London over the next two years.

The network holds monthly 'BioWednesday' meetings for London's biotechnology companies, research scientists, investors and professional support services.

There is also an investor network. London Biotechnology Network also hosts the largest one-day biotechnology conference in the UK.

London Biotechnology Network:
www.londonbiotechnology.co.uk
London BioScience Innovation Centre
www.lbic.com

CASE STUDIES

# Business Relations Unit

## Birkbeck College

Through funding from the Higher Education Innovation Fund, Birkbeck College has funded a Business Relations Unit. The unit works with managers in human resources and training to ensure that the college's courses remain relevant to changing needs for continuing professional development. When the unit formed in 2002, the college had 693 employer sponsored students enrolled. By 2006 this had increased to 989.

The Birkbeck Forum Series, including the Birkbeck Business One-on-One, is a programme that was designed to help SMEs understand, increase and realise the value in their businesses. It provides confidential, one-on-one access to experts in the fields of Business Strategy, Human Resources, Sales, Marketing, and Finance – all the topics on which sustainable business value is built.

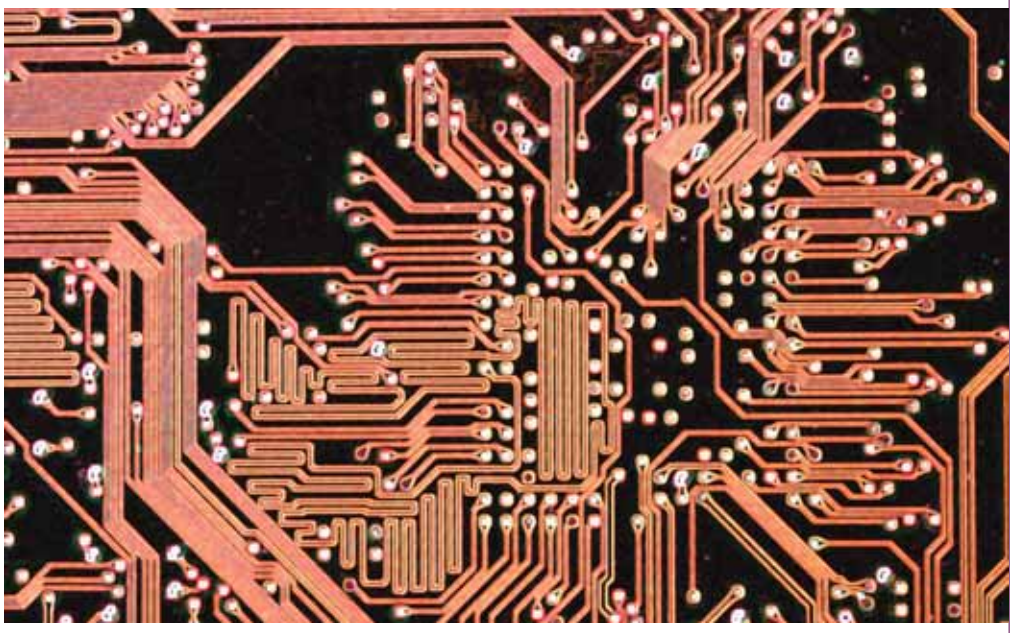
Birkbeck College: www.business.bbk.ac.uk

# Transitive Corporation

## University of Manchester

Transitive Corporation was founded in 2000, with support from the DTI's University Challenge Fund. The founder, Alasdair Rawsthorne, has remained a lecturer in Computing Science at the University of Manchester. The company exports computing technology to Silicon Valley. Its leading product, QuickTransit, allows any software application to run on any processor and operating system, thereby tackling the problem of hardware/software dependency.

This product is now included in every Silicon Graphics workstation, from basic desk-side systems to high-end supercomputers. The



crowning glory of Transitive Corporation was in June 2005 when Steve Jobs of Apple demonstrated the company's part in Apple's plans to migrate from PowerPC to Intel CPU chips.

The company has also received much attention in the international media and accolades from the trade press. For instance, '*The Wall Street Journal'* named QuickTransit as the runner-up in the software category of their Global Technology Innovation Awards for 2005.

Transitive employs more than 40 home-grown graduates at the company's offices in Manchester and Silicon Valley. R&D is done in Manchester, showing that there is not an inevitable brain drain from

Manchester to Silicon Valley, and that scientific training and knowledge are continually added to the national pool of expertise.

### The novelty of Transitive's technology

Transitive spent about three years on research in the School of Computing Science, developing the technology into a robust, commercial and industrial software base, and preparing for sale. This research eventually formed the foundation of their product. Banking on its potential, Manchester Technology Fund invested £200,000 and Pond Venture Partners of London and Silicon Valley £1.8 million to support R&D. Transitive subsequently raised more than $20 million in the US. Development contracts were signed in 2001 and 2002 with early customers acting as technology partners. In 2003, the company was ready to market its product. The first major deal was with Silicon Graphics.

The unique patented feature of Transitive's hardware visualisation technology is that it allows software developed for one platform to run on any other without any source code or binary changes. This results in minimum disruption in performance when programs are ported on to different chip architectures.

The technology claims to reduce dramatically software developers' costs, risk and time-to-market support of multiple hardware platforms. It also facilitates the migration to new platforms and increases the choice of software available on hardware platforms. The versatility of Transitive's software underpins Apple's choice of Transitive's technology in its recent move to Intel.

To date, Transitive has agreements with six of the world's largest computer companies to write customer software support for their platform. Independent software vendors have also supported Transitive's technology: many are collaborating with the company to write customised software as well. Together with its numerous awards, Transitive's grasp of cutting-edge computing technology places it in the 'big league' of enterprise technology.

# SETsquared Business Acceleration

The SETsquared Partnership (the universities of Bath, Bristol, Southampton and Surrey), works to support entrepreneurs and new companies through its Business Acceleration Programme. Since being set up in 2002, the Programme has provided in-depth support for more than 100 ventures.

A wide range of support is focused on the very early stages on developing new technology companies which have the potential for rapid growth in global markets. By providing serviced office space, intensive business guidance and mentoring as well as access to high-calibre national and international networks of experienced entrepreneurs, investors and business professionals, SETsquared offers new companies access to resources to accelerate the development of their business.

The programme operates from Centres run by the partner universities that are located on or near each campus. New companies are supported by a dedicated team of business development professionals from across the four Universities.

SETsquared Business Acceleration: www.setsquared.co.uk

CASE STUDIES

# Autosub

## National Oceanography Centre

The Autosub is a long range, deep diving, autonomous underwater vehicle (AUV) developed at the National Oceanography Centre, Southampton. It can carry a variety of sensors so that scientists can monitor the oceans in ways that are not possible with conventional research ships.

Subsea 7, a leading offshore construction and survey contractor, has signed an exclusive licence for use of the Autosub in the oil and gas and sub-sea cable markets, and for use of the technology and know-how associated with the Autosub development programme.

Subsea 7 intends to build on the know-how from the Autosub programme, and to use its experience in the design, build and operation of underwater vehicles, to introduce an advanced range of AUVs for offshore oil and gas exploration and production. A team of engineers has already started to build on the technology developed at the National Oceanography Centre, Southampton to bring Autosub to the commercial offshore market in the form of Geosub.

AUVs such as Autosub can survey remote environments that are inaccessible to Remotely Operated Vehicles (ROVs) and other underwater craft. Since 1996, Autosub has completed more than 400 operational missions, demonstrating the capability for unescorted missions, routine launch and recovery in Force 6 weather conditions, sensor or data driven path determination and terrain following.

The vehicle has been employed in projects ranging from assessing herring stocks in the North Sea to mapping manganese distributions in a sea loch. Autosub has also successfully undertaken missions beneath sea ice in Greenland and Antarctica.

National Oceanography Centre, Southampton:
www.noc.soton.ac.uk

# Rolls-Royce University Technology Centres

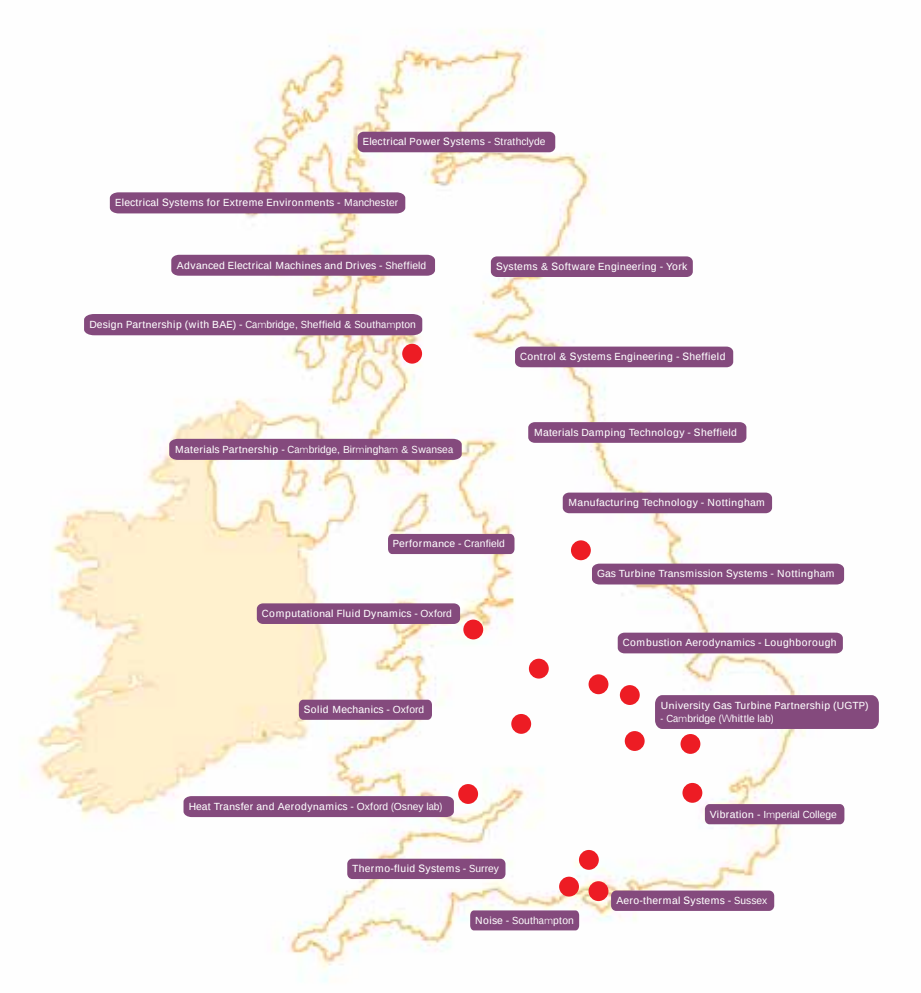
Rolls-Royce has established partnerships with universities around the UK. These University Technology Centres (UTCs) have enabled both partners to develop close, long-term relationships, concentrating on advances in specific tightly focussed areas of technology.

## Cranfield

Rolls-Royce established their UTC in Performance Engineering at Cranfield University to carry out long-term research in the field of performance engineering. The centre looks into performance improvement in stationary, marine and aero gas turbines and in overall aircraft performance.

## Imperial College London

The Rolls-Royce UTC for Vibration at Imperial was founded in 1990. The Centre houses major industrial and collaborative research projects and specialises in rotating machinery vibration, modal testing and analysis methods. As well as the Rolls-Royce related projects, the Centre is also heavily involved in projects funded by industry, EPSRC and the BRITE EuRAM programme. The Centre has a complement of more than 20 full-time researchers and a turnover in excess of £1M p.a.




Rolls Royce: www.rolls-royce.com
Cranfield University: www.cranfield.ac.uk/prospectus/research/research.cfm
Imperial College London: www3.imperial.ac.uk/vutc

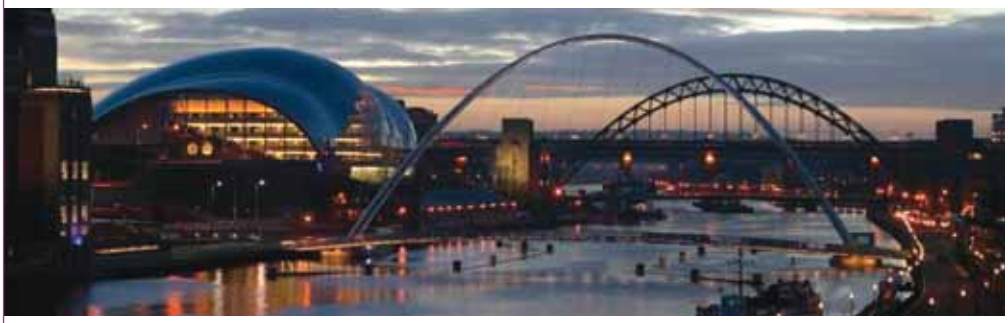
CASE STUDIES

# The Sage Group plc

With a history of interaction with universities, the Sage Group plc is a remarkable UK success story. Founded in 1981, the organisation today employs over 10,000 people in a global operation that last year turned over £777 million. Sage is a world leading provider of accounting and business management software.

Over 600,000 businesses in the UK alone rely on Sage to manage key business processes - one in four people in the UK are paid using Sage Payroll. Five million businesses worldwide use the company's products and services.

The business was founded in a local printing works on Newcastle's



Quayside. Working with a team of Newcastle University students, the company developed software to manage both print estimating and basic accounting for sale to other companies.

When Amstrad launched its first desktop PC, little more than a word processor, Sage's software was adapted to run on it. Sales shot from around 30 copies a month to over 300. To help to manage demand and design more software to tap into this lucrative market, Sage recruited new staff, including local graduates to help to run the business.

The business floated on the London Stock Exchange in 1981 and entered the FTSE 100 in 1999 where it remains today.

For the main UK business site in Newcastle, Sage actively recruits within the region from Newcastle, Northumbria, Sunderland, Teesside and Durham Universities. Today over 45 per cent of the company's R&D team are North East graduates: across the rest of the Newcastle based part of the business, around 30 per cent obtained their degree locally.

The Sage Group plc: www.sage.co.uk

# Electro-thermo mechanical testing

## Instron Corporation and the National Physical Laboratory

Many engineering failures are due to fatigue. Therefore, it is crucial for manufacturing companies to know the fatigue strength of metals, especially under varying temperature conditions. Measuring the fatigue strength while varying the temperature is surprisingly difficult.

Thanks in part to a DTI funded secondment - part of the Measurement for Innovators programme - NPL and Instron have jointly developed the ETMT 8800. This is a fully featured system suitable for measuring mechanical and physical properties and investigating microstructural stability under thermal exposure of miniature test specimens.

The purpose of the instrument is to allow rapid prototype testing, thus directly allowing companies to raise productivity by quickly assessing new advanced materials and to use current materials more cost effectively. The expectation is for this new system to tap into a new niche market of miniature test systems, generating sales worth £1 to 2 million per year.

National Physical Laboratory: www.npl.co.uk

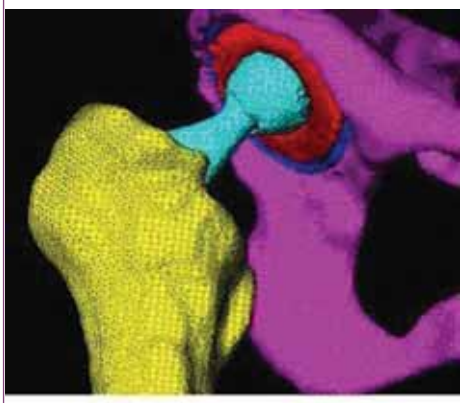
CASE STUDIES

# Improving the success of hip implants

National Physical Laboratory

Over 2 million people in the UK are affected by osteoarthritis or osteoporosis. More than 90 per cent are over 60 years old, and this will rise in line with life expectancy. By 2010, the number of sufferers in the UK could rise by 20 per cent. The projected increase in total hip replacement operations will add £250 million to the NHS's costs.

This project, funded through the DTI's National Measurement System, was designed to be a first step in developing tools that could reduce the failure rate of hip replacement implants, thereby significantly reducing both health risks to patients and costs for the NHS, while helping UK companies to address the world's orthopaedic market of £9 billion with improved products.



The project involved four orthopaedic industry partners, an NHS hospital, a simulations software developer and the University of Exeter's Biomechanical Engineering Centre. Led by the National Physical Laboratory, the collaborators set out to explore whether 3D computer models generated from patient specific scans could be used to assess bone strength and predict how successful the integration of bone and implants had been.

During the study, real human femurs, prosthetic implants and simulated 3D computer models were subjected to a variety of load-bearing tests and the results were compared.

The results showed good correlation between the real bone or implant and the corresponding computer simulation. The collaborators are now considering further work to predict how a particular implant will perform in an individual's body.

Industrial Partners, Simpleware Ltd, CH Medical Ltd
Yale Systems Ltd, Stryker Howmedica Osteonics, Abaqus UK Ltd,
NHS: Princess Elizabeth Orthopaedic Centre, Exeter

National Physical Laboratory: www.npl.co.uk

# Willis Research Network

Formed by the global insurance broker, Willis Group Holdings, the Willis Research Network (WRN) is the largest collaboration between the insurance industry and academia and offers countries and large organisations access to weather and environmental modelling expertise. This will provide practical research and expert analysis of global catastrophic risks such as volcanoes, landslides, floods, hurricanes and earthquakes.

The core of the WRN comprises seven leading university research groups, with multi-disciplinary research focusing on weather and environmental modelling to produce research which will ensure clients benefit from state-of-the-art interpretation of catastrophic risks and the financial mechanisms with which they can respond most effectively.

*Left to right:*
**Professor Stuart Lane**Durham University
**Dr Matt Horritt**, University of Bristol
**Matt Foote,** Willis Analytics and Solutions
**Professor Julian Bommer**, Imperial College London
**Professor David Stephenson**, Universityof Reading
**Professor David Rhind, Vice Chancellor**, City University, London
**Rowan Douglas**, Willis Analytics and Solutions
**Professor Colin Taylor**, University of Bristol
**Dr Luca Leone**, Cambridge Architectural Research
**Professor Julia Slingo**, Centre for Global Atmospheric Modelling, Universityof Reading
**Dr Vesna Brujic-Okretic**, City University, London
**Professor Robin Spence**, University of Cambridge
**Dr Kirsten Mitchell Wallace**, Willis Analytics and Solutions

Rowan Douglas, executive director of Willis, explains: "The primary purpose of the research network is to better predict the frequency, severity and costs of future catastrophes world-wide. The insurance market is the ultimate consumer product as it is the mechanism through which international society and the economy share the costs and burdens of severe catastrophes."

Willis Research Network: www.willisresearchnetwork.com

# Science and Society

The Government is pursuing a variety of initiatives at all levels of the education system, which contribute towards meeting the science engineering and technology (SET) skills shortages in the labour market. A related concern is that of working to ensure that the public are aware of science and scientific advances and are engaged in the debate on such controversial topics as genetically modified crops and nanotechnology. This follows the agenda set out in the *Science and Innovation Investment Framework 2004-2014*.

## Increased numbers of young people studying Science Engineering and Technology (SET) subjects

There is a steady increase in the stocks of SET skills and a relatively constant flow of them into the working-age population. A Level passes in SET subjects have remained fairly consistent over the last ten years.

## Informing the public

BA Festival of Science
The festival is a major showcase of UK science. This week long event is held at a different location each September and attracts around 400 of the best scientists and science communicators from home and abroad to reveal the latest developments in research to a general audience. www.the-ba.net

Sciencewise
Building the commitment and capacity of government to engage in public dialogue on scientific developments, Sciencewise is a government programme led by DTI that helps policymakers make effective use of public dialogue to inform decisions related to emerging areas of science and technology. Sciencewise provides the expertise and resources to bring together policymakers, scientists and the public to explore the health, safety, environmental, social and ethical issues raised by emerging areas of science and technology. http://www.sciencewise.org.uk

Just over 2 million people of working age in Britain have degrees in SET subjects - a 57 per cent increase since 1997. The annual number of first degrees obtained in SET subjects grew by 43 per cent between 1994/95 and 2003/04.

There is however a wide variation in subjects. Accepted applications onto degree courses in Chemistry and Physics have increased by 12.5 per cent and 9.6 per cent respectively in 2005 compared with 2004 figures. Latest statistics (January 2006) from UCAS reveal that applications onto mathematics degree courses have increased by 11.5 per cent on the same time last year.

While the numbers accepted onto science, technology, engineering and mathematical degrees have increased overall, this increase is not evenly spread. While the numbers accepted onto physical sciences and engineering courses in 2005 increased slightly, there were large increases in chemistry and physics acceptances.

## Science and Engineering Ambassadors (SEAs) programme

The Science and Engineering Ambassadors Programme (SEAs) is managed and run by SETNET. It deploys role models into schools and plays a key role in the Government's overall strategy to increase the number of scientists and engineers in the UK workforce. "The great bit of working with schools is seeing the difference you can make in terms of inspiring children about the excitement and variety of an engineering career. It's a chance to explain the difference engineers make to everyone's quality of life, and why engineers of all kinds are so vital in achieving sustainability as well as economic success." Tom White, Chemical Engineer.

CASE STUDIES

# Science and Engineering Ambassadors

Tulay D'Silva is senior analyst in the Veterinary Residues Department of LGC's Analytical Laboratory in Teddington.

My work in the laboratory involves analysing for antibiotics in animal tissue, in kidney and muscle, for example. I manage a team of five people. My career has developed since joining the company and I am currently a senior analyst in the Veterinary Residues Department. My most notable achievement was receiving my 'Chartered Chemist' status three years ago.

### What is SEAs about for me?

The SEA scheme encourages young people at a very early stage to get into science by meeting 'real scientists'. Science Ambassadors and schools are brought together by SETNET (Science, Technology, Engineering & Mathematics Network), which helps with the application process and provides induction training.

### My experience as an ambassador?

SETNET brought me my first assignment at Norwood Green School, where I spoke to pupils, aged 6-7 years, during the school's Science Week. The kids were very excited to meet a scientist wearing a white coat and to hear about my work. I received a letter from the head science teacher and one from one of the pupils, thanking me for my efforts. It was very rewarding to know that I had had some input into the pupils' thinking about science.

### What next?

As a Science Ambassador, I am developing my communication and presentational skills and meeting other people involved in science, as well as helping to encourage youngsters to follow a scientific career.
I certainly have a lot of enthusiasm and passion to see children take a valuable role in the sciences.
I have already arranged to visit more infant/junior schools.

# Postgraduate Students and Research Careers

Postgraduate training and research career development are key aspects of the work of the Research Councils and their support for the UK research base. The seven grant awarding Councils all offer studentship funding, fellowships, as well as funding research staff who work on Research Council project grants.

## The Academic Fellowship scheme



The Academic Fellowship scheme was developed as part of the implementation of the recommendations of the Roberts' Review, with the aim of providing more attractive and stable paths into academic careers. These five-year fellowships, 1,000 over five years, provide a permanent academic position at the end of the award, subject to the performance of the fellow, along with training towards an academic position. The fellow must also undertake outreach activities, for example, into schools.

Two rounds of awards have been made, with nearly 2,000 applications for 800 fellowships. The fellowships were awarded to 79 universities, covering all fields of research.

Universities with Academic Fellows report that the scheme has been an effective tool for the development and career management of research staff. Many fellows are taking recognised qualifications in higher education teaching and supervision.

The model has proved so successful that some universities have established their own schemes to nurture the next generation of research leaders. The University of Liverpool, for example, has launched a ‘rising stars’ investment scheme. Through this it has recruited 14 researchers nearing the end of prestigious fellowships, with the guarantee of an academic post funded by the institution.

Another university reports that ”a network of Academic Fellows now meets regularly to support interdisciplinary working across the university”.

The scheme has enabled universities to improve interdisciplinary working, and fellows have been undertaking outreach activities, such as registering as Science and Engineering Ambassadors, supervising and mentoring individual students and visiting schools.

CASE STUDIES

## PhD stipends and researchers' salaries

The Research Councils have increased the stipends for PhD students and salaries for postdoctoral researchers. The minimum PhD stipend has increased from £6455 in 1998-99 to £12,000 in 2005/06: the average PhD stipend has increased to £13,000 in areas of recruitment difficulties. Postdoctoral researchers' salaries have increased by around £4000 between 2000 and 2005. These increases are focus on areas where there is difficulty in recruiting high quality students. There is early evidence that these changes have made an impact on recruiting and retaining researchers in academia.

# The National Academies: supporting researchers

The national academies - The Royal Society, The Royal Academy of Engineering and the British Academy - play a vital role in underpinning the UK's research base. They enhance the world status of the UK's research and of those who undertake it. The academies fund excellent individual researchers through a variety of schemes.

## The British Academy

### Postdoctoral Fellowships

The British Academy's Postdoctoral Fellowships provide career development opportunities to outstanding individuals who have recently obtained their PhD. The fellowships offer time to conduct and write up research, and gain experience of teaching in a university environment.

Of the 30 individuals that received awards in 2002 and completed their fellowship in 2005, 21 now hold permanent lectureships. Dr Holger Hoock, for example, was appointed to a prestigious position, not only as a lecturer in British Cultural History at the University of Liverpool, but also as a Vice-Chancellor's 'Future Research Leader'. One former Postdoctoral Fellow, Dr Angela Poulter, has chose to transfer the skills she has developed with the Academy's support to industry, and is now working as a heritage consultant for a major engineering firm.

The Royal Academy of Engineering (RAEng) and the Engineering and Physical Sciences Research Council (EPSRC) jointly offer Research Fellowships to outstanding researchers in engineering. These Fellowships promote excellence in engineering. They do this by providing support for high-quality engineers to encourage them to develop their interests in academic research as a stepping stone to a successful research career. These are prestigious awards aimed at outstanding researchers from all branches of engineering who are about to finish their PhD, or have up to three years' postdoctoral research experience.

CASE STUDIES

# The Royal Academy of Engineering
## Supporting individuals

### Dr Máire McLoone

I am currently in the third year of my EPSRC/RAEng Research Fellowship at Queen's University Belfast.

This Research Fellowship has been of immense benefit to me in the development of my research career. I have been able to travel extensively, to build collaborative links and to present my work at national and international conferences. Due to the reduced teaching hours, I have more time to conduct research and to become involved in other professional activities. I was selected as an evaluator for the European Union Framework Programme Marie Curie 6 schemes in 2005. This involved attendance at panel meetings in Brussels. I participated in the Britain's Younger Engineers event at the House of Commons in December 2004 and was awarded the Vodafone-sponsored section prize for my poster on 'Providing High-Speed Security'.

### Dr Ruth Wilcox

My Royal Academy of Engineering Fellowship at the University of Leeds is focussed on a new treatment for spinal fractures. The treatment, called ‘vertebroplasty,’ is a keyhole surgery technique that involves the injection of a cement material into the fractured vertebra. Vertebroplasty is used for the treatment of compression fractures of the spine. There are over 120,000 such fractures each year in the UK, commonly as a result of osteoporosis. However, there are several complications associated with vertebroplasty. My research is focussed on how the technique can be optimised to reduce the likelihood of these complications occurring.

During the Fellowship, I have been successful in obtaining a number of grants, which has enabled me to establish my own area of research, and I have developed several new national and international collaborations that have led to joint grant proposals and publications.

Royal Society University Research Fellowships provide outstanding scientists with the opportunity to build an independent research career. Those appointed are expected to be strong candidates for permanent posts in universities at the end of their fellowships.

# The Royal Society

## University Research Fellowships

Dr Cait MacPhee was awarded a Royal Society Dorothy Hodgkin Fellowship in 1999 when she was still a graduate research student. In 2002, Cait was awarded a prestigious Royal Society University Research Fellowship. Her research has investigated the structure and physical properties of amyloid fibrils - implicated as the material cause of a number of debilitating diseases such as Alzheimer's, Parkinson's and BSE. Her work straddles a number of fields, including biomedical research, protein chemistry, and soft matter physics.

Those who, like Cait, combine dedication to their research with entrepreneurial success and support for the Royal Society's broader aims of furthering the role of science in government and society are truly outstanding. For three years, Cait has served on the Royal Society's Education Committee, debating the future of the science curriculum, discussing issues with science teachers and proving that active scientists are willing and able to help shape the future of school and college education not just for those coming after them, but for the benefit of all.

The Royal Society: www.royalsoc.ac.uk

CASE STUDIES

# The Royal Society

## University Research Professors

The Royal Society Research Professorships are designed to enable individuals of the highest ability and achievement to undertake independent, original research at a UK university of not-for-profit organisation into any of the natural and applied sciences including medical and engineering science.

Professor Carol V Robinson took up her Royal Society Research Professorship earlier this year to work in the Department of Chemistry at the University of Cambridge, on "Defining molecular interactions in cells - new horizons from old tools".

Carol Robinson's personal odyssey and scientific career have been remarkable. She has made the transformation from an unqualified technician at Pfizer to a world leader in biological mass spectrometry.

After a brief spell as postdoctoral researcher, she had an eight-year career break to bring up three children. Carol returned to research to a Postdoctoral research appointment at the University of Oxford. In 1995, Carol was awarded a Royal Society University Research Fellowship providing support during 'a crucial period' of her research. Carol was appointed Professor of Mass Spectrometry in the Department of Chemistry at the University of Cambridge in 2001.

Professor Robinson became a Fellow of the Royal Society of Chemistry in 2000. In 2004 Carol won the Royal Society's Rosalind Franklin Award and in the same year became a Fellow of the Royal Society. Carol has been described as an outstanding role model and mentor for younger women scientists.

CASE STUDIES

# The Royal Society

## Industry Fellowships

The Royal Society's Industry Fellowships foster knowledge exchange between academia and industry. The Fellowships provide the chance for scientists in industry and academia to work for up to two years in the other sector. The personal and

corporate links forged help to provide a foundation for future collaborative development. The scheme is jointly funded with EPSRC, BBSRC, NERC, Rolls-Royce and Astra Zeneca.

Dr David Walker is a Royal Society Industry Fellow in the Department of Physics and Astronomy at University College London. He has devoted much of his academic career to developing processes for the automated manufacture of lens and mirror surfaces, and large optics for use in astronomy in particular. In 2000, he co-founded Zeeko Ltd, a spinout company to develop and market computer-controlled polishing machines that are based on these technologies.

Dr Walker's dual perspective as an academic and business owner has given him a solid appreciation of the extent to which innovation can flourish when academic scientists and their industry counterparts cooperate effectively.

"Initiatives like the Royal Society's Industry Fellowships and Innovation and the business of science course have an important role to play in bridging the gap between science and industry, and fostering innovation." Dr Walker says.

## Diversity in Science Engineering & Technology (SET)

A priority for the DTI in their ten-year vision is to foster cultural change that will value diversity, to challenge old establishment thinking and to operate positive policies and measures to maximise the contribution of women and people from black and minority ethnic groups in the SET workforce and in the governance of SET.

## Women in SET

The Government established the UK Resource Centre for Women in SET (UKRC) in September 2004. The UKRC works with British business to maximise the opportunities for professional women in SET and close the skills gap that is damaging UK competitiveness.

Over the past year, the UKRC has supported more than 200 women with science or engineering qualifications and is supporting a further 122 women in trying to find them work placements or training. The Centre has established links with over 250 companies. It has become involved with three employer awards and five networking schemes and have allocated nine grants and 26 bursaries.

## Return

More than 600 women with previous experience and qualifications in SET have been encouraged to return to careers in SET by the UK Resource Centre's RETURN campaign. The programme is set to reach its target of 1,000 women returning to SET over the coming year.

CASE STUDIES

## UKRC Return Campaign

**Juliet Jopson**

After completing a research degree in plant cell biology, Juliet moved into science communication and television work. Realising that she was taking more and more projects that weren't science based, she decided that she needed to refocus. Following a three-year career break to have her two children, Juliet started looking around for her next move.

Juliet had wanted to return to a career in science for some years; so when she saw the Open University's T160 course, for women returning to science careers advertised, she decided to go for it. The course wasn't initially what she was expecting, starting with exercises designed to review her past career history, but she found that learning lessons from the past has helped her design a plan for the future. “The course really helped me get back into thinking as a working person and not just a Mum”.

Juliet successfully secured a position in science communication, this time in the Plant Science Department at her old university, helping to promote plant science to undergraduates and supporting plant science lecturers. “It's an ideal job, sometimes its just luck finding something like this, but I'm sure the course helped me get it.”

# Black and minority ethnic groups in SET

A key priority for the Government is to encourage more participation from under-represented groups in Science, Technology, Engineering and Maths (STEM). The Government recognises that certain ethnic groups are under-represented in the scientific workforce and is committed to tackling this at all levels.


The minority ethnic population in the UK has increased significantly over recent years, from only 1 million three decades ago to 4.6 million in 2005 and represents 7.9 per cent of the total population of the UK. However, numbers in SET careers remain very low. Recent research such as the Institute of Employment Research (Warwick) report for the Royal Society (RS) *'Science Engineering and Technology and the UK's Ethnic Minority Population'* suggests that the picture is complex.

Launched during National Science Week 2006 the Black and Minority Ethnic (BME) programme has funded extra-curricular science learning activities in 38 schools. Projects will provide case studies to allow dissemination of "lessons learnt" and of "good practice".

A second round of funding was announced in September 2006, with projects starting in 2007.

CASE STUDIES

# Management of technology and innovation

Students on six new Masters programmes - developed at Cambridge University with the support of the Cambridge-MIT Institute - have made a very favourable impression on their host companies while undertaking consultancy projects.

These MPhil programmes all combine a base in science or engineering disciplines with teaching in entrepreneurship and management. They range in focus from BioScience Enterprise to Technology Policy and Engineering for Sustainable Development.

Students on these Masters programmes participate in a core module on the Management of Technology and Innovation (MoTI) taught at Cambridge University's Judge Business School. As part of this module, students undertake a six-week project, working on a real business issue for a real business client.

To date 40 companies, ranging from start-ups to multinational corporations, have worked with over 300 Masters students. BT's Innovation Central received five students from the MPhil Chemical Engineering Practice, and were delighted by the calibre of their contributions.

MoTI students were drafted in to assess how effective Innovation Central had been in creating and delivering BT's innovation strategy. Because the students had no previous involvement, their insights were completely new. They built up comprehensive case studies on BT's innovation projects which the company plans to use to describe the work Innovation Central does for potential clients.

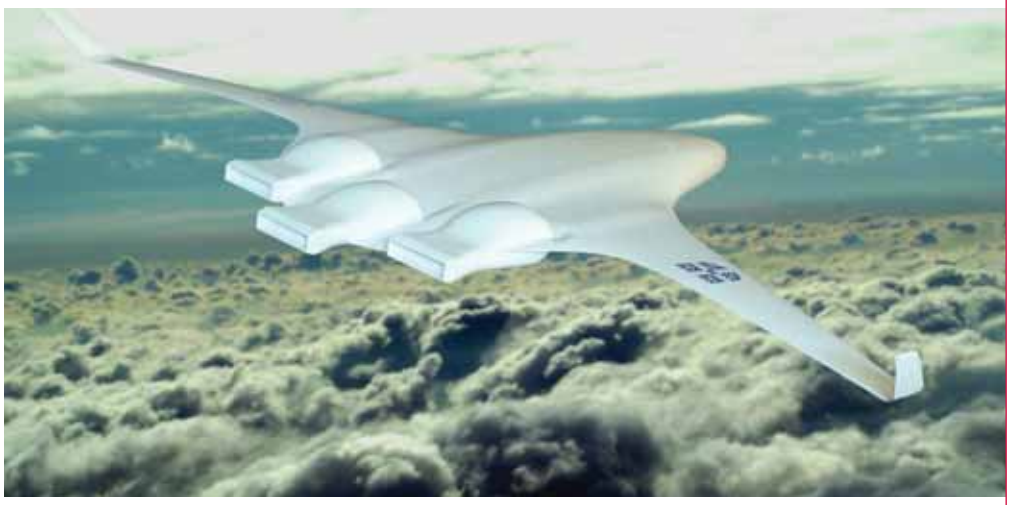
The Cambridge-MIT Institute: www.cambridge-mit.org

# Silent aircraft

## Cambridge-MIT Institute

Aviation is important to the British economy, adding £10 billion to the UK's GDP and supporting thousands of jobs. But at the same time, aircraft noise pollution severely impacts the quality of life of residents living near airports. Reducing this noise is essential if the air travel industry is to maintain its expected growth.

The Silent Aircraft Initiative of the Cambridge-MIT Institute has responded to this challenge by bringing together researchers at the University of Cambridge and the Massachusetts Institute of Technology in a collaboration with Rolls-Royce and Boeing, airports and airline operators, the Civil Aviation Authority, National Air Traffic Services, equipment manufacturers, Cranfield University and many others.

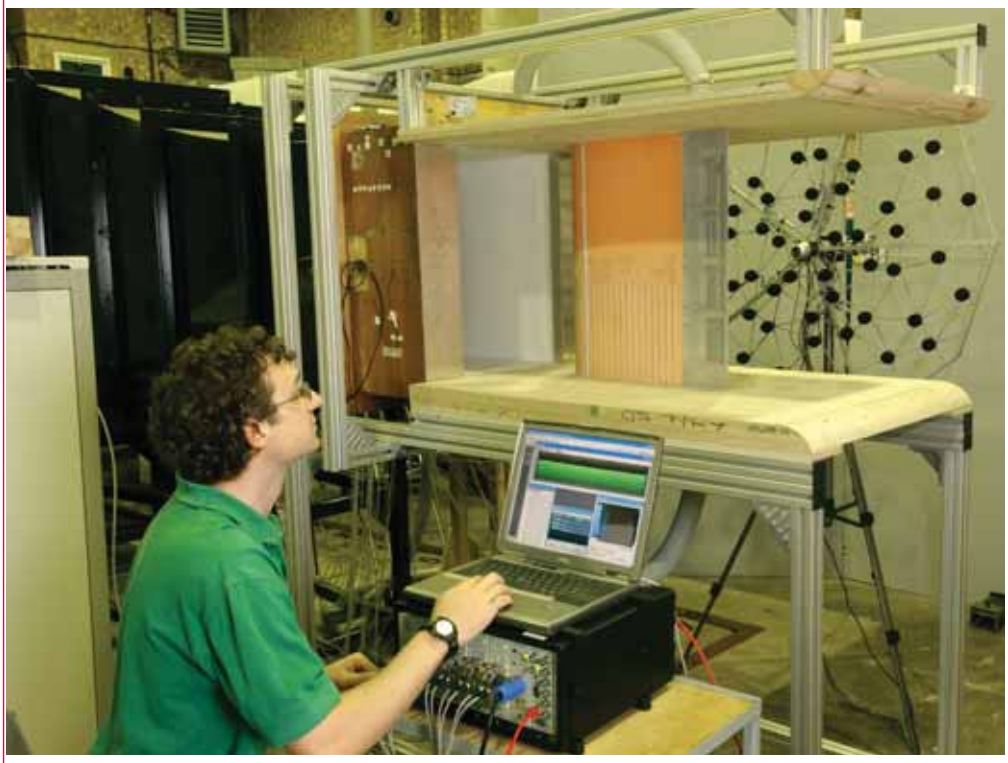


Researchers are working on conceptual designs for a ‘Silent’ Aircraft that would be imperceptible in the typical built-up environment outside of an airport. They are testing the feasibility of the new technologies required to make this aircraft a reality, looking at materials, engines, aerodynamics and other significant factors.

The Silent Aircraft Initiative also addresses growing concerns about the future supply of scientists and engineers in the UK by engaging with students from The Perse School in Cambridge.

Twenty-three pupils from Year 8, accompanied by their technology teachers, visited Cambridge 's Engineering Department to test their ideas for making a passenger aircraft fly more quietly. They took with them model ”fairings,” or shields, that they had designed in

their technology lessons. These enclose an aircraft's undercarriage to cut down the noise produced during approach and landing. During their visit, they got the chance to test their models in the university's Markham wind tunnel to see what effect they would have on noise levels. The students also visited a smoke tunnel, enabling them to see how an aircraft wing creates eddies and turbulence as it cuts through the air at high speed.



The visit was a great success: the hope is that activities like this will encourage future generations into taking up careers in science and engineering.

The Cambridge-MIT Institute: www.cambridge-mit.org

CASE STUDIES

# Entrepreneurship Centre Imperial College London

## Imperial College

'Tanaka Business School's Entrepreneurship Centre was launched in January 2001 to foster the entrepreneurial spirit at Imperial College. Since then, it has gained a strong reputation for the teaching and practical application of entrepreneurial ideas, focusing on new-venture creation in technology sectors:

- its courses range across undergraduate & postgraduate programmes, and it runs workshops for colleagues wishing to spin businesses out of Imperial
- since 2004, in collaboration with Imperial Innovations - the College's technology transfer office - Tanaka's MBA students have conducted commercial feasibility studies on live early-stage College technology
- the Centre's fellowship schemes allow science, engineering & design postgraduates into the MBA classroom informally to incubate their ideas alongside experienced business executives
- its College-wide business plan competitions (with a total prize fund of £55,000 in cash & services) capture the quality & range of innovation generated across the faculties and help to launch real businesses
- in 2006 it inaugurated Idea to Product Europe, the first pan-European technology commercialisation competition, with entries from Dublin, Aachen and Stockholm as well as Imperial itself.

Entrepreneurship Centre, Imperial College:
www3.imperial.ac.uk/entrepreneurship

CASE STUDIES

# Nanotechnology

## Informing policy through understanding public aspirations and concerns

To ensure the responsible development of nanotechnologies - those at a very small, atomic, scale - the Government is committed to promoting constructive dialogue on the health, safety, environmental, ethical and regulatory implications.

To establish what was known about the potential opportunities and risks, the OSI asked the Royal Society and the Royal Academy of Engineering to analyse the issues and to begin to seek the public's views.

Using their report as a basis, the Government has put in place a programme of public engagement, coordinated by the Nanotechnologies Engagement Group (NEG) project funded through the OSI's Sciencewise programme. NEG is actively built into the process whereby Government departments, regulators and Research Councils shape policy in this area.

The Nanodialogues project was the first focused nationwide public engagement project funded by Government bringing citizens and scientists to discuss applications of nanotechnologies, starting with the clean-up of contaminated land.

The UK is leading the way in this area, and we remain committed to enabling constructive dialogue between citizens and experts on this exciting area of technology. Only in this way will we maximise the opportunities and minimise the downsides of what has been called the "next industrial revolution".

CASE STUDIES

## National Science and Engineering Week

### An inclusive, nationwide celebration of science and its importance in our lives

National Science and Engineering Week is a public celebration, presentation and discussion of the sciences and engineering. Coordinated by the British Association for the Advancement of Science (BA) on behalf of the DTI, the Week consists of a widely diverse range of events, targeted at many different audiences and taking place in mid-March each year.

Organisations such as research institutes, university departments, science-based businesses, museums, art galleries and schools put on events for local audiences, while at a national level the BA and partners organise specific high-profile initiatives. The aim is to stimulate and support scientists, engineers and others to engage as large and wide a public as possible with science, engineering, technology and their implications.

National Science Week, as it was called in 2006,

saw the start of a new focus for the BA on climate change. In all, the BA estimated that there were well over 2,000 events and 660,000 participants - reflecting a steadily increasing trend over the last four years.

Awareness of National Science Week was tremendous in 2006. Not only did it attract huge additional numbers to the BA website, doubling last year's totals to well over 200,000 in March, but also awareness as measured by the NOP omnibus poll started at around 30 per cent of the UK population before and during the event, rising to 37 per cent after the event, indicating an increased level of awareness for the first time, following the publicity campaign.

In 2007, to celebrate the vital contribution that engineering makes to society, National Science Week, will be re-named National Science and Engineering Week. The BA has worked with the Engineering and Technology Board (ETB) to enhance the programme with the addition of around 500 engineering-focused events.



## ACKNOWLEDGEMENTS

DTI wishes to thank all those who have contributed case studies for use in this publication. Also to the following who have provided the images used throughout the text.

*AHRC, Alamy Ltd, Institute of Physics, University of Bath, Aston Academy of Life Sciences, CEH, NERC, Cardiff University, BBSRC, the Cambridge-MIT Institute, Monica Healthcare Ltd, Begbroke Science Park at the University of Oxford, IC Cave, University of Abertay, SEEDA, Isis Innovation at the University of Oxford, Andor Technologies PLC, Getty Images, SULIS, AHRC, NHS Innovations North, CCLRC, Offshore Hydrocarbon Mapping, Wolfson Microelectronics, 8inch, Advanced Manufacturing Research Centre, Sheffield, Birkbeck College, National Oceanography Centre, Southampton, Sage Group plc, National Physical Laboratory and Willis Research Network.*

# NOTES

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December 2006. Printed in the UK on recycled paper containing a minimum of 75% post consumer waste.
First published November 2006. Department of Trade and Industry. www.dti.gov.uk
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