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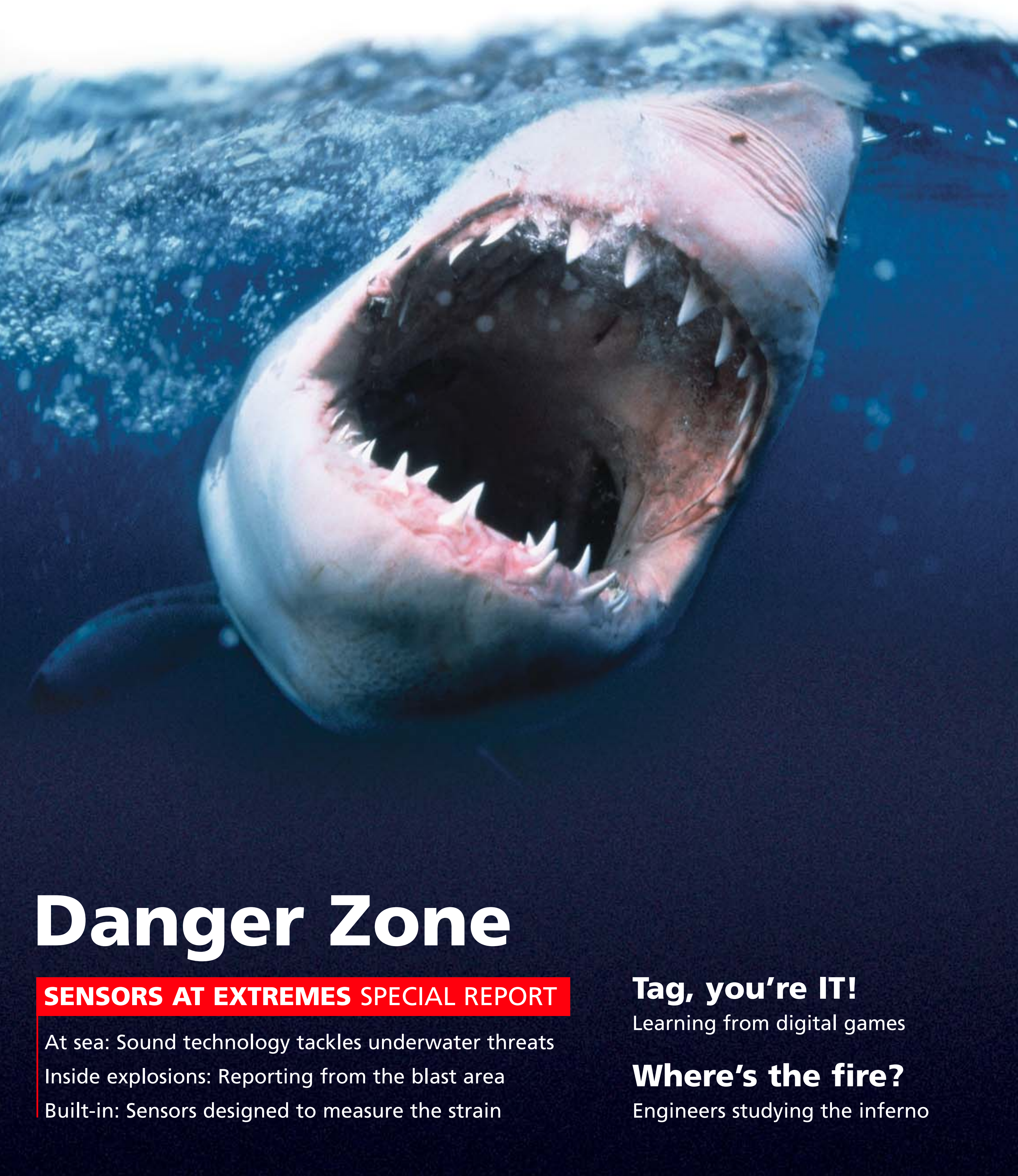
newsline



Danger Zone

SENSORS AT EXTREMES SPECIAL REPORT

At sea: Sound technology tackles underwater threats

Inside explosions: Reporting from the blast area

Built-in: Sensors designed to measure the strain

Tag, you're IT!

Learning from digital games

Where's the fire?

Engineers studying the inferno

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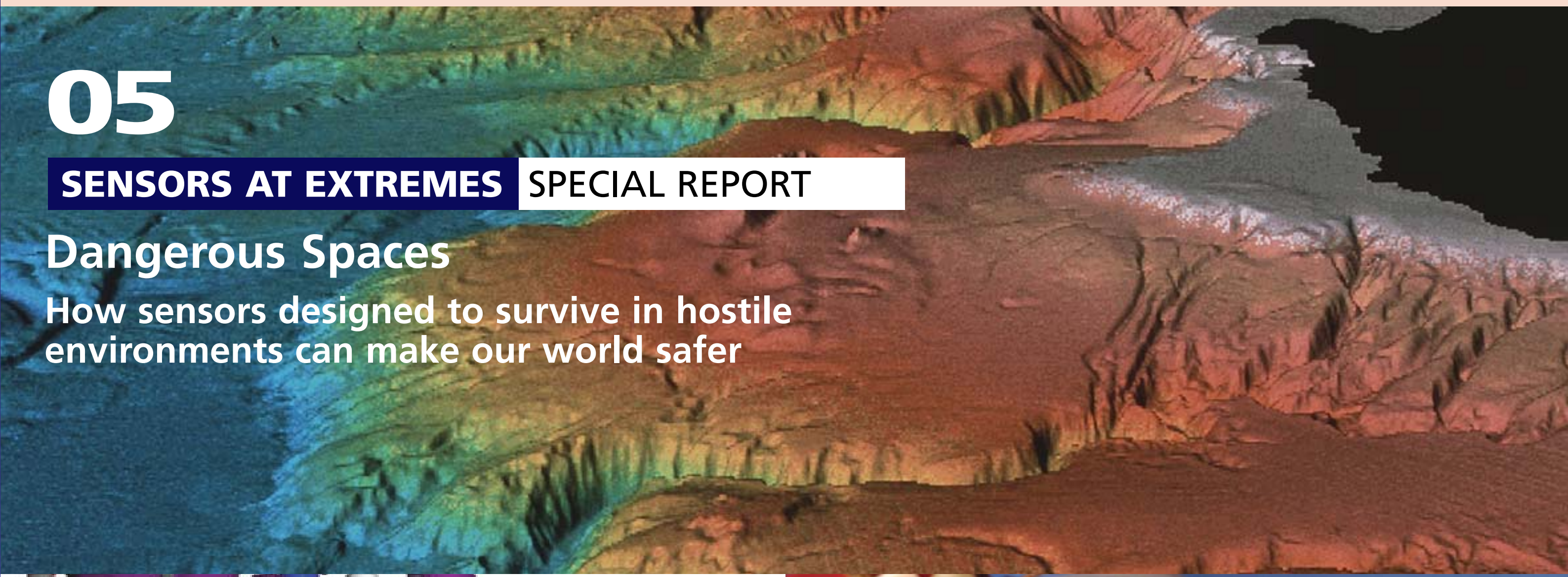

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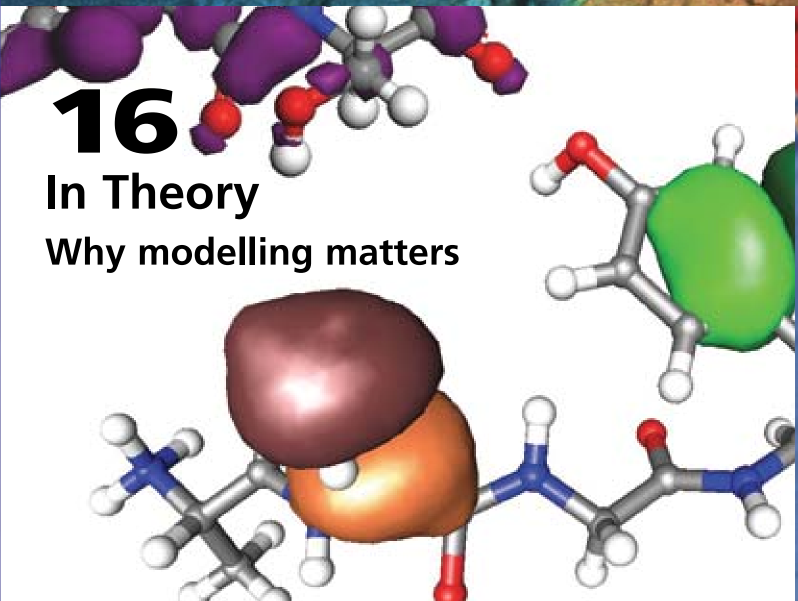
SENSORS AT EXTREMES SPECIAL REPORT

Dangerous Spaces

How sensors designed to survive in hostile environments can make our world safer



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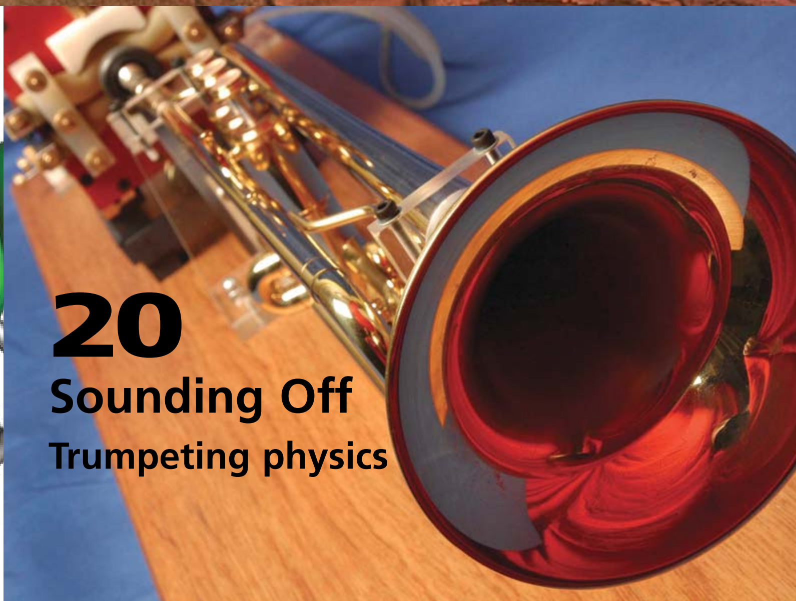
In Theory

Why modelling matters



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Sounding Off

Trumpeting physics

Walkabout: Making environments safer and more accessible could encourage more children to travel on foot.

Getting Kids Active

Research into how children use their local environment could help us to give them a healthier lifestyle.

Parents, doctors and even the Government are worried about childhood obesity and a generation shunning physical activity. Now new EPSRC-funded research will study children's behaviour and perceptions in an effort to understand how children currently use the local environment and what can be done to make it easier and safer for them to move about on foot. "There is clear evidence from the National Travel Survey that children are walking and cycling less, largely due to increased car use," says Professor Roger Mackett who is leading the CAPABLE (Children's Activities, Perceptions and Behaviour in the Local Environment) project alongside Professor David Banister, Professor Mike Batty and Dr Dorothy Einon at University College London.

CAPABLE builds on an earlier EPSRC-funded project focusing on reducing children's car use: "Our previous work showed that walking can make a very useful contribution to children's daily physical activity," Professor Mackett explains, "from this we came up with the idea of looking at how the local environment influences children's behaviour and affects parental attitudes to their children's travel, and to incorporate these into pedestrian modelling." CAPABLE will combine surveys carried out through schools in Hertfordshire with travel and activity diaries kept by children and data from Global Positioning Satellite (GPS) equipment and three-dimensional accelerometers worn by the children. Using GPS for such a study is quite a challenge: "We shall need to store the data over four days in the GPS monitors which obviously have to be lightweight since children will be wearing them," Professor Mackett explains, "we have already found equipment that meets our needs but we are very much at the forefront of using it in this way. It raises a number of interesting issues about how we can maximise the amount of useful data we can collect within the constraints of what we can reasonably ask of the children."

There is also work to be done on analysing the two-dimensional GPS data and linking this to the integrated travel diary/motion sensor information. Professor Mackett concludes: "We hope to establish a much better understanding of how children use the local environment, why they do not go to certain places, the barriers that need to be removed to help them be out being more active, and so contributing further to the debate on children's physical activity and obesity." Work on CAPABLE begins in August in partnership with Hertfordshire County Council, Groundwork UK and the National Children's Bureau.

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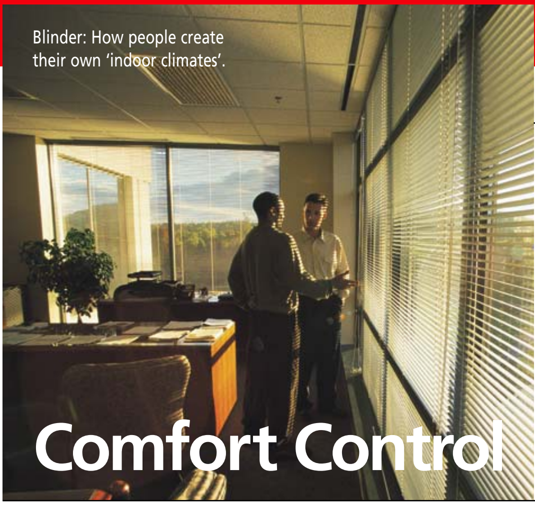

Blinder: How people create their own 'indoor climates'.

Comfort Control

New EPSRC-funded research will simulate how people alter 'indoor climates' by opening windows, closing blinds and turning on fans and lights. People use such actions to regulate conditions in most buildings but little is known about how they combine to affect energy use and occupant comfort. Scientists from Oxford Brookes and Strathclyde Universities will combine information about behaviour in buildings with dynamic building simulations to predict how human actions affect the risk of future discomfort and range of energy use in 'naturally ventilated' buildings.

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Modelling for Fusion

The materials needed to build future fusion power plants are being modelled as part of an EPSRC-funded project at the Universities of Oxford, Liverpool, Cambridge, Edinburgh, Queen's University Belfast and UKAEA Culham. The new research will examine the behaviour of materials such as vanadium, tungsten and iron-chromium alloys, on which structural alloys for fusion reactor components are likely to be based. It is hoped that computer modelling techniques will lead to a better understanding of the microstructure, flow and fracture behaviour of such materials, and their response to irradiation.

This project, which starts in October, will be closely linked to an experimental programme funded by UKAEA Culham.

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Technology at Home

How can we design computer technologies that people trust and enjoy? This is just one of the questions being addressed by a new study starting at the University of York. The EPSRC-funded project will develop theories and tools to help designers understand users' needs, expectations and experiences of technology. These will analyse how people interact with technology in the home and what they want from leisure, domestic and ubiquitous computing technologies in the future. This three-year project involves industrial partners Hewlett-Packard Ltd, Sapient Ltd and Image Semantics.

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@Home (right): Discovering what we want from future technologies.

Good to Glow

Chemists researching new ways of producing tiny particles could have a big impact on the biological and medical sciences. Researchers at the University of St Andrews are studying how nanoparticles of the light-emitting compound indium nitride could be synthesised and optimised for use as 'fluorescent tags' for highlighting processes and features within biological systems. The aim is to create particles which luminesce at different wavelengths across the visible and near-infrared part of the spectrum. Inidum nitride nanoparticles promise to be more stable than the organic flurophores and much less toxic than cadmium selenide currently used in tagging.

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Quantum Bandwidth

The physical limits of communication will be explored during an EPSRC Postdoctoral Research Fellowship. The project will examine the maximum rates that information can be transmitted using quantum systems. Specifically it will examine the communication of intact quantum states (such as 'entangled' photons) regarded as the building blocks of quantum cryptography and future quantum computing technologies. The work will take place at the Centre for Quantum Computation at the University of Cambridge.

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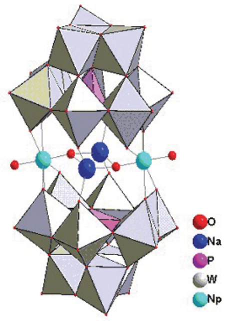
Actinide Action



Elementary: Creating and studying actinide compounds.

Improving our understanding of the chemistry of the radioactive actinide elements could help us to discover novel disposal methods for uranium and plutonium. New EPSRC-supported research, bringing together experimental expertise from the University of Manchester and computational expertise from University College London, aims to increase our understanding of actinide chemistry. Research will use state-of-the-art experimental facilities at Manchester, in collaboration with groups in France and the USA, to safely synthesise novel complexes. Modern computational techniques will be employed at UCL to study the bonding of these newly created actinide compounds.

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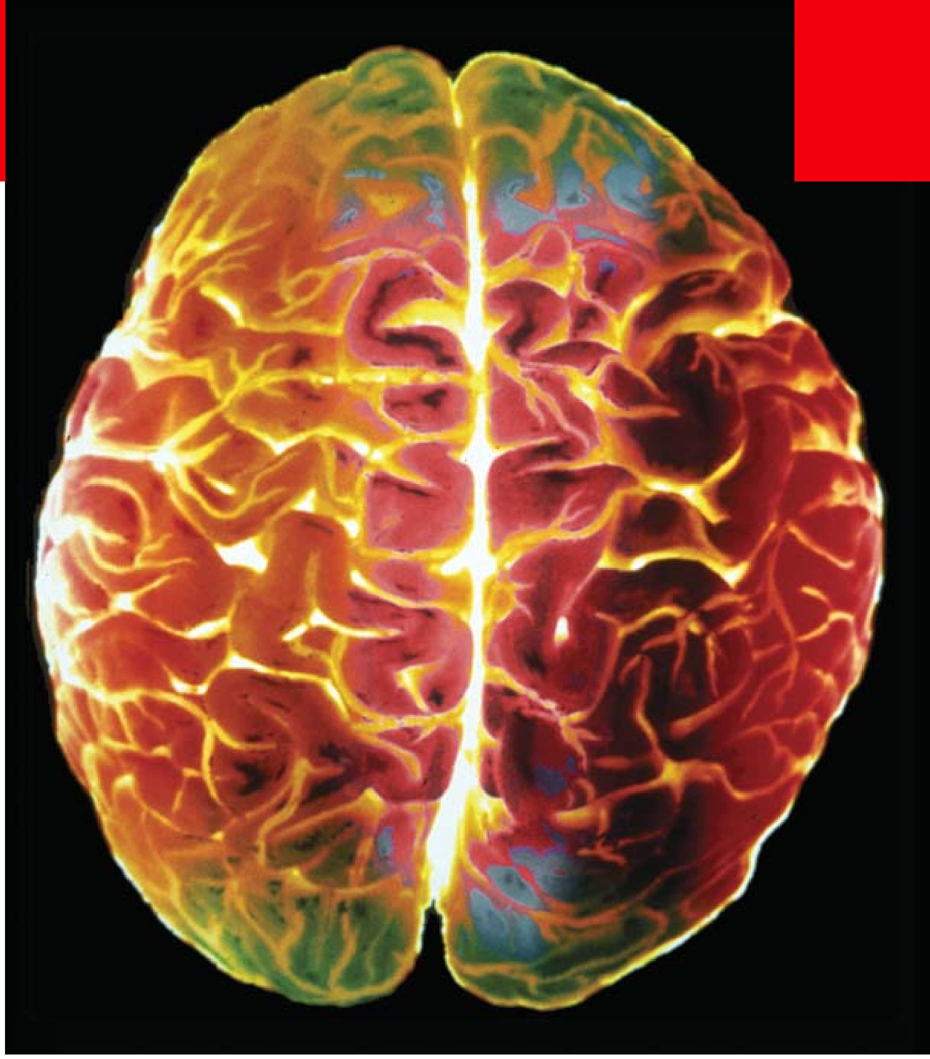
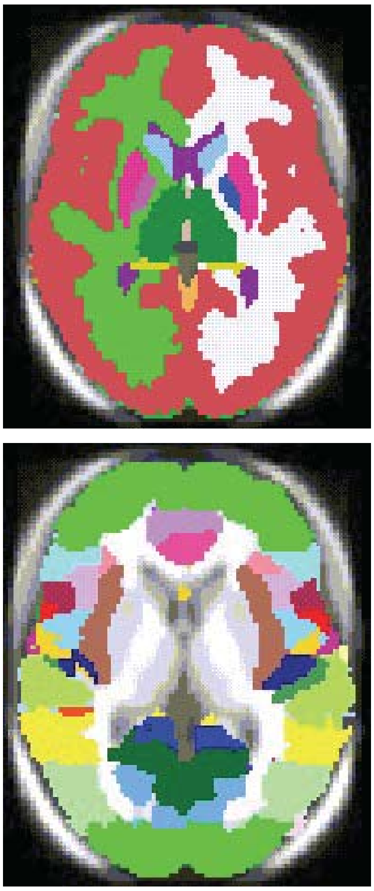
Picturing the Brain

Patients stand to benefit from integrated modelling.



A new system to analyse magnetic resonance images of the brain could help to predict the onset of Alzheimer's disease and aid in the search for the causes of schizophrenia. "The information contained in magnetic resonance images of the brain is so rich that current methods of image analysis are unable to efficiently extract this information in a quantitative fashion," explains Dr Stephen Smith, who is leading the EPSRC-funded project at the University of Oxford.

The new system would automatically identify and outline each brain substructure and tissue type "more importantly it would also quantify how different brain structures relate to each other in terms of position, size and shape," comments Dr Smith. He adds that understanding these relationships is likely to be highly valuable as neuroscientists attempt to find, for example, brain development markers of schizophrenia.



Right: New systems could automatically interpret how brain structures, shown on magnetic resonance images, relate to each other.

Over the last 20 years the analysis of brain images has grown increasingly sophisticated. Most techniques are highly specialised and have been developed for asking particular questions of particular diseases or patient groups. Such techniques tend to use low-level analysis tools that each look for different things: These can be loosely categorised as 'registration' (alignment of images, for example from different subjects), 'segmentation' (tissue-type classification or structure identification) and 'shape modelling' (how brain structures vary over time or across a population). "These techniques are limited," says Dr Smith, "because potentially interacting processes are considered as separate problems. We believe that it is necessary to take a much more fully integrated approach to these analysis problems."

An integrated approach to the problem of the alignment, classification and statistical modelling of brain images in healthy and diseased populations is, Dr Smith believes, the best way forward. "It promises to answer some of the complex questions asked by clinical researchers such as "how can we use measures of brain structure and function to better evaluate drug treatments?" and "how can we predict the onset of Alzheimer's at an early stage to initiate preventative drug treatments?" he comments. Researchers on the recently-funded project, called 'IBIM: Integrated Brain Image Modelling', are all part of the EPSRC/MRC Medical Images and Signals Interdisciplinary Research Collaboration.

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By Kate Ravilious

Feeling the Strain

Hazardous environments are all around us: They can be found inside our bodies, deep underwater or at the heart of engines and explosions. Designing sensors that can function in these dangerous places may be the key to making our world a safer place. In the first part of our special report on sensors *Newsline* looks at everyday structures under extraordinary conditions.

Crrrrunch! Once again a truck has crashed into a railway bridge. Luckily no one is hurt, but thousands of people are delayed in their journey to work. Traffic has to be diverted and trains cancelled, while engineers are called out to inspect the bridge and check that the structure hasn't been weakened. This kind of accident is all too frequent on Britain's crowded transport network and the resulting delay is a major cause of traffic jams and cancelled trains. But soon cars and trains may be able to avoid some of these lengthy tailbacks, thanks to a special new sensor that can continuously monitor the state of a bridge and provide instant feedback after events such as traffic accidents, earthquakes, ground subsidence or extreme weather.

An EPSRC-funded team headed by Dr William Boyle, from the School of Engineering and Mathematical Sciences at City University in London, has been experimenting with fibre optic technology to develop sensors for engineering environments. Working in collaboration with researchers at Cranfield University and with a number of industrial partners, as part of the Intersect Faraday Partnership, they have created fibre optic sensors that can be placed in environments that have never been monitored before. ▶

A truly extreme test: A Sherman tank is driven over Westmill Bridge, a state-of-the-art structure into which 40 fibre optic sensors have been incorporated. The sensors will continually monitor the strain the bridge is under during traffic flow and any extreme events.

Image courtesy of the ASSET project.

From oilrigs to aeroplanes and bridges to furnaces, many structures need to be monitored to ensure that they are still strong and capable of doing their job. Measuring properties such as strain, temperature and pH can provide an indicator of how a material is wearing. But finding sensors that can withstand the harsh conditions in some of these environments is a tricky problem. Traditional sensors make use of the way that electrical properties respond to strain, temperature or pH. For example a strain gauge measures changes in electrical resistance in a wire to estimate how much the wire (and hence the material around it) is being stretched or compressed. However these wire-based sensors are vulnerable to chemical corrosion and susceptible to electromagnetic interference and this makes them unsuitable for many engineering environments.

"Each sensor is a bit like a mirror that reflects light and then looks for changes to the wavelength of the light." Dr Yonas Gebremichael

Instead, Dr Boyle and his colleagues at City University have been working with fibre optic cables to develop a sensor that is based on changes in the properties of light. Unlike the electrical currents in traditional sensors, light is immune to electromagnetic interference. What is more, fibre optic cables are extremely tough compared to metal wires, making them ideal for some of the extreme environments that engineering sensors have to be placed in.

Fibre optic cable sensors work by continuously assessing the wavelength of light passing down the cable. Each of these tiny sensors (no thicker than a human hair and about 1cm long) is embedded into the material they are monitoring. If the material is stretched or heated then the sensor feels this too. These physical shape changes in the sensor alter the way that the light travels down the fibre. Engineers can monitor how the light changes and extrapolate this information back to estimate how the material has deformed. A device called a 'Bragg grating' is inserted into the optic fibre and this provides a measure of the disturbances to the fibre. "Each sensor is a bit like a mirror that reflects light and then looks for changes to the wavelength of the light," explains Dr Yonas Gebremichael, a member of the City University team. The Bragg grating can be used to measure micron-scale changes in the length of the fibre, fluorescence characteristics and wavelength response. An engineer can then interpret this information to assess the state of the material that the optic fibre is surrounded by.

Reaching the inaccessible

Until now there was no way that engineers could continuously monitor structures such as bridges. Conventional strain gauges tend to suffer from hysterisis from repeated heavy loading and don't bounce back to their original shape and size, meaning that they wear out quickly. "Optic fibres are completely reversible so that when the strain or temperature is reversed to its initial point, the wavelength shift reverses back to where it started from," says Dr Gebremichael. Another major advantage of the optic fibre sensors is their ability to 'multiplex'. This means that sensors that respond to different wavelengths of light can be strung out within a single optic fibre, to give more than one sensor per cable. By comparison, conventional strain sensors require an individual wire leading to each sensor, making them much more difficult and time-consuming to install. In addition, optic fibre sensors have the ability to transmit signals over huge distances with no loss in signal power, making them perfect for remote and inaccessible locations.

For the first time ever, it is now possible to incorporate sensors into a bridge and receive continuous feedback about the state of the bridge. This means that after high winds, or a minor accident, civil engineers can make an accurate assessment about the structural integrity of the bridge, without having to visit the bridge. In most cases engineers will now be able to re-open a bridge very soon after an accident and ensure minimum disruption to the transport network. As part of a pilot study, the City University team worked with civil engineers at Mouchel

Parkman, and fibre optic instrumentation experts at EM Technology to test the optic fibre sensors in Westmill Bridge, a 'state of the art' road bridge that was being built near Shrivenham in Oxfordshire.

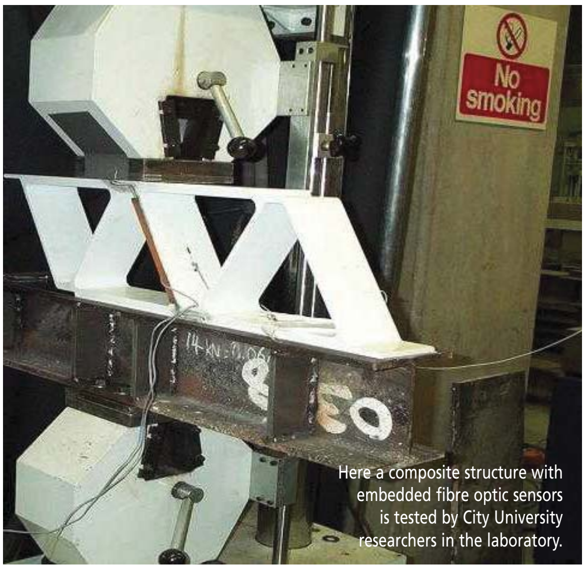
During the bridge construction, 40 fibre optic sensors were inserted into the ten-metre stretch of fibre polymer composite making up the bridge. "Polymer composites are frequently used in the aerospace industry, but this is the first time that a bridge has been made from polymer composites in Europe. It was an ideal opportunity for us to test fibre optic sensors in this type of material," says Professor Bev Meggitt from EM Technology. Currently the team is setting up a pill box next to the bridge to receive the data from the sensors and upload it onto a web-page. Soon these sensors will be keeping a continuous eye upon the strain that the bridge experiences as the traffic flows over it. The intention is that the sensors will last for the lifetime of the bridge, providing information about the wear and tear of the structure as well as its response to bumps and bashes from cars and lorries.

While a Sherman tank crossing a bridge is unusual, 'bridge strikes' in which vehicles collide with road and railway bridges are, unfortunately, all too common. Fibre optic sensors would be able to tell engineers almost immediately whether bridges were safe after this kind of accident.

Data at your wing tips

Once these sensors have proved their worth in the Westmill Bridge there is exciting potential for them to be used in more extreme locations. For the aerospace industry these lightweight and robust sensors could provide the perfect solution to monitoring the vibrations in an aircraft's fibreglass wing, or watching for wobbles in a space shuttle's outer shell. What is more, the data from the sensors may also help scientists to better understand how materials interact with their environment. For example, strain sensors on an aircraft wing could unravel some of the mysteries about how turbulent-air flows around a wing and how different weather conditions can alter this airflow. Back down on the ground, the steel company, Corus, is considering using fibre optic sensors in their cranes to measure the strain as a crane moves heavy objects such as iron cores. They are also interested in monitoring the searing temperatures in the lining of blast furnaces, to test how the lining is wearing. Working under the umbrella of the Intersect Faraday Partnership has enabled academics to put their heads together with different industries to apply new research and technology to solve some real-world problems. "Together we have developed an engineering solution to an industry-wide problem," says Dr Gebremichael. The field trials are already demonstrating the success of the project and now the European Union is interested in using them on all European railway bridges. For fibre optic sensors it is Europe today, the World tomorrow and maybe even outer space one day. ■

Left: Final testing on the sensing system and sensors in preparation for the Westmill Bridge field trials. The City team (left to right): Dr William JO Boyle, Dr Brett McKinley and Dr Yonas Gebremichael.



Here a composite structure with embedded fibre optic sensors is tested by City University researchers in the laboratory.

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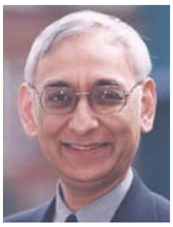
By Michelle Knott

Inner Space

For sensors implanted in the human body this inner space is a hostile environment. As soon as these detectors arrive they are plunged into a sea of bewilderingly-similar compounds and are in perpetual danger of being buried under a torrent of molecules and proteins. Yet if we can create biological sensors able to survive these harsh conditions the benefits will be immense.

In the bizarre world of 1960s science fiction films, the failure of conventional medicine to cure a prominent scientist leads to the next obvious choice – shrinking a team to microscopic size and injecting them into the unfortunate patient. Based on a book by Isaac Asimov, *Fantastic Voyage* (1966) may be utterly daft yet the idea of implanting small devices that can help patients from the inside out is a powerful one. No one is suggesting that miniaturised medics are on the agenda but, as Director of the Biomedical Materials Interdisciplinary Research Centre (IRC) at Queen Mary University of London (QMUL), Professor Pankaj Vadgama devotes much of his energy to developing better biological sensors that will be able to withstand the difficult conditions inside the human body.



"The key advantage of implantable, miniature and continuous reading biosensors is that they provide an ongoing flow of biochemical data."

Professor Pankaj Vadgama

The IRC was founded in 1991 with the help of an EPSRC core grant, and the Research Council has been supporting its work ever since. Professor Vadgama took over as director in 2000 when his predecessor, Professor Bill Bonfield, moved to Cambridge. As well as biosensors, the Centre is known for its work on dental biomaterials, musculoskeletal mechanics, hard tissue replacement materials and engineering soft tissue such as cartilage.

Operating inside the human body presents big challenges for any sensor but the potential benefits are worth it. "The key advantage of implantable, miniature and continuous reading biosensors is that they provide an ongoing flow of biochemical data along with information about short term variations," says Professor Vadgama. "This continuous knowledge is not possible using intermittent blood measurement." In diabetes, for example, problems such as eye damage and poor circulation are the long-term result of numerous short excursions from stable blood glucose levels. An in vivo ('in body') glucose monitor could notify the patient the moment their glucose levels reach troublesome levels, allowing them to manage their condition much more closely. Critical care medicine and surgery are among the other applications where continuous in vivo monitoring could show big benefits. In critical care, sensors could check oxygen, pH and carbon dioxide levels in the blood, as well as lactic acid and pyruvic acid, which indicate tissue damage. In some cases, sensors could measure the local condition of tissue rather than blood chemistry, so they

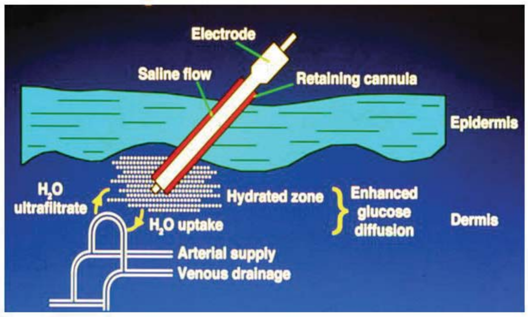
could monitor the health of a particular organ, for example, following a transplant or other surgery.

In harm's way

However, getting reliable results from in vivo sensors isn't easy. "The big problems are fouling and selectivity," says Professor Vadgama. Fouling – in which cells or proteins build up on the surface – interferes with the sensitivity of devices in an unpredictable way and can make readings unreliable. Selectivity relates to the ability of sensors to distinguish between the compounds they're looking for and the innumerable other compounds in complex biological fluids that can lead to false or artefactual readings, which are potentially dangerous in applications where the sensors are being used to manage clinical conditions. Implanting a device will also spark an inflammatory or wound healing response from the surrounding tissue, and this can distort readings in the short term. In the longer term, a fibrous capsule can grow around the implant, masking it off from the rest of the body. In the case of vascular implants, there is also the potential for a blood clot to form around the device. Such dangerous clots could break away and block vessels elsewhere in the body. On the positive side, a response from the immune system isn't usually a problem, provided that any antigenic (immune-triggering) chemicals used in the sensor are masked off from the surrounding tissue by a membrane. Even so, inflammatory cells may produce chemicals or enzymes that degrade some of the materials in the biosensor.

With all these issues in mind, much of the biosensor work at the IRC focuses on designing membranes that will screen off the sensor probe from potential contaminants while allowing the molecules of interest, or analytes, to pass. Biosensor probes are typically coated in a biological molecule such as an antibody or enzyme, which selectively binds to the analytes. This results in a measurable optical or electrical change. Some versions also include chemical components that send electrons from the enzyme back to the underlying electrode surface. Although antibodies are useful tools for lab-based tests, they usually can't be used for continuous in vivo sensors because the binding reaction with the analyte is irreversible and quickly uses them up. "Such sensors are reported," says Professor Vadgama, "but a continuous readout of the analyte is really not possible, since the response does not reverse by itself." In vivo sensors must instead rely on enzymes such as glucose oxidase, which can be used to monitor glucose levels in the blood of diabetics.

Open Microflow



Marvellous membranes

As well as outer membranes to mask off the sensor probe and control the rate of analyte entry to the sensor, biosensors from QMUL also use ultra-selective membranes between the enzyme layer and the underlying surface of the probe. These prevent unwanted components in the fluid from reaching the sensor and reducing its selectivity. Some outer membranes allow the analyte to pass via discreet holes, while others allow it to diffuse through their general structure. They also need to be biocompatible in order to minimise fouling. Professor Vadgama and his colleagues have worked on a range of membranes at the IRC, including organosilane and microporous membranes with a diamond-like coating, coated PVC and cellulosic membranes, among others. He says that designing membranes is something of a departure for the medics on the team. "The study of membranes borders on materials science," he says. For example, one collaborative project uses nanoscale indentations to gauge how hard the surface of a membrane is. It is hoped that this may give the researchers a tool to predict how cells will respond when in contact with the membranes. Another new capability involves microfluidic hydration of tissue, which dramatically stabilises the operation of glucose sensors.

According to Professor Vagdama, today's biosensors are not yet robust or reliable enough for general use. He believes the way forward lies in finding better ways to prevent fouling, such as improved membranes and the Centre's patented Open Microflow system, which reduces fouling and also helps analyte to reach the sensor more easily. "In my view, the next generation of devices to fully overcome problems of reliability and stability is still five to seven years away," he says. It seems our fantastic voyage into the body may have to wait a little while.

Contacts

For more on the work at QMUL visit www.irc-biomed-materials.qmul.ac.uk/index.htm or e-mail Professor Pankaj Vadgama at p.vadgama@qmul.ac.uk

By Pete Wilton

Sounding the Deep

Left: An ultrasound image of the seafloor off the coast of California: Advanced ultrasound transmitters (transducers) would enable even more detailed surveys of the seafloor as well as better detection of underwater obstacles and terrorist divers.

There are many problems associated with using ultrasound devices to survey underwater environments and detect potential dangers. While modern ultrasound technology has addressed most of these challenges the fundamental problem of delivering a powerful beam of ultrasound across a range of frequencies is still a major stumbling block. EPSRC researchers believe that a new sort of transmitter holds the key.

It is only in unusual circumstances, such as when we are confronted by a cliff or enter a confined space, that we begin to notice the echoes created by our own voices. Yet, underwater, sound above the upper limit of human hearing of around 20kHz – ultrasound – is an invaluable tool for sensing our environment. Modern ultrasonic transmitters (known as transducers) that create the sound and receivers that detect the returning echo can operate at a depth of over 5000 metres where the pressure is around 500 times what it is at the surface. However, just like the traveller shouting towards a cliff and listening for the echo, the 'louder' or more powerful the ultrasound you produce the further away you can be from an object and still detect the echo.

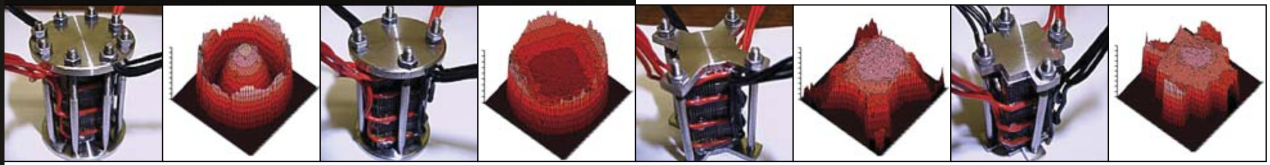
Dr Sandy Cochran (centre) and colleagues at the University of Paisley have been working on a new type of ultrasound transducer.

Traditionally, ultrasonic transducers are made of a single piece of piezoelectric material. Yet this design has two important disadvantages: Firstly, it is impossible to manufacture pieces of material thick enough to create low frequencies of around 30kHz. Secondly, the power of the transducer is limited by electrical impedance across the thickness of the material and its area. "The approach taken in my work adds an extra dimension to the possibilities available to the ultrasonic transducer designer," explains Dr Sandy Cochran of the University of Paisley. Dr Cochran, an EPSRC Advanced Research Fellow, is studying how transducers built up from multiple layers of material could overcome both these problems. "Even with relatively recent innovations in piezoelectric ceramic/polymer composite materials the avenues open to a commercial transducer designer are quite limited," he says, "some of these limitations relate to the active component of the transducer, the part that converts electrical energy to sound and vice-versa. In my work, this active component is made up from a number of layers, and it is possible to vary the design of each of these layers – for example the amount of active piezoelectric material relative to the polymer in a composite structure." This multilayer approach could not only give more scope to designers but should significantly improve the power output and frequency range of devices.

Underwater terror

In a world where attacks on oil tankers and commercial shipping, as well as military vessels, are an increasing concern, high performance sonar has a role to play in keeping our seas safe. Dr Cochran points to a recent incidence of 'underwater terrorism' where two divers were killed by the Israeli army. Better transducers, he tells us, could help to detect divers more easily and accurately. Of course sonar

Below: Measuring the surface motion caused by four different designs of multilayer transducer: Surface motion is what generates the ultrasound in the medium with which the surface is in contact. A crucial issue in surface motion is the uniformity of the amplitude.



also has many peaceful applications: "Environmental changes can be monitored by surveying the seabed," comments Dr Cochran, "for instance, sonar can be used to map changes in populations of different types of shellfish and changes in the seabed itself. The more accurately this can be done, the better the data scientists will have to monitor the changes." He says that better transducers are analogous to better camera lenses "they let scientists see things they could not see before, that's the aim of my work."

Technology that was originally developed to sense objects underwater has, over many years, been adapted to 'look' inside our bodies. We are all familiar with ultrasound images of unborn babies but the next generation of ultrasound systems will be far more sophisticated. "Until recently, biomedical ultrasound imaging was based on arrays made up of a single line of transducers," says Dr Cochran, "these give the familiar two-dimensional images. Now, advances in electronics will enable three-dimensional imaging, ideally through the use of an array made up of a grid of transducers. However, in this case, each transducer has to be very small – typically less than 0.5mm square. Such small elements have awkward electrical properties and multilayer transducers are one way to overcome this." Ultrasound can be used not only to identify potential problems but also to treat them, as demonstrated by its role in breaking up kidney stones and in physiotherapy treatment. "The frontier in therapy at the present time is as an energy source for the treatment of tumours. In this approach relatively low power beams of ultrasound are focused within the tumour and literally cook it, heating the cells above the temperature at which they can survive," comments Dr Cochran. He believes that multilayer technology could greatly increase the flexibility of therapeutic ultrasound systems.

"Sonar can be used to map changes in populations of different types of shellfish and changes in the seabed itself. The more accurately this can be done, the better the data scientists will have to monitor the changes." Dr Sandy Cochran

Louder by design

Better transducers are essential if ultrasonic technology is to fulfil its potential for any of the application areas described above. One area where Dr Cochran and his colleagues hope to make progress is in producing better tools for designers. "Up until now transducers have been designed using conventional methods in which an expert designer tries different approaches based on his or her experience and tests them through prototyping or computer modelling," explains Dr Cochran. "What we would like to see is mathematical optimisation of these models. More efficient modelling would have an immediate impact on the creation of complex multilayer transducers that are simply too time-consuming to design using traditional methods." New materials could also make a big difference to the performance of transducers and the sensors that rely on them. The team at Paisley are particularly interested in single crystal active materials that promise to be an improvement on the ceramics they currently use. "Until recently these new materials were extremely expensive but now the number of suppliers in the US, Korea and China is mushrooming, bringing tumbling prices and driving up quality," he tells us. Funding from Scottish Enterprise, he says, has been particularly useful in helping to acquire and apply these materials.

His EPSRC Advanced Research Fellowship is enabling Dr Cochran to explore new types of ultrasound source that will one day echo through our oceans or resonate inside our bodies. If his group and others are successful in creating the next generation of ultrasonic devices then we may have to coin a new phrase: 'Hearing is believing'.

Contacts

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Sensing the Future

The Microscale Sensors group at Paisley University is collaborating with several other groups on a wide range of future technologies and applications:

- **University of Birmingham** – Work is underway with Dr Tim Button and Nicola Porch of the Functional Materials Group and its spinout firm, Applied Functional Materials, on exploring ground-breaking composite transducer structures.
- **Queen's University Belfast** – Collaboration with Dr Robert Bowman and Dr Marty Gregg in the Electroceramics Group at QUB to explore the potential benefits of single crystal materials in thin film form with applications in microsystems and nanotechnology.
- **University of Glasgow** – Investigating, with Dr David Cumming of the Microelectronic Systems Group at Glasgow, how electronics can be integrated with transducers to produce better 2D arrays and autonomous ultrasound devices.

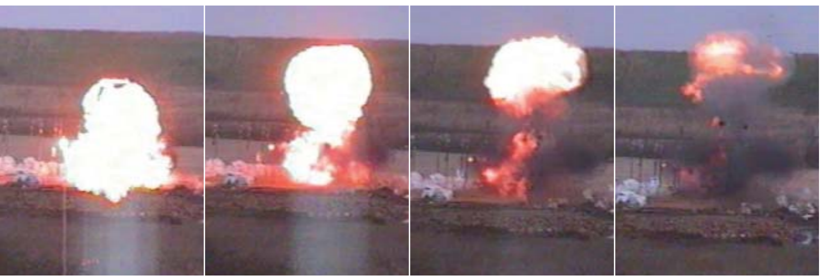
By David Bradley

Observing explosions close-up is not advisable for humans or conventional sensors. Yet, without a better understanding of what happens at the heart of a blast, research into making everything from buildings to jet turbines safer is likely to stall. What are needed are sensors that can survive in the ultimate danger zone.

Danger: Blast Area

Novel optical sensors that can withstand the extreme environments within an explosion or a jet engine simulation rig are being developed by a team at Heriot-Watt University, Edinburgh, with EPSRC funding. The emerging technology could help researchers understand in more detail what happens in confined spaces when there is an explosion – whether controlled, accidental or deliberate – as well as provide engineers with important insights into the effects of turbine design on jet engine performance and wear. EPSRC Advanced Research Fellow Dr Bill MacPherson and Dr Jim Barton are working on two aspects of fibre optic sensors that could be used in two very different but equally extreme environments. The sensors could provide information that is otherwise almost impossible to access.

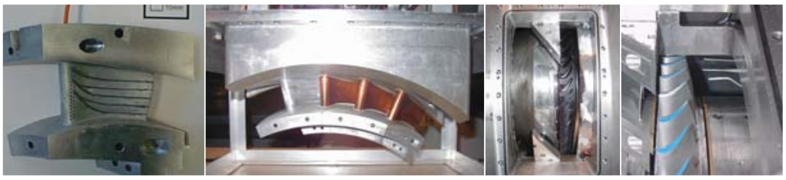
Tiny but tough sensors can be used to record variations in pressure in scale models during an experimental explosion. It is hoped such tests can improve computer models predicting the effect of explosions on military, civil, and industrial structures.



According to Dr Barton air-borne blast waves from high explosives are difficult to measure experimentally. There is little reliable experimental data on how explosions occur in confined spaces and how corners and gaps in everyday structures affect the blast. More detailed measurements could lead to much better models. “These would improve our understanding of blast damage,” explains Dr Barton, “and aid in the design of structures that minimise the damage, such as in buildings, military vehicles, industrial plant, and body armour.”

Tough and cheap

Dr Barton, working in the Fibre Optics Group at Heriot-Watt University and with colleagues at the University of Sheffield, is devising miniature fast-response pressure sensors to get inside explosions. “Blast measurement introduces challenges because the sensor must be very robust!” he says. “By the nature of explosive air-blasts there is a likelihood of airborne debris travelling at very high speed.” In collaboration with Dr Andy Tyas, Department of Civil Engineering, University of Sheffield, and Dr Richard Allen of the Defence, Science and Technology Laboratory at Fort Halstead, the team hopes with EPSRC and MoD funding to overcome the various problems associated with such sensors. “For explosives research it’s beneficial if the sensors can be low cost – due to the potential damage they might incur,” comments Dr Barton. “Conventional sensors concentrate their cost at the measurement point, so sensor damage can be costly, however fibre sensors have the expensive interrogation system remotely located, therefore loss of the sensor is, in principle, less costly.” He points out that economies of scale will cut costs further



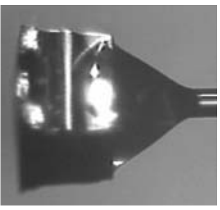
Left: Optical fibres embedded in a jet turbine assembly can be routed to the exact point at which measurements need to be made. Data gathered from these sensors during tests show engine emissions and efficiency.

when it becomes possible to use mass production techniques such as micromachining. To this end the team is also working with the Central Microstructure Facility at the Rutherford Appleton Laboratory and the Scottish Microelectronics Centre, in Edinburgh, on the microfabrication of the sensor bodies.

"By the nature of explosive air-blasts there is a likelihood of airborne debris travelling at very high speed." Dr Jim Barton

The new sensors being developed have very low mass diaphragms as the pressure-sensitive element. This diaphragm vibrates as the pressure wave hits it and the movement is detected by a variation in the light signal reflected back along the optical fibre to which the sensor is attached. Conventional electrical pressure sensors in explosives research are larger, resulting in sensitivity to vibration which can appear as a spurious signal in blast tests. "An additional bonus of fibre sensors is the absence of electrical leads and long wire connections which need careful screening against electromagnetic pick-up, a particular issue when setting up electrically-detonated explosive tests," adds Dr Barton.

Systematic trials will allow the researchers to record the variation in pressure at the surfaces of model structures in an enclosed space as an explosion progresses. Because of the small size of the fibre optic pressure sensors a range of scale models will be tested to allow the scientists to investigate the effects of a blast and improve computational models for military, civil, and industrial structures.



Above: The team at Heriot-Watt have produced sensors on the trailing edge of a blade less than 1mm thick – small enough to be embedded in very small jet engine parts.

The second harsh environment in which these sensors could be used is in gas turbines, such as those found in aircraft engines. Aerodynamic flows in gas turbines can exceed the speed of sound as well as becoming hotter than the melting point of the engine components, requiring active cooling. "Clearly engine design is critical for efficiency and low pollution emission," says Dr Barton, "however, although computational techniques are excellent at predicting complex flows, there is still a requirement to validate these predictions experimentally." The problem is, of course, any conventional sensor placed in such a harsh environment will quickly be destroyed. Many of the necessary validation experiments on new turbine blades can be done in wind tunnel test facilities under slightly less harsh conditions that simulate real engine conditions. The flow velocities are similar but the temperatures used are hundreds of degrees lower, which gets around the damage problem. Optical fibres provide the solution to getting the sensors into a vantage point, says Dr Barton. "The advantage of optical fibres is that they can be routed to the point at which the measurement is to be made," he explains. The researchers also point out that the sensors must be tiny and so capable of being embedded in small jet engine components. "We've placed sensors on the trailing edge of a blade less than 1mm thick," adds Dr Barton, "we've also now installed miniaturised probes that perturb the flow less than conventional-sized probes might."

Versatile fibres

The turbine engine sensor research is being carried out with Professor Terry Jones of the Department of Engineering Science at the University of Oxford, and Kam Chana of Experimental Programmes at QinetiQ Pyestock. "The Holy Grail of turbine engine instrumentation is a sensor that could survive combusting flow, at temperatures approaching 2000 degrees Celsius," says Dr Barton. Direct measurements in test engines rather than simulation rigs could then be done allowing efficiency losses to be pinpointed accurately for better engine design.

There are two further types of sensor being developed. The first uses multicore fibre: Unlike conventional fibre which carries light in only one central core, this fibre has typically two to four separate cores, which opens the door to multi-parameter/multi-sensor probes by allowing different sensors to be integrated on the end of a single fibre. For example, a diaphragm pressure sensor can be combined with a thin film temperature-sensitive coating on a single fibre end. Multicore sensors are only just being investigated but offer plenty of potential in both the explosive and turbine applications.

Dr MacPherson is investigating a second branch of the optical sensing technology that could offer its own advantages over conventional optical fibres. He hopes to learn how photonic crystal fibre (PCF) technology might be exploited in optical sensor systems. He is building on existing links with Bath University, which is at the forefront of PCF fabrication in the UK and Dr MacPherson is undertaking a systematic investigation into the use of PCFs for optical sensing for environmental, structural, and multi-parameter measurement. PCFs, he points out, could offer far greater control over the fibre properties than is available with conventional doped fused silica fibres, greatly extending the type and performance of possible sensors. In particular, these materials could lead to miniaturised sensors (for engineering research and structural monitoring) and high power beam delivery for full field measurements and spectroscopic chemical detection schemes. ■

Contacts

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By Michelle Knott

Digital Adventures

Above: An aerial map showing pollution in an urban environment: This is part of a plan to use distributed sensors to build up a real-time picture of changing local pollution levels.

When people get hold of new digital technologies they soon begin to use them for fun as well as for business. An EPSRC-funded collaboration is exploring how systems that mix physical and digital realities will change how we work, rest and play.

Challenging, fun, ground-breaking, unorthodox and even wacky have all been used to describe the work of the Equator Interdisciplinary Research Collaboration (IRC). As Tom Rodden, Professor of Computing at the University of Nottingham and the IRC's director admits: "The adventurous nature of our research can occasionally make our work look strange at first sight."

Equator aims to merge the digital and physical worlds in new and exciting ways and its work encompasses computer science, psychology, sociology, design and the arts across a community of eight institutions. And if it's rather unconventional, that's just as it should be. Even so, many areas of the research tick all the usual boxes in terms of more obvious practical benefits, such as distributed systems for tracking pollution or using smart messaging to support care workers. However, part of Equator's job is to look specifically at novel applications of digital technology away from the restrictions of the normal working environment. "Part of our remit is to stretch digital technology beyond the world of work and production to consider its use across all aspects of our lives. Some parts of our work deliberately seek to explore ludic, or playful, pursuits that support our leisure time," says Professor Rodden. But he stresses that these less hard-nosed applications still present big challenges: "They're far from trivial in the technologies, the methodologies and the overall learning they demand."

Tag, you're IT

Funded by EPSRC to the tune of over £10.5million, Equator is halfway through its six-year term and it has already produced scores of innovations across its five project areas (see 'Interactive Lives' below). It involves groups from eight institutions; the University of Nottingham, the Royal College of Art, University College London, the University of Bristol, the University of Glasgow, the University of Lancaster, the University of Southampton and the University of Sussex. Picking highlights is tricky, but Rodden's favourite moments so far have emerged from two very different projects. "One of the best moments was 'Can You See Me Now?' simultaneously winning a major international prize at Ars Electronica and being accepted for the leading academic conferences and journals on human-computer interaction," he says. In this city-based game of tag, runners on the streets use hand-held computers to chase down and 'capture' on-line players. Each on-line quarry can monitor the

Far left: Virtual environments can be powerful therapeutic tools as well as fun playgrounds. Here a simulated crowd is used as part of Virtual Reality-based work to help people with agoraphobia.

Left: In Antarctica researchers have deployed sensors developed by Equator to monitor pollution in a lake.

Above: What happens when you combine real-life performers and on-line games players? Equator researchers found out in 'Can You See Me Now?' a game in which real-life runners navigating real cities were chased by on-line players navigating a maze of virtual streets.

position of the pursuers and must manoeuvre around a digital map of the city until they're caught and thrown out of the game. The game has already been played in Sheffield, Rotterdam and Oldenberg, and a follow on experience called 'I Like Frank', in which street and on-line players follow clues through a city premiered at the Adelaide Festival Fringe in March 2004 and has been the world's first mixed reality game to be delivered on 3G mobile phones. "Another great moment was watching the reaction of school children in the Ambient Wood," says Professor Rodden. Ambient Wood is part of the Digital Play Project and is a field trip with a difference. A variety of technologies track each child's progress through the woods and digital stimuli, such as the amplified sound of a butterfly drinking, are used to supplement the conventional experience.

Position, position, position

In terms of technology, the Digital Play Project has helped the Equator team develop novel position sensing systems and the team at Bristol is now patenting a new low-cost, easy-to-deploy positioning system developed to meet the demands of both the Digital Play and the City Projects. Meanwhile the City Project is completing a new phase in Glasgow. While previous work has concentrated on tracking physical and on-line visitors inside an exhibition, the project has stepped out of the museum and enables a pair of visitors to explore city centre buildings and streets. GPS, maps, the web, VR and camera tools all run on the same mobile computer and visitors to the city can share their experience of exploring the city streets.

A number of the technologies to emerge from Equator are already starting to attract commercial interest, including those artefacts that are arguably some of the oddest. The Drift Table, for instance, is a coffee table with a round window in the surface through which an aerial view of a small portion of the British Isles is visible. By moving objects around to change the distribution of weight across the surface of the table the user can make the view in the window drift in different directions. The Equator researchers are due to hold talks with the company that supplied the mapping data with a view to commercial development. The History Tablecloth is another contender. This incorporates an electroluminescent film that starts to glow when the user places an object on top, so that every object on the table is surrounded by an expanding halo of light. The companies supporting the project believe that the cloth could find a commercial home in the hospitality industry, with brewers among the likely customers.

"Part of our remit is to stretch digital technology beyond the world of work and production to consider its use across all aspects of our lives." Professor Tom Rodden

According to Professor Rodden, the unique breadth of expertise across the IRC is vital to develop the huge range of ideas within Equator. "By coming together we can tackle research at a scale impossible to consider for a single research group or institution. Within Equator a single experience project can be addressed in its totality," he says. The upshot is that new concepts, designs, systems and hardware can be explored from every angle. EPSRC support for Equator will continue for another three years but Professor Rodden and his colleagues already predict that it will create a lasting impression. As well as the artefacts and new techniques that have already started to emerge, he predicts that the success of Equator will be measured in terms of the people involved. "The legacy of this support will be a world-leading research community in this area of work," he says. "I would expect a number of researchers who grew up in Equator to become leading figures in their fields." The IRC as a whole has already made significant contributions to the UK Computing Research Committee's initiative on Grand Challenges for computer science. He remains more cautious about predicting where the new technologies might lead, concluding: "I think Nils Bohr got it right when he said "prediction is very difficult, especially if it's about the future.""

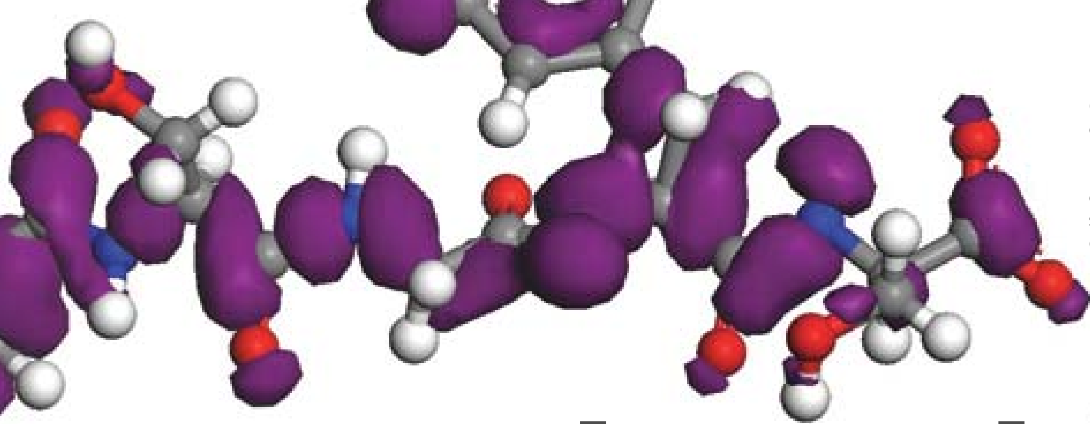
Contacts

For more on Equator visit http://machen.mrl.nott.ac.uk/home.html or contact Professor Tom Rodden by e-mail at tar@cs.nott.ac.uk

Interactive Lives

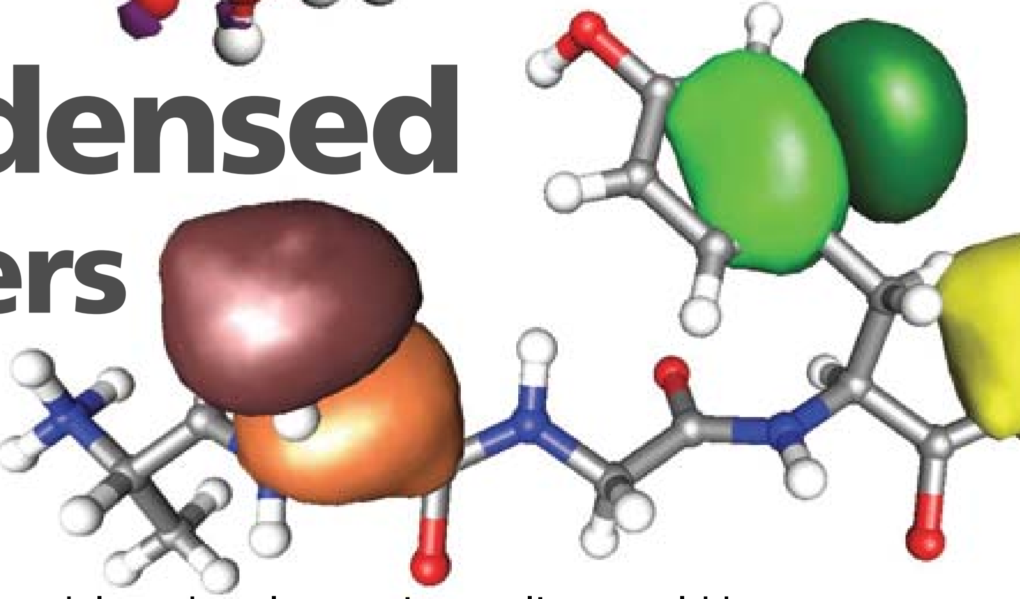
The research supported through the Equator IRC can be grouped into five experience projects areas:

- **City** produces interactive technology to mediate urban experiences, such as visiting galleries or historic buildings.
- **Citywide Performance** incorporates the 'Can You See Me Now?' mass participation games.
- **Digital Care** aims to boost community care with unobtrusive technologies.
- **Digital Play** supports new ways of learning for young children.
- **Domestic Technologies** is about enriching the home environment with novel IT, much of which is playful rather than labour-saving.



Quantum mechanical calculations generate functions called ‘orbitals’ which contain all the information necessary for calculating all chemical and physical properties of molecules and solids. Calculations carried out using CASTEP and the new ONETEP system on the same small peptide are equivalent in quality but ONETEP can carry out the calculation on 5000 atoms while CASTEP’s limit is about 300 atoms.

Condensed Matters



By David Bradley

Without theories, models and tools experimentalists would be unable to understand what is happening both in the laboratory and in the world around us. *Newsline* talks to the Cambridge scientists who are developing new ways of predicting and modelling the behaviour of matter.

EPSRC’s Portfolio Partnerships are aimed squarely at world-leading research teams with a proven track record of ground-breaking science. Through them, EPSRC provides the kind of stable and long-term funding to allow such teams to innovate, explore new research, and establish collaborations with industry and others. The Condensed Matter Group and the Centre for Computational Chemistry at Cambridge University is one such partnership that is benefiting from this inherent stability. With a Portfolio Partnership following on from an EPSRC rolling grant, the Cambridge team has matured into a group with international standing that carries out research at what lead researcher Mike Payne describes as a level above: “We deliver ideas and techniques that lots of other researchers can use, this requires something special!” he enthuses.

“The code would provide a ‘virtual laboratory’ in which you can carry out any experiment you can think of; experiments that might be very expensive or even impossible in real-life would become possible.” Peter Haynes

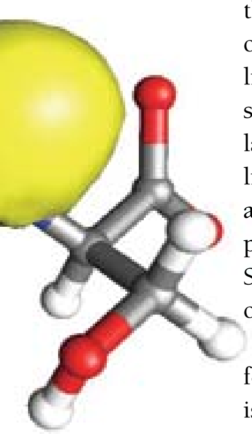
“The Portfolio Partnership cuts us free from the usual round of funding applications,” Payne told *Newsline*, “allowing us to be innovative and take risks. If something new comes up, we can change track immediately and chase after it.” As such, the scientists within the Portfolio are working on a wide range of research projects – from modelling chemical reactions to understanding superconductivity, and ion transport through narrow pores. They are accessing the behaviour of chemicals at the heart of technologies including drug design and catalysis. Moreover, related mathematical approaches that provide chemists and biologists with new solutions can be applied to cosmological systems and even studies of human aging.

Exotic materials

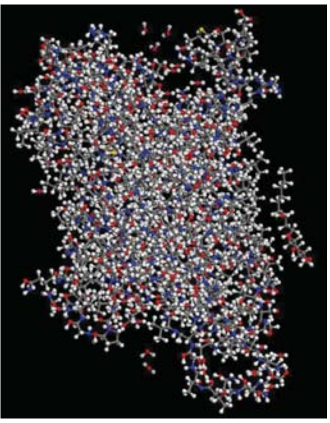
Payne hints that it is in fact very difficult to define specifically the research of the Cambridge team as it is so varied. One colleague, theoretical physicist Mark Warner received the 2003 Agilent Technologies’ Europhysics Prize for Outstanding Achievement in Condensed Matter Physics for his work on liquid crystal elastomers carried out with experimentalist colleague Heino Finkelmann and his team at the University of Freiburg in Germany. Liquid crystals are well known in their role in liquid crystal displays (LCDs) on laptops, mobile phones, and digital watches. However, Warner and Finkelmann combined theoretical and experimental work to develop an

Professor Mike Payne (left) and Dr Chris-K Skylaris are hoping to simulate thousands of atoms in a range of systems from water channels to catalyst surfaces.

entirely new class of rubber-like polymers (elastomers) that incorporate the properties of liquid crystals. The resulting unique materials could make them useful in a variety of optoelectronic, telecommunications, and other applications. For instance, liquid crystal elastomers undergo an enormous and reversible stretching when they are warmed and cooled. An equally large effect is obtained on illumination when the elastomer absorbs light, causing them to bend. Further developments of such materials could make them useful as actuators in lab-on-a-chip devices or as artificial muscles. Other liquid crystal elastomers change colour when stretched and could be used to make a new type of laser that can produce any colour depending on the tension applied. Such materials might have applications in optoelectronics and telecommunications.



Work carried out by Jean-Pierre Hansen's team, formerly Rosalind Allen, and now Joachim Dzubiella, is using molecular dynamics to simulate the nanopores that transport water and ions in and out of living cells as well as the kinds of pores found in industrial catalysts, such as zeolites. Results due to appear in the prestigious Journal of Chemical Physics reveal how water permeation controlled by the electric field due to a concentration gradient is coupled to ion transport through a nanopore. The finding will help explain many biological as well as catalytic phenomena seen by experimentalists.

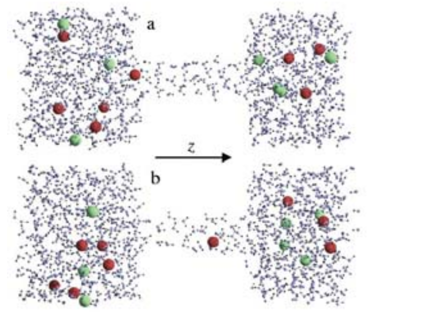


A picture of a 'water channel' showing every individual atom.

A recurrent problem in simulating atomic systems is how to model big systems, such as proteins and catalytic surfaces with limited computer power. Doubling the number of atoms requires eight times the computing power using codes such as Payne's commercial computer package CASTEP. Cambridge researchers would like to circumvent this scaling problem and make quantum simulations scale in a linear way – double the number of atoms and the computing power merely doubles. "Many research groups around the world have attempted this," says Payne, "and there are computer programs that are capable of doing this but with limited accuracy or efficiency." Colleague Peter Haynes and Chris-Kriton Skylaris have been working on an approach to make simulations scale linearly, but without loss of accuracy. Ultimately, the aim is to allow anyone from condensed matter physicists to bench biologists to be able to use a successor to CASTEP to carry out calculations on any atomistic system. "The code would provide a 'virtual laboratory' in which you can carry out any experiment you can think of," Haynes enthuses, "experiments that might be very expensive or even impossible in real-life would become possible."

Nanoscience simulations

For instance, the shape of a protein is crucial to how it works. A biologist can reach inside the protein 'in silico' and alter bond lengths and angles, or add extra chemical groups to the structure. "Identifying the key aspects of the structure can be done much more quickly and cheaply on a computer than in the lab," adds Haynes, "this clearly has huge implications for the development of 'designer drugs'." Chris-Kriton Skylaris and Arash Mostofi are working on the new linear scaling ONETEP code and running simulations on systems with thousands of atoms, such as cellular water channels. "ONETEP can be used to perform highly accurate modelling of such molecules to understand their function at the atomic level," Skylaris told *Newsline*. "The ONETEP method is a 'first principles' approach for quantum mechanical modelling which means that it makes no prior assumptions regarding the properties of the system under investigation," adds Skylaris. The method can therefore be applied to any nanoscience problem, from biology to surface science, which needs an accurate description of the interactions between thousands of atoms, he adds. "The advent of this technique at the same time as the nanoscience revolution is hugely significant," says Haynes, "as technology is becoming increasingly miniaturised, so the scale of systems accessible to quantum-mechanical simulation is increasing and we are entering the era when the scope of these two branches overlap which is tremendously exciting."



Simulation snapshots show how sodium ions pass through a narrow cylindrical pore in the presence of water.

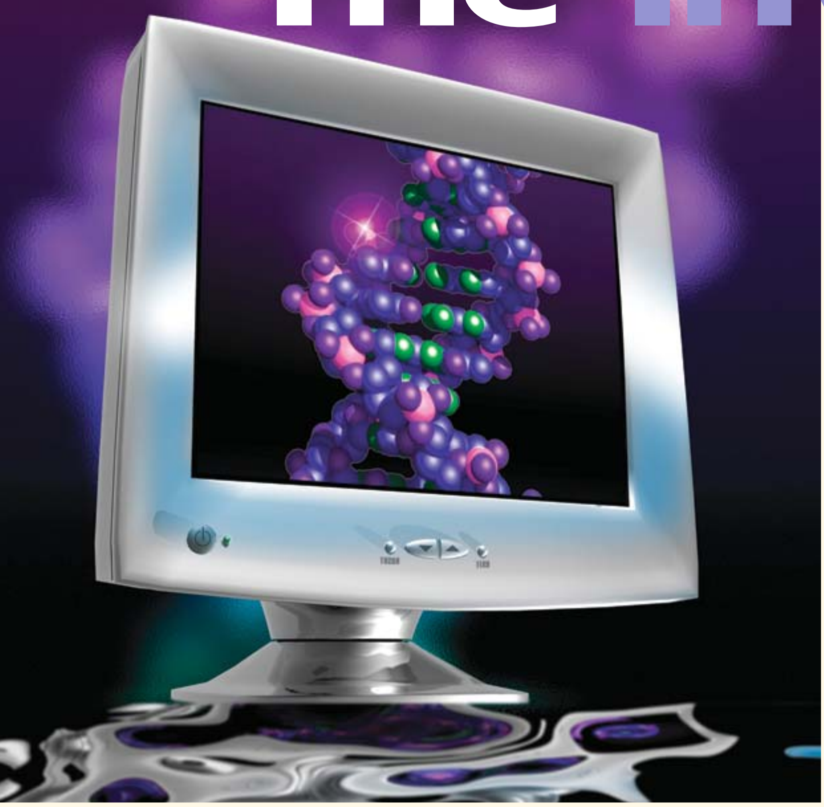
ONETEP is typical of the superb work that is emerging from the Cambridge Portfolio Partnership and represents a discovery with serious practical applications in seemingly disparate research fields. The Portfolio Partnership has played a key role in this development. "How else could one run an eight-year project, fail several times, but still take that sort of strategic view?" asks Payne. ■

Contacts

For more on the work of the Portfolio Partnership contact Mike Payne by phone on 01223 337381 or e-mail mcp1@cam.ac.uk Alternatively, visit www-cmt.phy.cam.ac.uk/

By Pete Wilton

The Invisible Ally

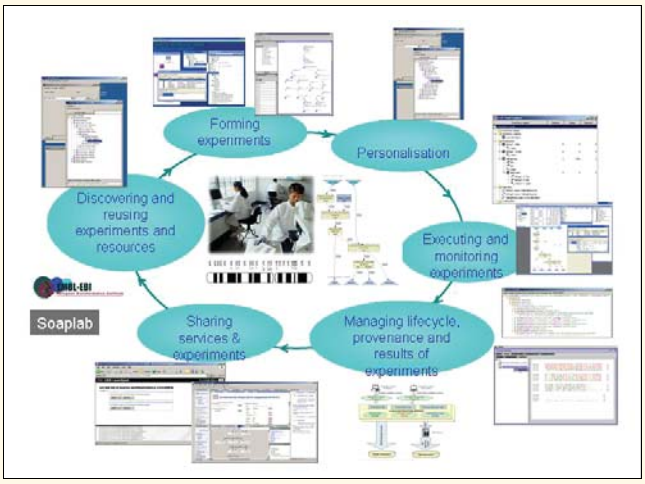


Behind the scenes advances in computer science are revolutionising not just what calculations researchers can do but how they work on and approach problems. We decided to investigate one example of how the power of e-Science is helping to cut today's big scientific problems down to size.

Computer science is already involved in almost every area of science. On the one hand computer technologies are used to capture and store vast amounts of experimental data while on the other they offer an array of powerful tools to run virtual (or 'in silico') experiments away from the lab bench. Yet with so much data being stored at different locations around the globe, and so many computational tools to understand, researchers are in danger of being overwhelmed by the logistics of a project rather than getting on with the science. This is where computer scientists, such as those developing *myGrid*, can help.

myGrid is what is called 'middleware', software that bridges the gap between the tools people want to use and the data and resources they need to access. *myGrid* is specifically aimed at helping those working in the new field of bioinformatics, a discipline that uses computer technology to model and understand biological processes and systems. Professor Carole Goble of the University of Manchester, who leads the *myGrid* project, has a vision of how her middleware can benefit scientists in their day-to-day work: "By speeding up the life cycle of an in silico experiment you can repeat that same experiment over and over, and adapt it and pass it on. For example what used to take one of our bioinformaticians two days to do will only take her two hours. Moreover, she can just run the experiment and do something else instead of being tied to a screen having to hand manage the inter-operation of the different tools she has to use. At the end she has an accurate record of what she did. By relieving her of the boredom of the task she will be less likely to make mistakes, more likely to undertake the task more regularly and more inclined to speculate." Professor Goble points out that there are many other advantages: The records kept by the system will enable scientists to track the 'who, why, when and where' of the data used so that it can be interpreted more accurately. It will also save on researchers carrying out similar calculations from reinventing the wheel as it will look to reuse work that has been done elsewhere. Not only bioinformaticians but also service providers who publish data or produce applications and those working on specific applications for biologists stand to benefit if the EPSRC-funded *myGrid* project can make this leap forward.

> "By speeding up the life cycle of an in silico experiment you can repeat that same experiment over and over, and adapt it and pass it on." Professor Carole Goble



Yet before the *myGrid* team can help other researchers solve their problems there are plenty of thorny challenges in computer science to tackle. "We are trying to make services work together that were never intended to work together so they mismatch," comments Professor Goble, "then there's coping with services that break when you are using them or disappear or change, tracking changes in the services, helping the biologist easily combine services to answer a scientific question and capturing the know-how (the workflow) so that they can repeat it, reuse it or repurpose it." And that's just the beginning, the *myGrid* research programme encompasses many of the hottest topics in computer science today; distributed computing, distributed query processing, data management, knowledge representation, portal development, workflow management, text mining, event notification, access rights and authentication and much more. "Another challenge is in building an architecture that is as flexible and extensible as possible using open source and open standards," says Professor Goble, "because we are based on Web services we have a comfortable migration path to the next generation of the Grid – Open Grid Services Architecture (OGSA). We've already experimented with some of our components as Grid services."

Access all areas

Gaining access to databases is another major hurdle and here the team work closely with the OGSA Data Access and Integration Programme funded by EPSRC/DTI. So-called 'Semantic Grids' are another key area, these are technologies that can reason over which services can be combined in a chain or find a close match for a workflow that achieves a particular task. She adds that Semantic Grids have now become a key topic in the European Union Framework 6 Programme to build intelligent middleware.

Below: Software such as *myGrid* is designed to work behind the scenes supporting researchers. Pictured here are PhD students Hannah Tipney and Richard Wroe using *myGrid* and discussing ways to develop a virtual experiment.

With success depending upon advances in so many different areas it is perhaps not surprising that, three years into the three and a half year *myGrid* project, there is still plenty to do. Professor Goble points to the fact that many components – such as Taverna/Freefluo (workflow environment) and Soaplab (web service wrapping) – are already available and being used by other projects. "We have access to around 300 biological services (databases, applications, algorithms, tools) that we can use in our workflows. Other components, like the information repository, event notification, user portal and the services registry are on their second round of development and will be finished by the autumn." Work on representing the knowledge that comes out of running workflows is still at an early stage, with various ideas being piloted in conjunction with the Semantic Web community and a development team at IBM. The *myGrid* researchers have also pioneered an approach to naming and identifying data resources stored in multiple, distributed data stores ('Life Science Identifiers') which has been proposed as a standard to the Object Metadata Group. The second prototype of *myGrid* is due to be published in September 2004 with the third and final version Professor Goble calls "*myGrid* in a box" scheduled for April 2005.

Linking up

Although the project aims to solve particular logistical problems associated with bioinformatics it has the potential to be applied much more widely. "Medicine, ecology, social science and environmental science all have similar characteristics so our middleware can provide a platform for tools in all these areas," Professor Goble tells us. *myGrid* has links with six other pilot projects in the e-Science Core Programme (a programme managed by EPSRC on behalf of all the Research Councils). "We are also the platform for the MRC CLEF project, individual components are picked up by the Human Genome Mapping Group and our semantic service registry work is informing the I3C bioinformatics standards body and the BioMOBY bioinformatics open source project," she tells us. "Internationally we have funded links through the e-Science sisters programme with major US e-Science projects at the San Diego Supercomputing Centre and the Information Systems Institute at the University of California." So where does Professor Goble see e-Science work such as hers in the future? Her answer is that we won't see it at all: "Eventually e-Science will disappear as using data collections and simulations/analysis is as much a part of the scientific method as bench experiments and hypothesis-driven science." ■

Contacts

For more on this project visit www.mygrid.org.uk or e-mail Professor Goble at carole@cs.man.ac.uk

Blow Your Own Trumpet, based on PhD research carried out by Mark Neal, uses artificial lips to demonstrate how trumpets are played.

By Nina Morgan

Science in Tune

How do you blow your own trumpet? What does the sound of a plucked guitar string look like? *Newsline* listens in as a group of physicists from Edinburgh take musical acoustics to the masses.

All work and no play can make for a dull life. But when work and play combine it's a different story, especially when the work is physics and the play involves musical instruments. Professor Murray Campbell of the School of Physics at the University of Edinburgh began his research career in atomic physics and moved on to studies of spin-polarised electrons. Yet his research entered a new dimension when, as a young lecturer, he was asked to take on the School's course on acoustics for music students.

Like many, he first assumed that scientists such as Helmholtz and Rayleigh had discovered all there was to know about musical acoustics back in the 19th Century. However, as he prepared for his lectures he realised that there was still plenty to find out. "It's such an intellectually rewarding field of research," he explains. "There are a vast number of fascinating unanswered scientific questions about music and how it is perceived as well as about musical instruments and how they work. With the growth in music technology a lot of these questions have become of some commercial importance."

"There are a vast number of fascinating unanswered scientific questions about music and how it is perceived as well as about musical instruments and how they work." Professor Murray Campbell

Spurred on by the challenges of the unknown, Professor Campbell and his colleagues began conducting experiments in musical acoustics in the 1980s. Today the Edinburgh School of Physics is home to one of the major European research groups in musical instrument acoustics, and receives support from a number of organisations including EPSRC.

Blowing his own trumpet

Although he still continues to work in the field of spin-polarised electrons, research into musical acoustics now takes up a large part of Professor Campbell's time. Except, that is, when he's on stage performing his unique one-man-band version of Handel's 'The Trumpets Shall Sound' on a hosepipe trumpet while adding in the string orchestra accompaniment using the keyboard of a synthesiser.

It's all in aid of an EPSRC-funded Partnerships in Public Awareness (PPA) project known as Science in the service of Music. Together with his colleague, Professor Clive Greated and his former PhD students, Mark Neal and Jonathan Kemp, Professor Campbell has been hitting the road, travelling to venues all over Scotland with a series of shows that

Left: In Rainbows of Sound, a computer display reveals the spectral components of any sound made into the microphone. It went on display at the Edinburgh Botanic Gardens as part of the Eden's Orchestra project.

Above: X-ray Specs of Sound, which draws on the PhD research of Dr Jonathan Kemp, demonstrates how pulse reflectometry, an advanced echo-based measurement technique, can be used to display the internal profile of an instrument.

include hands-on exhibits designed to demonstrate the principles of science as they apply to music and musical instruments (see 'Sounds on show' below). The group's road shows are drawing in the crowds at venues ranging from schools to shopping malls. Since the schools programme got under way in the spring of 2003, they've already played to enthusiastic audiences at ten schools – including two in the Orkneys – and will be visiting many more in the next few months. They've also contributed scientific input to the Edinburgh Botanic Garden's Eden's Orchestra exhibition about music and plants which was held in 2003, where a stand-alone version of their Rainbows of Sound exhibit attracted attention all summer long. Over 50,000 people have already attended one of their road shows or visited one of their exhibitions.

Their approach has proved so effective that Professors Campbell and Greated have already secured EPSRC funding for another PPA project on a related topic – sound in the environment. Even before the music road show officially ends in July 2004, the pair will be starting to develop a travelling exhibition based on paintings and installations by Glasgow artist, Marianne Greated. This will be accompanied by soundscapes, poster boards and video interviews with scientists and engineers. The idea is to explain the techniques for studying different types of sound and to show how the results can be applied in the community.

Physics and fun

The public, notes Professor Campbell, are not the only ones to benefit from his approach to putting the fun into physics. "Edinburgh University and its College of Science and Engineering are very enlightened, and support and realise the value of public engagement projects," he says. "I get a lot of support from my colleagues and department for my work in this area." He also finds the public engagement work offers a fresh source of research ideas because musicians who come to the group's events often introduce the scientists to interesting problems. "This kind of activity is quite important for building an essential bridge between scientists, those who are actually working in the practice of music, and the general public," Professor Campbell explains. "We're trying to get over that physics isn't just about galaxies and quarks. It's also about things in everyday life. We want to show people that physics is fun, and that people who work as physicists have a great time!"

Contacts

For more information or to enquire about the possibility of the road show visiting your area contact Professor Murray Campbell at d.m.campbell@ed.ac.uk

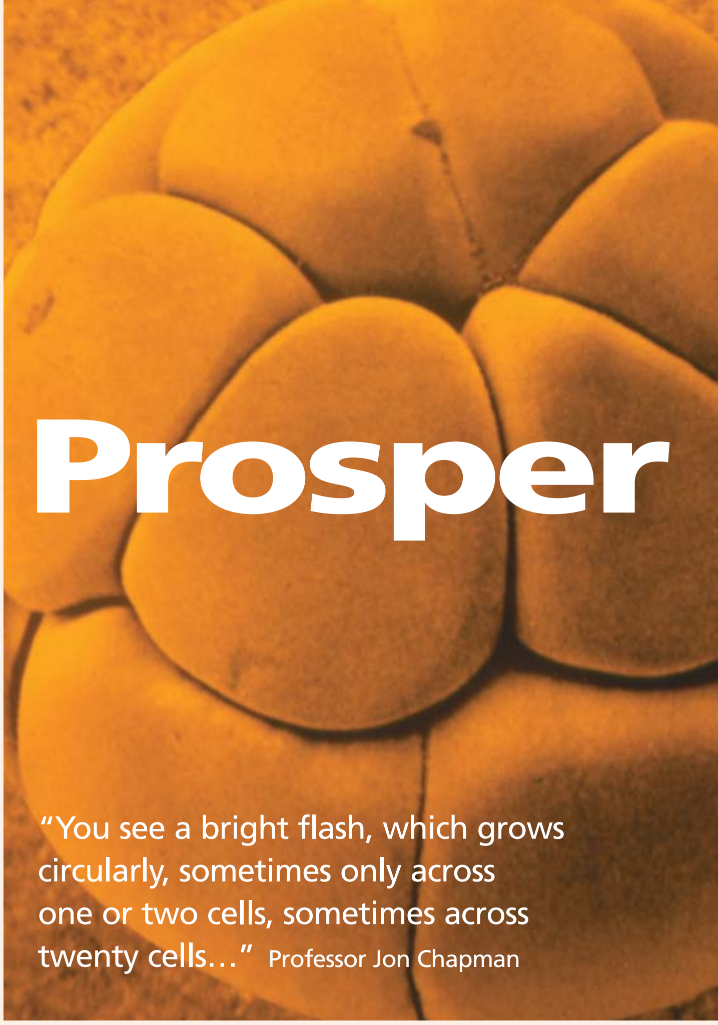
Sounds on show

The Science in the Service of Music Road Show currently includes four exhibits: Blow Your Own Trumpet, based on PhD research carried out by Mark Neal, uses artificial lips to demonstrate how trumpets are played. X-ray Specs of Sound, which draws on the PhD research of Dr Jonathan Kemp, shows how pulse reflectometry, an advanced echo-based measurement technique, can be used to display the internal profile of an instrument. Dr Kemp, a keen guitar player, also put together the Good Vibrations exhibit: This includes a single string electric guitar which is used to demonstrate the harmonic structure produced by a plucked string, as well as how the tone changes when the pickup is moved to different positions. In the more general Rainbows of Sound exhibit, a computer display reveals the spectral components of any sound made into the microphone. Two new exhibits, one involving drums and another to do with organ pipes, are also in the pipeline. The exhibits are backed up by a website **www.ph.ed.ac.uk/sitsom**

A CD for use by teachers containing computer programs for running frequency analysis and other acoustic experiments is also available. All the exhibits are designed to be accessible at many levels. Younger children, for example, can enjoy them by just turning on switches and hearing things playing, "the exhibits were also devised to engage older children and adults in a dialogue about the work we do and what information it can reveal," says Professor Campbell.

By Maria Burke

Divide and Prosper



Far from dispelling the mysteries of creation today's life scientists are uncovering intriguing new questions about the way a ball of cells becomes a fully developed individual. Increasingly, mathematicians are being called upon to help biologists find the answers.

Professor Jon Chapman and his team at the University of Oxford are developing models that they hope will help biologists better understand how cells start to develop into embryos. The first step is for a single cell to divide and divide, ending up as a spherical blob of about 1000 cells, explains Professor Chapman. About this point, the blob compresses in one direction and elongates in another, forming a long and thin shape. This process is called convergent-extension and happens just before limbs start developing in the embryo. The question that still baffles biologists is what triggers the cells to move collectively at the right time?

Life scientists have been interested in this question for a while. They know that cells release waves of calcium when under stress, such as when they are poked. But Scott Fraser, a biologist at Caltech, showed that cells undergoing convergent-extension would release calcium spontaneously without any stimulation. Using confocal microscopy and calcium tagged with fluorescent markers, he could watch calcium pass from one cell to another along the line. "You see a bright flash, which grows circularly, sometimes only across one or two cells, sometimes across twenty cells," describes Professor Chapman, who was working at Caltech at the time of Fraser's experiments.

This work generated a new raft of questions. Did the cells release calcium randomly? Or were they communicating with one another? Was this what happened to start the process of conversion-extension? But how did they know it was the right time? And how did the waves propagate? Did the waves cause convergent-extension, or were they a by-product of it? Professor Chapman with his background in mathematical modelling brought a new approach to answering these questions. Now back in the UK, he started working with his team at the Oxford Centre for Industrial and Applied Mathematics to design models to simulate two possible ways the calcium could move from cell to cell in embryonic frog cells. One theory relies on diffusion: Calcium levels rise in one cell and then pass through a gap junction – the connection between cells – to a cell where the calcium levels are lower, he explains. The other is a mechanical theory: When a cell releases calcium, it swells, relaxes and then contracts. This exerts force on its neighbouring cells, and this form of stress could be enough to prompt that cell to release its internal store of calcium.

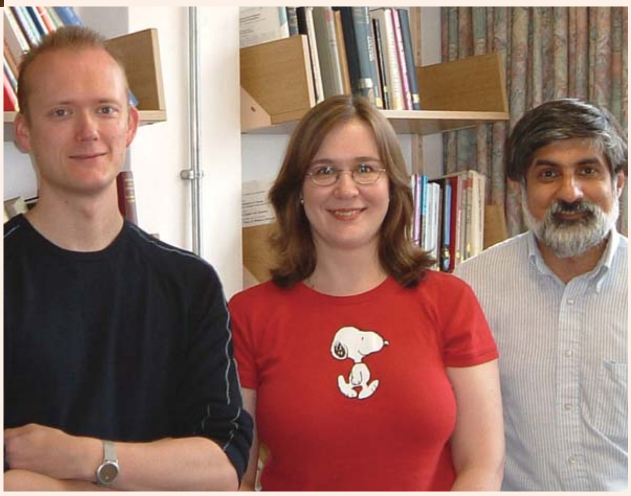
Calculated to fit

Professor Chapman and his team have developed and refined a set of partial differential equations to fit both theories. "The models predict how the cells behave and what is seen for each theory," he says. "Then we check if these predictions fit with the experimental data. It is classic hypothesis testing." They have found

Left: Researchers at the Oxford Centre for Industrial and Applied Mathematics are designing models to simulate two possible ways that calcium could move from cell to cell in embryonic frog cells (image shown is a frog embryo at the 16 cell stage).

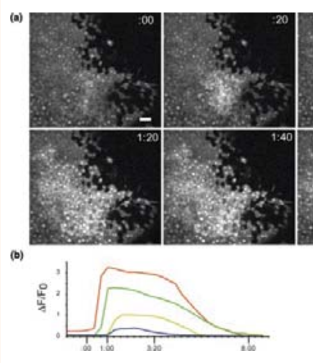
that both models fit with the experimental data, and both produce very similar results. "It might be that what happens in the cells is a combination of both these mechanisms," he adds. Now the team is looking into whether these waves are enough to kick-start conversion-extension. Professor Chapman: "We are working on a model that assumes that calcium travels in a mechanical wave and have built in a plasticity factor to the numerical simulation. That is, when the wave of calcium passes through, the cells don't go back into exactly the position and shape they were before. They are arranged slightly differently. We want to see whether this might lead to conversion-extension."

The Oxford team has faced a number of challenges with perhaps the biggest problem being a lack of quantitative data. "There's lots of qualitative data but when it comes to data on concentrations and flow rates, for example, we've not much to go on. We get around this by hypothesis testing. We also had to overcome the language barrier," says Professor Chapman, referring not to problems understanding



The team at Oxford (left to right): Professor Chapman, Tiina Roose (postdoc on the grant) and co-investigator Professor Philip Maini.

any transatlantic anomalies, but to understanding biologists' language. "On one level, there is the learning curve of understanding the jargon of the other discipline, especially when the same word is used to mean two different things. For example, 'model' to a biologist means an animal used in an experiment: A mouse model is a (probably transgenic) mouse. To a mathematician, a model is a set of equations." Professor Chapman found it equally challenging to understand the different way of thinking of mathematicians and biologists. "Mathematicians think in terms of equations, biologists in terms of concepts. But these can be brought together by thinking in terms of mechanisms." His collaboration with Fraser was



Calcium signalling during convergent-extension: This image was captured using calcium tagged with fluorescent markers by a team at Caltech led by Scott Fraser.

helped by the fact that Fraser had trained as a physicist and then moved into biology. This meant there was some common ground and Fraser could discuss things from a mathematical point of view. "These people at the interface of two disciplines are invaluable in terms of getting collaborations like this started," adds Professor Chapman.

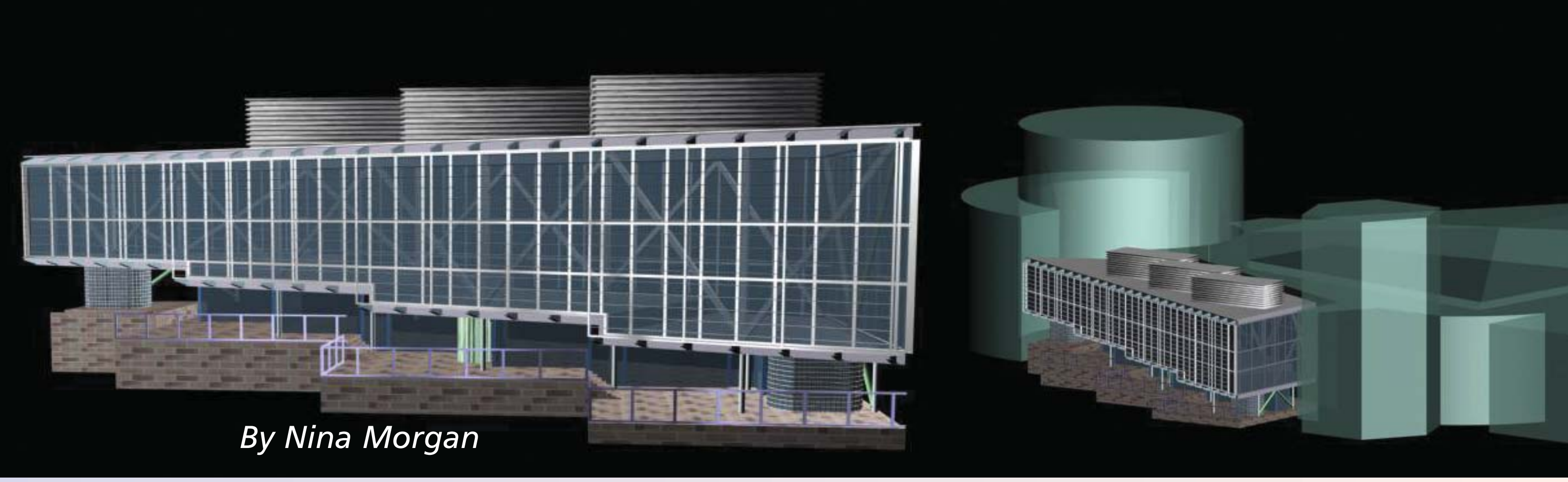
Notwithstanding these hurdles, Chapman's team have made some progress and hope that by the end of the project they will be able to give Scott Fraser a series of suggestions for new experiments. These, it is hoped, will shed light on how to distinguish between the two possible mechanisms involved in the calcium waves, and the role they might play in convergent-extension.

Pilot test

Professor Chapman is also hoping that the methodology data from this project may prove helpful with an upcoming e-Science pilot project in Integrative Biology that he is involved in. In this project, Chapman's team is modelling the growth and development of early-stage cancers "We hope that some of the models and ideas will be applicable because, even though the cells are different, the combination of chemical triggers and mechanical forces, and the interactions between the two, should be similar. We may be able to take what we have learned from our work on embryonic cells and apply it to the integrative biology project, but the integrative biology project may also feed something back to this project, too." As for the future, Chapman thinks this – his first venture into 'maths biology' – will lead him to do more in this exciting field. "I am already working on models for biological tissue deformation with application to detection of breast cancers. My future plans include more on cancer. I've just started a project on the methods of delivering gene therapy and a project on spinal cysts."

Contacts

For more on this work contact Professor Jon Chapman by e-mail at chapman@maths.ox.ac.uk



By Nina Morgan

Integrated Innovation

What is the secret to successful innovation? Researchers at Salford believe that bringing together three schools – Construction and Property management, the Information Systems Institute and the School of Art and Design – in one multidisciplinary centre will enable them to build for the future.

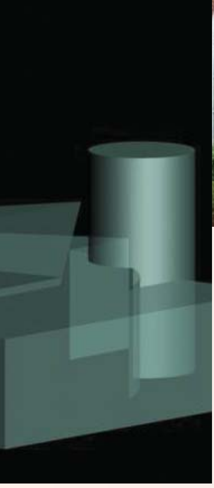
The University of Salford has long had a reputation for being a hotbed of innovation and collaboration. After seeing a succession of projects funded under EPSRC's Innovative Manufacturing Initiative (IMI) Salford received another boost in 2002 with the founding of the Salford Centre for Research and Innovation (SCRI), one of 16 centres set up under EPSRC's Innovative Manufacturing Research Centre (IMRC) initiative. "Our vision at SCRI is to promote a construction industry that is highly valued by society, and to create a built environment that is sustainable, easily maintained and accessible to all, including people with disabilities," explains Professor Ghassan Aouad, head of the School of Construction and Property Management at Salford and director of SCRI. "Our overall aim is to carry out the type of world class research needed to create a better environment for society as a whole."

"Buildings are just one application, but our concepts are also relevant to applications ranging from roads to water treatment, or even healthcare." Professor Ghassan Aouad

The initial five-year funding for SCRI has enabled its researchers to create the infrastructure and stable environment needed to develop a long-term strategy. "Not only has the creation of SCRI really boosted innovation," says Professor Aouad, "it's also improved the way we work. When SCRI was set up we inherited a collection of individual projects funded under the IMI initiative. We've now moved away from the idea of projects and concentrate instead on programmes of work, developing good team working, and maintaining a balanced portfolio that includes both blue skies and applied research." As a result, he believes that SCRI is better able to respond to the construction industry's needs and requirements, both now and in the future. The fact that SCRI is working with more than 60 industrial organisations suggests that this approach is already having a positive impact.

Broad appeal

One of the secrets to SCRI's success is its forums. These are regular training workshops where industry representatives are invited to discuss their research needs, learn about the innovative research being carried out and suggest problems that SCRI might usefully look into. Another is the 'generic' approach that SCRI's programmes take: "The concepts we are developing can be applied in many sectors," explains Professor Aouad. "Buildings are just one application, but our concepts are also relevant to applications ranging from roads to water treatment, or even healthcare." One example is SCRI's work on process mapping – which involves setting out the steps in the design and construction process from inception to completion, identifying the stakeholders, and determining how information flows between processes to establish what needs to be done by whom and when. This was so well received that it has become a flagship method for process mapping, and a number of companies working in different areas have now taken



Left: The Salford Centre for Research and Innovation includes experts from three different schools at the University.

Top left: Work at Salford is taking building design beyond just three-dimensional modelling and incorporating other design 'dimensions' such as cost, sustainability, energy, accessibility, maintenance, crime and acoustics.

up the results and customised the process to suit their own organisational needs.

Elsewhere, research at Salford is expanding the concept of three-dimensional computer modelling of the built environment into an almost infinite number of dimensions, to cope with whole-life construction issues in the design of modern buildings and facilities. The EPSRC Platform grant funded four-year project 'From 3D to nD modelling' will combine computer modelling, visualisation and simulation techniques to enable the results of design ideas to be 'visualised' in advance, so that people can actually 'see and try' suggested building designs by walking through and around them. Eventually this will accommodate 'what-if' analysis of design issues such as planning, cost, sustainability, energy, accessibility, maintenance, crime and acoustics. So far the project has developed an nD prototype tool that incorporates aspects of accessibility, costing, sustainability and crime. It is currently being tested on the extension of the flagship Lowry building (which houses two theatres for the performing arts and the works of LS Lowry amongst more contemporary exhibitions) and a social hosing development project in Gibraltar. It is anticipated that clients, designers and planners will be able to experiment with designs and govern the impact of design decisions at will. This work has led to a collaboration with more than 75 European partners in the €12m EU Framework 6 Intelligent Cities (INTELCITIES) project.

SCRI's growing reputation has also helped to attract international experts, such as Professor Lauri Koskela, a specialist in 'lean project and production thinking' in construction from the Finnish National Research Institute, VTT, to Salford. "His arrival is a great opportunity for us," says Professor Aoaud. "All in all, I would say that becoming an Innovative Manufacturing Research Centre has given us a lot more flexibility. It's really transformed the way we do our research!" ■

Contacts

For more information on SCRI visit www.scri.salford.ac.uk or for more on From 3D to nD Modelling visit http:///ndmodelling.scpm.salford.ac.uk Professor Ghassan Aouad at g.aouad@salford.ac.uk is the contact for both the Centre and this project. For more information about the EU INTELCITIES project contact Amanda Marshall-Pointing at a.j.marshall-pointing@salford.ac.uk

2020 Visionaries

What will the cities of the future be like? It's difficult to say, but if tomorrow's decision makers use the tools and resources now being developed as part of the VivaCity2020 project, tomorrow's cities are likely to be vibrant, sustainable and based on socially responsible urban designs.

VivaCity2020

The multidisciplinary VivaCity consortium led by Professor Rachel Cooper, a co-director of SCRI and the director of the Adelphi Research Institute for Creative Arts and Sciences at the University of Salford, is drawing on Salford's long history of research into design and development to tackle a wide variety of issues. These range from urban land use, environmental quality, and the provision of public conveniences in city centres to the role of design in crime prevention, and issues related to the design of socially responsible and affordable housing.

As well as academics, the consortium also includes a wide range of social, environmental, local government and industrial partners. But to ensure that the decision-making tools they develop really will offer practical benefits, the teams also liaise closely with the key stakeholders in the urban development processes such as Regional Development Agencies and community organisations – the groups with the hands-on, day-to-day experience in the areas that are being studied.

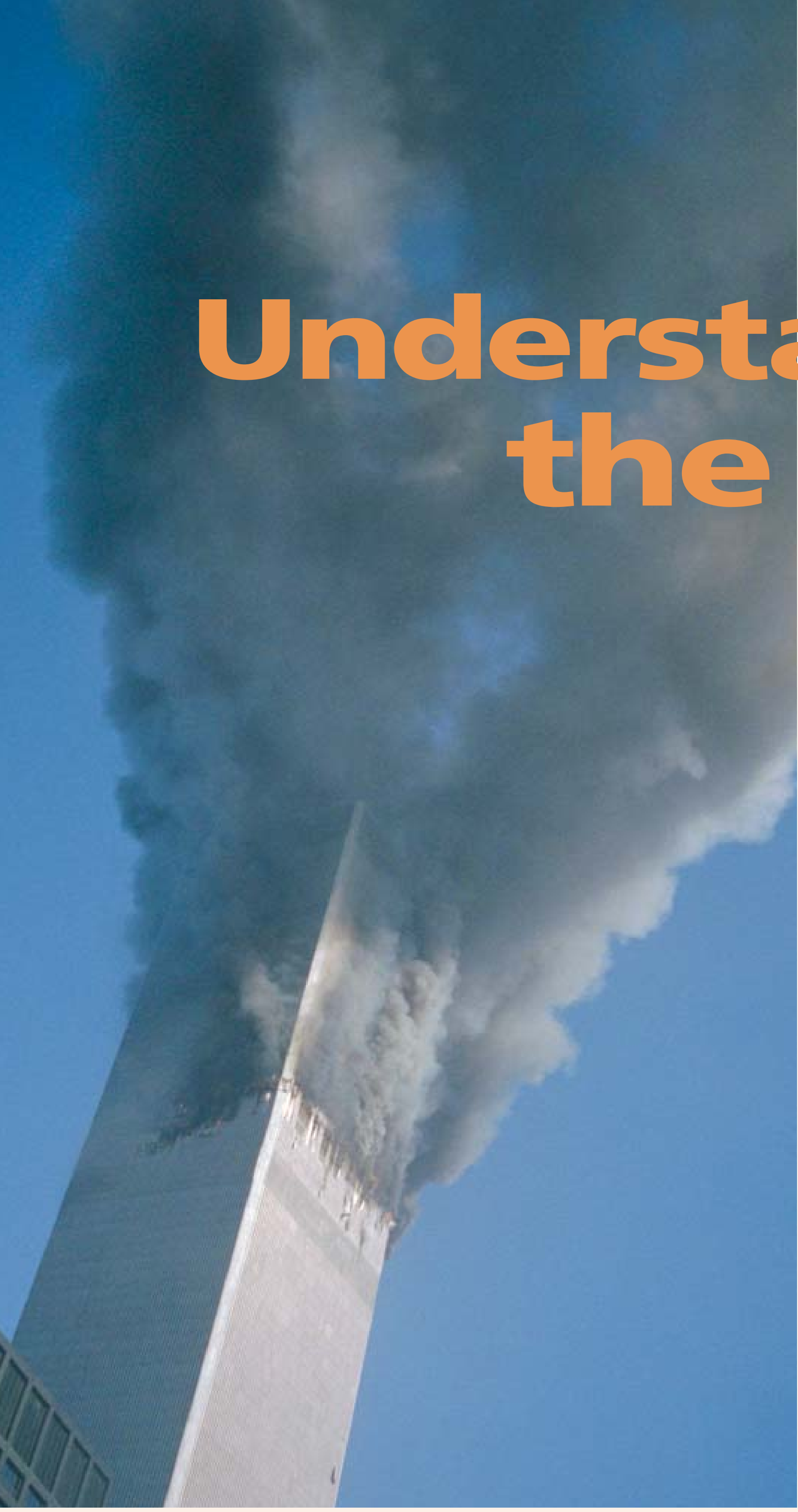
"There are many benefits of working on such a large and integrated project," says Professor Cooper. "I think everyone on the project would agree that their horizons are being broadened, both by exposure to so many areas of research and by working with so many enthusiastic fellow researchers, industry partners and community agencies and groups. We feel the project is really going places. In ten years time we would hope to see government and industry making informed, holistic and sustainable design decisions aided by our work. It's very rewarding to work with other universities and industry at the cutting edge of policy and to look at new issues where your results can really make a difference."

The VivaCity 2020 project is funded under EPSRC's Sustainable Urban Environments programme: The consortium includes the University of Salford, University College London, Sheffield Hallam University and London Metropolitan University.

For more on Viva City visit **www.vivacity2020.org** or e-mail Joanne Leach at **j.leach@salford.ac.uk**

By Pete Wilton

Understanding the Inferno

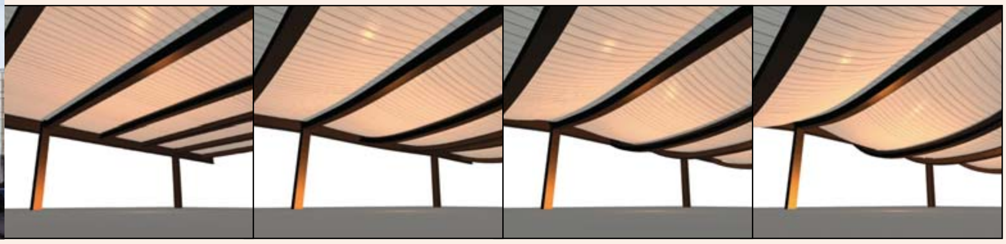


In any confined space fire is an ever-present danger. Yet as we fill our towns and cities with larger, more complex buildings the need to understand how fire affects modern structures has never been greater. *Newsline* meets the engineers who study what an inferno can do.

It is the most terrible, unforgettable moment. One of the twin towers, with smoke pouring from its sides, begins to collapse and then disintegrate in a cloud of dust and debris. Yet it was not, as might be supposed, the impact of the planes themselves that caused this catastrophic failure but something rather more prosaic: Fire. Understanding how a fire can lead to such a failure in a modern building is one of the aims of a research team consisting of EPSRC-sponsored CASE students Allan Jowsey and Graeme Flint, Dr Asif Usmani and Dr Jose Torero at the University of Edinburgh and industrial partners ArupFire.

Structural fire engineering is a way of quantifying just how robust a building will be in the event of a fire. "It allows designers to assess their design and determine how to increase its strength in a fire," explains Barbara Lane, an associate at ArupFire. "In addition, it enables material choices to be made in a more refined manner, so that cost-effective solutions to protecting a building against fire can be proposed." There are standard equations that describe the transfer of heat from a fire to its surroundings but for large, complex structures these are overly simplistic. Such equations do not take into account, for instance, that heat radiates not only from the flames themselves but also from the smoke and invisible hot gases produced. Additionally, existing models tend to ignore heat transfer between gases and solid surfaces and how different building layouts affect heat carried by convection. "Allan Jowsey and Graeme Flint have the time to investigate complex problems like this in depth so that we can use the end results in real building design," says Barbara Lane.

CASE student Allan Jowsey is currently working on three projects, one of these being the collapse of the World Trade Center. "The study of World Trade Center 7 is a popular topic," he tells us, "mainly because it was the first multi-storey composite steel-frame structure to collapse purely due to fire. My research into the possible collapse mechanisms will provide Arup with a basis from which to comment on the official report." Elsewhere he is studying building specifications, fire safety design for a transportation centre and the effect of fire on structural members. Meanwhile, fellow CASE student Graeme Flint is modelling the WTC towers under



Structural fire engineering techniques are being applied to a proposal for the 'Mincing Lane' development. Lessons learnt from the Cardington fire tests will inform both what sort of protection is recommended and how reactions to different types of simulated fire are modelled.

fire conditions. "The main challenges at this stage are finding an analysis technique that will provide realistic results within a reasonable time frame," he tells us. Allan Jowsey is only a year into his CASE studies but he already feels he has learnt a lot about creating models using the Fire Dynamics Simulator software. "My understanding of fire models has been vastly increased," he says, "while it's very easy for inexperienced users to build pretty models, the results they obtain are useless without a full understanding of the concepts behind the model and how to interpret these outputs."

The models used by fire engineers are, of course, only as good as the data they are based on. Both case studies of real fires and tests simulating the effect of fire on large steel frame buildings produced some unexpected results. These results showed that the components of a steel frame behaved in a different way when they were assembled and embedded in a building than they did when each component was tested individually. Fire engineers discovered that fire resistance could be maximised by protecting certain areas of the frame with special attention being needed around the connections to columns and floor slabs to increase the overall strength of the structure. These examples also demonstrated how many variables are involved in a real-life fire such as different combustible materials, the effect of sprinkler systems, whether glazing breaks or not or whether a fire keeps growing. The engineers concluded that passive fire protection could only achieve so much and should be used alongside active protection systems (such as sprinklers).

Below: Industrial CASE student Allan Jowsey

"My research into the possible collapse mechanisms will provide Arup with a basis from which to comment on the official report."

Allan Jowsey

"Allan Jowsey and Graeme Flint are pivotal to the progress of our research programme in structural fire engineering," comments Dr Asif Usmani, one of their supervisors. He points out that the School of Engineering and Electronics at Edinburgh is an internationally recognised centre of excellence and has created some of the world's largest computer models of building structures and set them (virtually) ablaze. "It is only through the combined understanding of the fire growth and the structural behaviour that the necessary integration of structures and fire models will be achieved. Developing robust and reliable integrated models is the ultimate goal and this is directly linked to Allan and Graeme's work and these CASE awards," he adds. According to Dr Usmani the studentships provide a pre-determined and immediate route to exploitation of the group's research by applying it to real-world problems from Arup projects. "The application of our work to these projects has enabled us to identify gaps in our knowledge that have led to new areas of research," comments Dr Usmani. Fellow supervisor Dr Jose Torero notes that there are other benefits too: "The biggest benefit, in my opinion, is the continuity that comes from a relatively steady stream of research funding. This helps us to maintain an impetus to make greater progress on a range of unanswered questions."

According to Allan Jowsey, a CASE studentship offers a great way to continue studying while building strong links with industry. "Not only are you allocated academic supervisors at a university, you are also linked often to more than one industrial supervisor at the company, so there are lots of people keen to help with any of your problems," he tells us. "Students are encouraged to get a taste of the work environment and gain experience. The CASE studentship also provides extra financial help."

Arup clearly believe that CASE has a lot of benefits for them too. Before joining the company Barbara Lane studied for her PhD at the University of Edinburgh as an EPSRC/EU-funded student: "On arrival at Arup I linked Edinburgh University into our CASE award scheme here and Susan Lamont, now also an employee, was our first sponsored student with the fire group," she explains. "Since then we have funded three other students at Edinburgh, two at Manchester University plus an additional student at Sheffield University." She tells us that the scheme helps them to recruit highly skilled personnel: "It also enables us to remain at the cutting edge of British research and offer specialists skills our competitors may not have access to."

At the end of his studentship Allan Jowsey hopes to work for ArupFire as a consultant. "There appears to be a new phase of buildings that are pushing the limits of structures," he says, "I expect these will push the limits of fire engineers too."

Contacts

For more information on the work at Edinburgh visit www.civ.ed.ac.uk/research/fire/index.htm or e-mail Dr Asif Usmani at asif.usmani@ed.ac.uk For more on ArupFire visit www.arup.com/fire or e-mail Barbara Lane at Barbara.lane@arup.com

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Above: Everyone enjoyed finding out about science at Science Alive!

Thousands of people learnt about the science of bridges, birdsong, volcanoes and many more topics at this year's Science Alive!

The event, held at Bristol's Galleries shopping centre 19-20 March, featured 19 different teams of scientists from a range of disciplines eager to talk about their exhibits to everyone from schoolchildren to shoppers. The brainchild of staff at the University of Bristol, Science Alive! was opened by scientist and TV presenter Professor Robert Winston and visitors included nearly 600 schoolchildren and over a thousand alumni as well as shoppers who went out looking for bargains and returned home with a better knowledge of the IgNobels, dinosaurs and heart disease.

Contact: www.gly.bris.ac.uk/www/sciweek/

Festival Taps In

Schoolchildren got to show off their knowledge of science and engineering alongside the experts at the annual Bath Taps Into Science Festival. Stalls on such wide-ranging topics as maths, liquid nitrogen and slime, electrostatics and Lego robotics caught the imagination of visitors bussed in from schools around Bath and North East Somerset. The event, organised by the University of Bath under EPSRC's PPA scheme, saw pupils from three schools run their own stalls. Other contributors included the City of Bath College, Wessex Setpoint and the BA. The event was held at Green Park Station, 12 March.

Contact: More at www.bath.ac.uk

Left and above: Pupils from all around Bath attended the Bath Taps Into Science Festival.

SAT's Balancing Act

EPSRC asks research community about the bigger picture.

The second Annual Conference of EPSRC's Strategic Advisory Teams, held 12-13 May at the DeVere Hotel Swindon, saw groups of delegates brainstorming key aspects of the research/training balance. The main role of the SATs is to assist EPSRC in identifying new and emerging opportunities in research and training and advising on specific topics.

SATs members are helping to develop EPSRC strategy.

EPSRC Chief Executive Professor John O'Reilly introduced the event by telling delegates that: "A special theme of this conference is to help us develop a high-level strategy for the balance of funding between postgraduate training and research, culminating in our 2005 business plan." Many interesting suggestions came out of the discussions that followed including the creation of a four-year PhD, developing interdisciplinary courses and input by EPSRC into course content. One group advised that "the top priorities for training should be the EngD and a four-year PhD" while others concluded that "the need to train the trainers and to use real-life role models," was of prime importance. Many attendees were impressed with the event including Professor Kathy Sykes who commented: "Not many organisations would respond so quickly to the views of an advisory group."

Left: The winner of this year's National Cipher Challenge, David Simner, with an enigma machine.

Web Cracker

David Simner from Nottingham High School has won the National Cipher Challenge for the second year running. The web-based cipher cracking competition is open to under-18s in full time education in the UK and involves solving a sequence of eight enciphered messages which were published between October 2003 and January 2004. The competition was designed so that participants in the Cipher Challenge trail learnt not only about ciphers but also some mathematics, science and engineering and the social and cultural context of the time in which the challenge is set. David Simner was presented with the IBM Prize, a cheque for £1,000, at Bletchley Park. The Cipher Challenge is the brainchild of Dr Graham Niblo at the School of Mathematics at the University of Southampton. This year there were 14,000 entries from 300 schools.

Contact: Solutions to this year's challenge and information on next year's at www.cipher.maths.soton.ac.uk

e-Science Expands

The expansion of e-Science to take in new institutions and new disciplines is the theme of this year's e-Science All Hands Meeting. The Meeting, to be held 31 August-3 September at the East Midlands Conference Centre, Nottingham, brings together e-Science collaborators from around the UK. Over the four days attendees will be able to join in tutorials and workshops and see demonstrations and presentations covering a wide range of projects. Discussions will cover every aspect of building and running Grid services as well as related topics such as data mining and visualization.

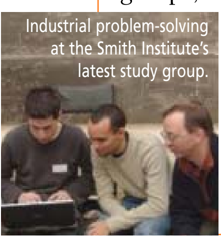
Contact: For info or to register visit www.allhands.org.uk

Maths Trouble-Shooters

Take about 100 mathematicians, add eight industrial problems and let the mixture simmer with good ideas and you have the recipe for the Smith Institute's latest Study Group.

The Group, which met at the University of Oxford 29 March-2 April, got to grips with real-life industrial problems such as modelling consumer behaviour, monitoring traffic flow using mobile phone data and optical measurement of glucose in the aqueous humour.

This 49th European Study Group with Industry attracted top firms such as Vodafone, Unilever and Motorola with the promise of new insights and solutions into their toughest problems. After the event an attendee from Unilever commented: "Good fun! We thought it very good value regarding what we got on our problems versus costs," while a representative from Motorola called it "an enriching experience." The EPSRC-supported Smith Institute Faraday Partnership runs workshops and groups, and offers advice and consultancy services, to help companies gain a competitive advantage through the application of mathematical modelling and analysis.



Industrial problem-solving at the Smith Institute's latest study group.

Contact: For more on this work visit www.smithinst.ac.uk

Talent, Training and Tomorrow

At this year's EPSRC Annual Conference details of a major new initiative to strengthen links between training and industry were unveiled. The new Collaborative Training Account (CTA) will provide a single, flexible method of funding all the schemes that link postgraduate training with the workplace. CTAs amalgamate current schemes including; Engineering Doctorate, Industrial CASE, Knowledge Transfer Partnerships, Masters Training Packages and Research Assistant Industrial Secondments. So far nine universities have run a pilot of the scheme. EPSRC Chief Executive Professor John O'Reilly commented that "the aim is to establish a dynamic and responsive environment which is better able to match training provision with industry's needs." The conference was opened with an address from Professor Julia Higgins DBE, Chair of EPSRC, who focused on the success stories of ten years of EPSRC, citing work by Sir Richard Friend and Sir Mike Brady amongst others. In his speech Professor O'Reilly highlighted the issue of how 18 year-olds "voting with their feet" about what subjects to study directly affects the research leadership capacity available at UK universities. He said that EPSRC was looking at how it could, in partnership with other funding bodies and Government, tackle the problem. The theme of attracting and retaining talented people in engineering and the physical sciences was continued with presentations from Professor Roland Clift of Surrey, who spoke on CTAs and EngDs, and Professor John Ryan of Oxford, speaking about interdisciplinary research and the LSI Doctoral Training Centres. The event took place at the British Library Conference Centre, 28 April.

Contact: More at www.epsrc.ac.uk

Above: Professor John O'Reilly raised the issue of research leadership capacity at EPSRC's Annual Conference.

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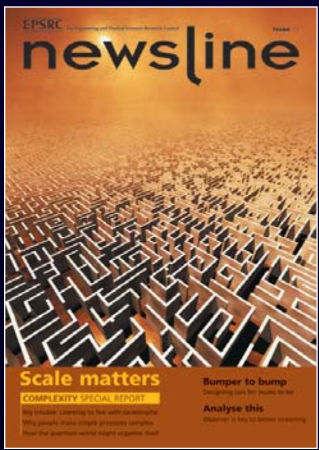
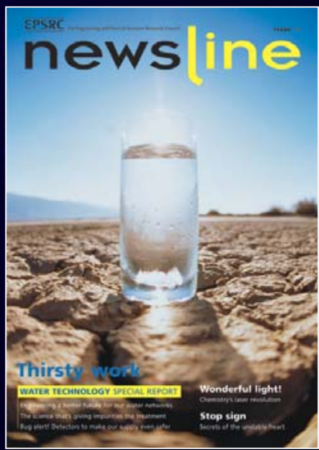
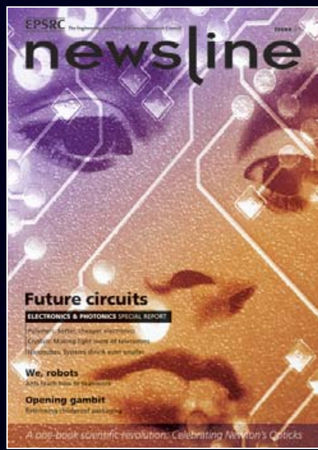


Newsline 27
A complexity special report with articles on car safety, cervical screening, spectroscopy and more.



Newsline 28
A special report on water technology with articles on laser chemistry and heart-stopping science.



Newsline 29
Electronics and photonics uncovered in a special report plus features on robotics and cell science.

Spotlight:
Women in Research
The support available to women in our research community.

Spotlight:
Border-Crossing Science
Highlighting the rewards and pitfalls of interdisciplinary research.

Spotlight:
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How EPSRC encourages researchers to develop international partnerships.

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