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UNIVERSITY OF Southampton
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New Boundaries | Issue 14 | June 2012

Exploring uncharted waters

Deep-sea vents teeming with new life

Enhancing MRI
Pioneering research could revolutionise MRI in hospitals

60 years of optical achievement
Revolutionising telecommunications

Reducing risk of bone disease
Improving childhood bone strength

In this issue

Welcome to *New Boundaries*, the University of Southampton research magazine. In this issue, you can discover the wide variety of world-leading multidisciplinary research that is being carried out here, in this our 60th year as a University.

On page four, learn how Southampton researchers from Ocean and Earth Sciences at the National Oceanography Centre Southampton discovered new species of animals while exploring the deep sea and how these discoveries affect how we view the oceans as a natural resource.

In 1952, one of Her Majesty The Queen's first acts as monarch was to sign the University's Royal Charter, enabling it to award its own degrees. On page 16, read about how the groundbreaking research that has been carried out at our Optoelectronics Research Centre (ORC), has made a difference to the world over the last 60 years.

From transforming the way we live to improving our long-term health, a team of researchers at the Medical Research Council Lifecourse Epidemiology Unit at the University are investigating the role of vitamin D in bone development with the aim of preventing diseases such as osteoporosis. Read more on page 22. And carrying on the medical theme, on page 10, find out how pioneering research in Chemistry could revolutionise MRI in hospitals leading to the early detection of cancerous cells.

On page 26, you can also find out how collaboration between our Health Sciences researchers and our world-class musicians involving motion capture technology is helping shed light on the techniques they use when playing music, in order to prevent repetitive strain injury.

This year to celebrate our 60th anniversary, we are promoting 60 of the University's world-changing successes and achievements. For more information, visit **www.southampton.ac.uk/60**

For more research stories, visit our website **www.southampton.ac.uk/research**

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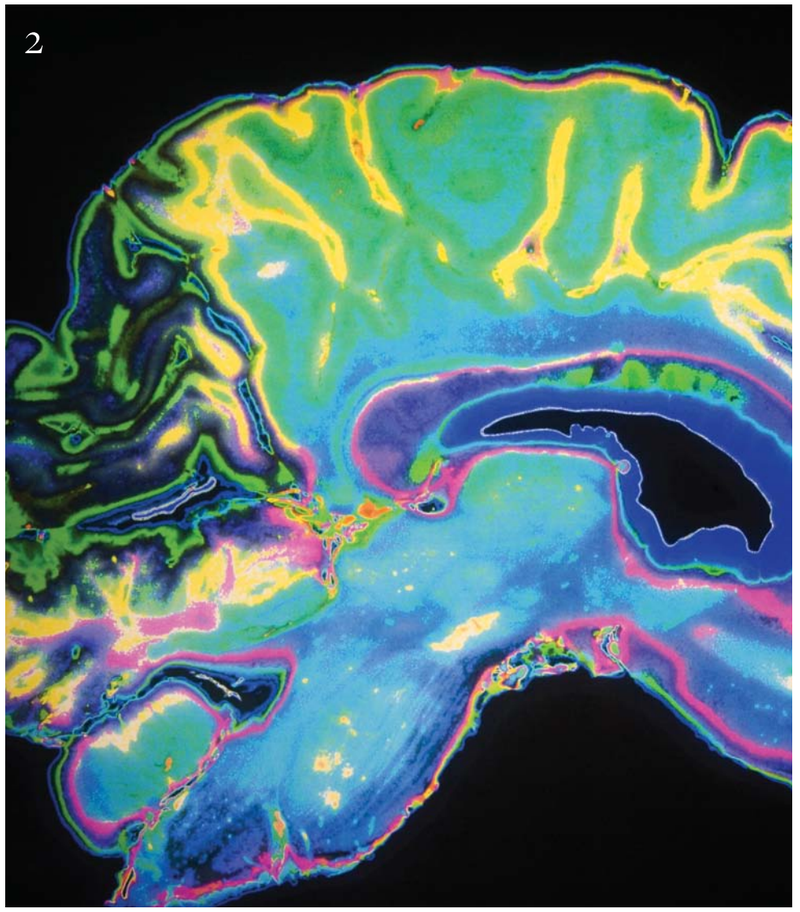
If you have any comments or suggestions about *New Boundaries*, please do send them to **newboundaries@southampton.ac.uk**



More highlights

Exploring uncharted waters

The deep sea is still relatively unexplored, but pioneering Southampton researchers have discovered deep-sea vents teeming with new life and valuable metals such as gold, platinum and copper. As precious metal resources on land increasingly become a cause for concern, we could consider looking to the oceans to provide the means to support our technology-led society.

Image courtesy of Leigh Marsh/
NERC ChEsSo Consortium

"It is very important for as many people as possible to be aware of our exploration and see what is down there, so that we can make informed choices regarding the exploitation of ocean resources."

Dr Jon Copley,
Lecturer in Marine Ecology

The vents are teeming with thousands of marine species

"This is the first set of hydrothermal vents to be found in Antarctic waters – hot vents in a cold ocean."

Paul Tyler,
Professor of Marine Biology

Two teams of scientists from the National Oceanography Centre Southampton have been the first to discover deep-sea vents and the marine life around them in the Caribbean and the Antarctic. In collaboration with the UK Natural Environment Research Council (NERC), a team led by marine geochemist Dr Doug Connelly and marine biologist Dr Jon Copley has found the world's most extreme deep-sea volcanic vents 5km down in a rift in the Caribbean sea floor, while a team led by marine biologist Professor Paul Tyler has discovered a new set of deep-sea volcanic vents in the chilly waters of the Southern Ocean.

Missing puzzle piece

Doug explains that the deep-sea vents in the Cayman Trough, an undersea trench south of the Cayman Islands, are the world's deepest known 'black smoker' vents, so called for the smoky-looking hot fluids that gush from them. The undersea hot springs, which lie 0.8km deeper than any seen before, may be hotter than 450°C and shoot jets of mineral-laden water more than a kilometre into the ocean above.

During an expedition in April 2010 aboard the Royal Research Ship *James Cook*, Doug and Jon's team used the National Oceanography Centre's robot submarine called Autosub6000 and a deep-diving vehicle, HyBIS, manufactured by the British firm Hydro-Lek, to locate and study the vents.

Mining for minerals

The vents, which the team named the Beebe Vent Field after the first scientist to venture into the deep ocean, gush hot fluids that are unusually rich in copper, and shoot mineral-laden water four times higher than any known deep-sea vents, into the ocean above, explains Doug. "As well as scientific interest, there is an economic interest in copper as well as other metals such as platinum and gold," he says. Although they were not able to measure the temperature of the vents directly, the hot fluids and the presence of copper deposits indicate that these vents may be hotter than 450°C. "These vents may be one of the few places on the planet where we can study reactions between rocks and supercritical fluids – liquids that behave like gases – at extreme temperatures and pressures," Doug adds.

"More than half of our planet is deep ocean and we are increasingly using this resource for different things such as fishing and extracting oil and gas. We are also starting to see mining for metals such as copper and iron from the sea floor," says Jon. "But we don't yet fully understand what governs the patterns of life down there. If we want to make responsible decisions about how to use the oceans sustainably, it is imperative we get the understanding and knowledge of the habitat," he adds.

Teeming with new species

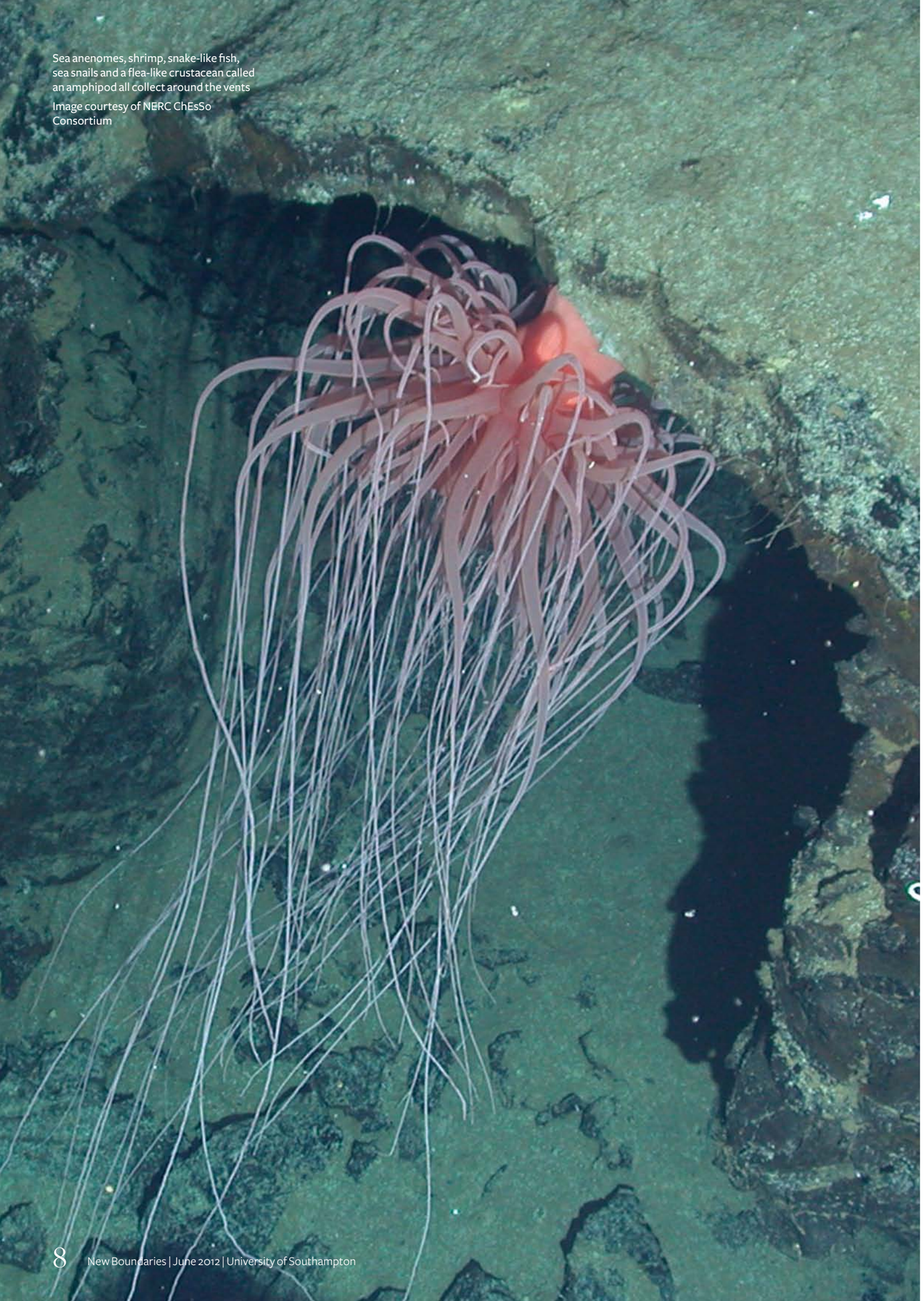
Jon explains that the concern with mining minerals from the sea floor is that it would have an effect on the animals that live there. "But it is worth pointing out that for every one active vent that has colonies of marine life around it, there may be 10 inactive ones where the venting has shut down and the life has moved on. Metal deposits would still remain and so there would be less impact mining near inactive vents," he says.

Despite the extreme conditions, the vents are teeming with thousands of a new species of shrimp that has a light-sensing organ on its back which may help it to navigate in the faint glow of deep-sea vents as it lacks normal eyes. The shrimp congregate in hordes (up to 2,000 shrimp per square metre) around the six-metre tall mineral spires of the vents and the team has named the shrimp *Rimicaris hybisae*, after the deep-sea vehicle that they used to collect them.

The Cayman shrimp is related to a species called *Rimicaris exoculata*, found at other deep-sea vents 4,000km away on the Mid-Atlantic Ridge. Elsewhere at the Beebe Vent Field, the team saw hundreds of white-tentacled anemones lining cracks where warm water seeps from the sea bed. "Studying the creatures at these vents and comparing them with species at other vents around the world will help us to understand how animals disperse and evolve in the deep ocean," says Jon.

Technological advancement

Jon explains that finding new species also has benefits for the advancement of technology: "Some species found at other vents have been used in biotechnology research to develop biomaterials," he says. "A lot of the microbes that live in these environments have enzymes that work at very high temperatures and these can be used in industry. Soft drink manufacturers already use a high-temperature enzyme to convert starch from potatoes into sugar. And the scaly foot snail, found in the central Indian Ocean, has metal plates on its foot – the unusual structures of which are helping researchers come up with improvements to body armour," he adds. ▸



Sea anenomes, shrimp, snake-like fish, sea snails and a flea-like crustacean called an amphipod all collect around the vents

Image courtesy of NERC ChEsSo Consortium

The researchers also found black smoker vents on the upper slopes of an undersea mountain called Mount Dent. Mount Dent rises nearly 3km above the sea floor of the Cayman Trough, but its peak is still more than 3km beneath the waves. The mountain formed when a vast slab of rock was twisted up out of the ocean floor by the forces that pull the plates of the Earth's crust apart.

"Finding black smoker vents on Mount Dent was a complete surprise," says Doug. "Hot and acidic vents have never been seen in an area like this before, and usually we don't even look for vents in places like this." Because undersea mountains like Mount Dent may be quite common in the oceans, the discovery suggests that deep-sea vents might be more widespread around the world than previously thought.

Hot vents in a cold ocean

The vents on Mount Dent, which the team has named the Von Damm Vent Field to commemorate the life of geochemist Karen Von Damm, are also packed with the new species of shrimp, along with snake-like fish, a previously unseen species of snail and a flea-like crustacean called an amphipod. "One of the big mysteries of deep-sea vents is how animals are able to disperse from vent field to vent field, crossing the apparently large distances between them," says Jon. "But maybe there are more 'stepping stones' like these out there than we realised."

Paul's research team aboard the *James Cook* in the chilly waters of the Southern Ocean has also discovered a new set of deep-sea volcanic vents. "This is the first set of hydrothermal vents to be found in Antarctic waters – hot vents in a cold ocean," says Paul.

Using an underwater camera system, Paul's team saw slender mineral spires three metres tall, with shimmering hot water gushing from their peaks, and gossamer-like white mats of bacteria coating their sides. The vents are at a depth of 520m in a newly discovered sea floor crater close to the South Sandwich Islands.

"When we caught the first glimpse of the vents, the excitement was almost overwhelming," says Leigh Marsh, a University of Southampton PhD student who was on scientific watch at the time of the discovery.

"We're finding deep-sea vents more rapidly than ever before," says Paul. "And we're finding some in places other than at mid-ocean ridges, where most have been seen previously." Paul explains that like Jon and Doug, his team has been finding new species living around the vents. "Some of them are known to live around hydrothermal vents, like the kiwa crab and the barnacle, but the densities of these species are amazing," he says.

The researchers were exploring Adventure Caldera, a crater-like hole in the sea floor 3km across and 750m at its deepest point. Despite its size, Adventure Caldera was only discovered last year by geophysicists from the British Antarctic Survey.

Privileged few

The new vents are the fourth set to be discovered around Antarctica in three expeditions since 2009. The Southampton team's discovery is part of a project funded by NERC, which involves researchers from the National Oceanography Centre Southampton, the British Antarctic Survey in Cambridge, the universities of Southampton, Newcastle, Oxford, Bristol and Leeds, and Woods Hole Oceanographic Institution in the US.

Paul, Jon and Doug believe that deep-sea exploration is truly a multidisciplinary science. To explore the uncharted depths of the oceans you need collaborations with organisations like NERC that bring together engineers and technologists to build the equipment and the expertise of chemists, biologists and physicists to analyse the resulting finds, explains Doug. "Our work with our research partners ensures that multidisciplinary research is done really well at the University of Southampton," he says.

"For me, one of the greatest things about our work is that we are the first people to see it. Jon and I have been very fortunate that in the last two years we have seen some really amazing things," says Doug. "It is a privilege to be the first people to see these places and I am very conscious that we need to share this with the public," says Jon. "None of us own the deep ocean; we all share the responsibility for its stewardship. So it is very important for as many people as possible to be aware of our exploration and see what is down there, so that we can make informed choices regarding exploitation of ocean resources," he adds.

For more information, visit **www.southampton.ac.uk/60** and **www.southampton.ac.uk/research**

Key facts

- More than 50 per cent of our planet is deep ocean and is still relatively unexplored.
- Deep-sea vents in the Cayman Trough lie 0.8km deeper than any seen before and may be hotter than 450°C.
- Despite extreme conditions, the vents are teeming with thousands of a new species of shrimp that has a light-sensing organ on its back.

Enhancing MRI

New research from the University of Southampton could lead to enhanced MRI scans, producing brighter and more precise images, and potentially enabling doctors to detect cancerous cells early, before they cause health problems.

Professor Malcolm Levitt from Southampton has been awarded a grant from the European Research Council of €2.8m to support research into enhanced nuclear magnetic resonance (NMR). Along with collaborators Professor Richard Brown, Dr Giuseppe Pileio from the University and Dr Lynda Brown, a Royal Society Dorothy Hodgkin Fellow, Malcolm hopes the research will lead to a range of clinical applications, including the early detection of cancer.

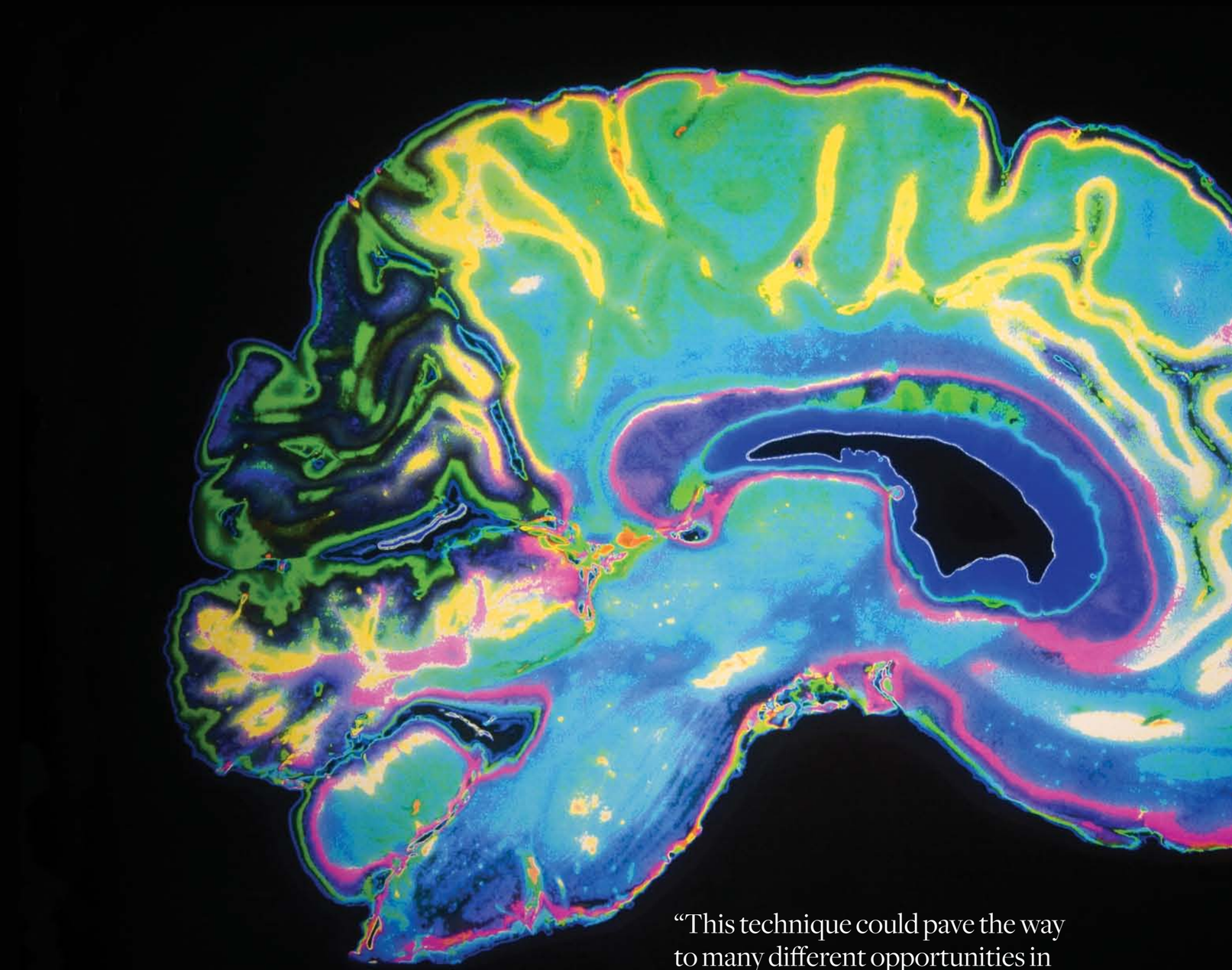
NMR is the physical principle underlying MRI scanning, which is used routinely to detect abnormalities such as tumours. NMR was discovered in the 1950s and is a technique where the nuclei of atoms, many of which are magnetic, interact with magnetic fields. The technique can be used to probe the molecular structures and properties of materials. Images of how the nuclei are distributed can then be created, which is the basis for MRI.

Strengthening signals

NMR signals are inherently very weak. However, methods have been developed recently which lead to substances exhibiting a phenomenon called hyperpolarisation which gives rise to NMR signals that can be more than 100,000 times stronger than normal. The problem is that this incredible enhancement only lasts a short amount of time – up to one minute in optimum conditions.

Research at Southampton has previously demonstrated the existence of quantum states that have extremely long lifetimes relative to the norm of several seconds – up to half an hour in the case of the common substance nitrous oxide, also known as laughing gas. The new research grant has been awarded for a project that involves a combination of the hyperpolarisation effect with the long-lived quantum states developed at Southampton. The combination could give the best of both worlds – enormously enhanced NMR signals, which last long enough to perform an MRI scan.

Malcolm says: "This could have benefits for MRI scanning. If you have strong signals, you can detect smaller amounts of substance that are less concentrated. For example, some substances naturally occur in a cell as part of the metabolism process, but occur in greater amounts in cancerous cells. Through this method, we should be able to detect when these substances are present and cells are potentially cancerous earlier than ever before." ▸



"This technique could pave the way to many different opportunities in MRI that are currently not possible and ultimately, it can benefit us all."

Richard Brown,
Professor of Organic Chemistry

A new NMR machine will be able to perform small-scale MRI experiments to test new concepts

"This method could allow us to detect oxygen levels in cells. When oxygen levels are depleted, this can mean that cells are metabolising more quickly, which can suggest that the cells are cancerous."

Malcolm Levitt,
Professor of Magnetic Resonance

Isotope labelling

Richard and Lynda are working on the design and synthesis of molecules that are labelled with stable isotopes such as carbon-13 with the objective of supporting these very long-lived quantum states.

Carbon-13 is an isotope of carbon that can be used in NMR because it is magnetically active, but its natural abundance is only 1.1 per cent, explains Richard. "This means that common MRI markers enriched with carbon-13 still do not have long enough lifetimes so their potential for MRI cannot be fully exploited," adds Giuseppe.

One group of compounds showing promise are synthetic carbon-13 labelled molecules that are derived from a natural product found in the human diet. "We are mainly looking at the synthesis of the molecules – that is the priority – but we are also still thinking about whether the molecules are soluble in water and compatible with human tissue," says Lynda. "We don't know the toxicology of the molecules yet; they would need to be tested, but we are keeping it in mind to make sure we stay on the right path," she adds.

Richard explains that another option would be to investigate metabolites as potential molecules to label. However, a lot of pre-existing work in the area of imaging focuses on metabolites. Their advantage is that they are not toxic as they are involved in metabolic pathways in the body, but the drawback has been that they can only be kept in an excited state for a matter of seconds, so it is impossible to track them to specific organs in the body.

Through this project Southampton researchers will be pushing the boundaries of what is known about molecules in hyperpolarised states and explore them in more detail. While they are in a hyperpolarised state for long periods of time, the team can manipulate the molecules to explore their unique properties, bind them to proteins with the aim of delivering them to certain organs in the body, or tag them to other proteins so they can follow their movements.

Meeting milestones

"At present we have got two classes of molecules that can support these hyperpolarised states," says Richard. "Already the lifetimes we are achieving are very interesting and way beyond what is in existence for carbon-13 magnetisation. As we get information back from the NMR experiments using these molecules, we can then refine the design," he adds.

The team's collaborators at GE Healthcare in Copenhagen are currently carrying out in vitro studies on the first set of molecules that Richard and his team have developed. "So it is actually moving really fast – the project is progressing really well because we have two groups here that can work closely and quickly together. The close cooperation between the synthesis and NMR groups, where the molecules containing stable isotopes are made and then assessed for their suitability for progression, or refinement of the molecular design, is really what counts," Richard says. "We have met some of the major milestones already," he adds.

New equipment

In addition to funding the research, the grant will allow for two new pieces of equipment to be installed at Southampton. One will be a polariser, which will be designed and constructed at the University, and will generate substances exhibiting the hyperpolarisation phenomenon. The second piece of equipment will be a NMR spectrometer equipped to perform small-scale MRI experiments, to test out the new concepts in preparation for performing experiments on a clinical MRI scanner.

Malcolm explains that one of the possibilities in applying this research to MRI scanning is that the images will have better resolution and be brighter. This could be important when imaging small structures like coronary arteries. "Additionally, this method could allow us to detect oxygen levels in cells. When oxygen levels are depleted, this can mean that cells are metabolising more quickly, which can suggest that the cells are cancerous."

Aiding existing therapies

From talking to medical experts, Malcolm has discovered that what the medical community really want is to image oxygen levels in cells to detect cancerous cells early. Doctors could then treat the affected area with radiotherapy at a very early stage and have a better rate of success. The enhanced-NMR technique could also be used in conjunction with radiotherapy to monitor the progress of cancer. "At present, the only way to tell if radiotherapy is working is to wait and see if the tumour grows again or regresses," he says. "What you need is a marker the day after the radiotherapy treatment to tell you if it has worked. By looking at oxygen levels in the tissue we might be able to do that."

The team hopes that this research, which will run over the next four years, will lead to the development of new tools for clinicians to detect all sorts of metabolic or anatomical abnormalities in the body. "This technique could pave the way to many different opportunities in MRI that are currently not possible and ultimately it can benefit all of us," says Richard.

Malcolm says that although the project is still at an early stage, the first results are promising. "The potential impact on medicine is quite large," he says. Applying the fundamentals of this enhanced NMR technique to MRI could lead to better quality images of all the body's internal organs.

The key to the versatility of the technique is to develop molecules that can stay in the hyperpolarised state for much longer amounts of time – as long as 30 minutes. This would allow the molecules to be used for many different applications. "What is exciting for the field of imaging is that if the lifetime issue can be overcome, it will really open the door again to major advances," says Lynda. "Such a long lifetime will give access to remote organs – this is not possible with current techniques – or allow images with enhanced contrast by allowing the agent to accumulate over a longer period. It could also be possible to tag the hyperpolarised long-lived agent onto a molecular vehicle to deliver it to the desired target – either a cell, tissue or organ," adds Giuseppe.

MRI technology is basically static at the moment and there is a limit to the organs we can image, explains Richard. "What we are really excited about is the prospect of seeing the first in vivo images using our technique," he says.

For more information, visit **www.southampton.ac.uk/research**

Key facts

- MRI is based on NMR, a technique where the nuclei of atoms, many of which are magnetic, interact with magnetic fields.
- Enhancing NMR signals could lead to brighter, more detailed MRI images.
- Depleted oxygen levels indicate that cells could be cancerous.

Safe water: a basic human right

Dr Jim Wright joined the University of Southampton in 2004 as a lecturer in geographical information systems – designed to capture, store, manipulate and manage all types of geographically referenced data. He talks to *New Boundaries* about the need for safe drinking water in the developing world.

Q *What are the main aims of your research?*

I am involved in the Aquatest project that looks to develop a new test for contaminated drinking water that can be carried out without specialist laboratory equipment or training. In many parts of the world, the laboratory infrastructure for monitoring drinking water does not exist, so people do not know if their water is contaminated. The new Aquatest device is intended to address this problem. Having adequate safe water is a basic human right, which is why the developed world has a responsibility to tackle this problem.

Here in Southampton, we have not been involved in the development of the new Aquatest device, but have instead been looking at water quality monitoring more generally. In particular, we looked at an existing low-cost test that is quite often used in developing countries, called the H2S test. Knowledge of the performance of this existing test not only provides useful information to those who use it, but also provides a benchmark for the new Aquatest device.

Q *What impact will your research have on society?*

The World Health Organization estimates that diarrhoeal disease resulting from inadequate water, sanitation and hygiene is still responsible for 1.9 million deaths a year – even more than 100 years after the public health pioneer John Snow did his groundbreaking work on cholera in London. We hope that by improving water quality monitoring, we can go some way to preventing at least some of these deaths.

Q *What sparked your interest in this topic?*

On a trip to southern Africa some time ago, I was struck by a curious contradiction. It seemed as though the world could successfully ship crates of fizzy drinks to even the remotest store in the most hard-to-reach village, yet providing people with water that was safe to drink was somehow a much harder challenge. This seemed like a very worthwhile issue to investigate further.

Q *What do you enjoy most about this topic?*

The project has given me a chance to work with an interesting and diverse group of people and do research that might someday make a difference to a major health problem.

Q *Could you tell us more about one of your team's recent successes?*

In the last 10 to 20 years, people have become increasingly interested in encouraging people to treat their water at home, for example by boiling or filtering it, to make it safe. However, it's unclear how many people around the world already treat their water in some way. My colleague Dr Hong Yang recently found some data from China, a country previously not included in the statistical data. Since China has such a large population and many people in rural China boil their water, including these Chinese figures doubled the global estimate of the number of people who treat their water at home.

Q *Why is Southampton a good place to do this type of research?*

Geography is a very broad discipline and that breadth is very useful in studying problems that cut across many different disciplines. Within Geography here in Southampton, we have quite a large group who work specifically on health issues as part of the Centre for Geographical Health Research. Being able to draw on the skills and expertise of this group is a big help.

Q *How important is multidisciplinary collaboration in your research?*

Multidisciplinary collaboration is very important. The Aquatest group has included people from many different academic backgrounds, such as chemists, civil engineers, microbiologists, social scientists, public health experts and environmental scientists. Having the right interdisciplinary mix is not only important for solving real-world problems that cross academic divisions between disciplines; it can also help you personally as a researcher understand how somebody with very different academic training would approach a problem.

Q *How would you rate Southampton for early career research opportunities?*

Southampton presents quite a few interesting opportunities for early career research – it has a very multidisciplinary philosophy and I think many of the most exciting opportunities lie at the boundary between disciplines. Younger researchers here are in a particularly strong position to exploit those opportunities.

Q *What have been your biggest achievements since joining the University?*

We are just about to publish an article looking at what would happen if the way of measuring access to safe water under the international Millennium Development Goals (MDG) was modified to include water quality. At the moment, the MDG indicator is based on the type of water source because water quality data are patchy internationally. For example, piped water is considered safe while streams and rivers are unsafe. We looked at what would happen if we took into account robust water quality data on major contaminants like arsenic in five countries. Factoring in water quality like this suggests that there is still much to be done in delivering safe water internationally.

For more information about geography research at Southampton, visit **www.southampton.ac.uk/geography**

60 years of optical achievement

Our 60th anniversary year is a time to celebrate and reflect on the successes achieved at the University over the last 60 years. One such success story, the Optoelectronics Research Centre (ORC), has revolutionised the telecommunications industry by developing optical fibres that have formed the basis of the global internet.

The results of research at the ORC have touched everyone's lives one way or another, according to Professor David Payne, Director of the ORC. Arguably the most important break-through here is the development of low-loss optical fibres which now form the basis of the global internet, he explains.

"The whole global internet relies on our invention of erbium-doped fibre amplifiers that amplify optical signals, which allow fast telecommunications. Whenever you use a mobile phone you are probably using our amplifiers, because the phone signal goes to a mast that is then optically connected through fibres to other masts," he says.

Solid foundations

The ORC was established in 1989, but the research that forms its foundations at Southampton began in the 1960s when researchers started work on a newly invented device – the laser. One such researcher is Dr Robert (Bob) Smith who went on to become the first Vice-Chancellor of Kingston University in the UK. "I started my laser research about 12 months after the first working laser was operated in the United States," he says.

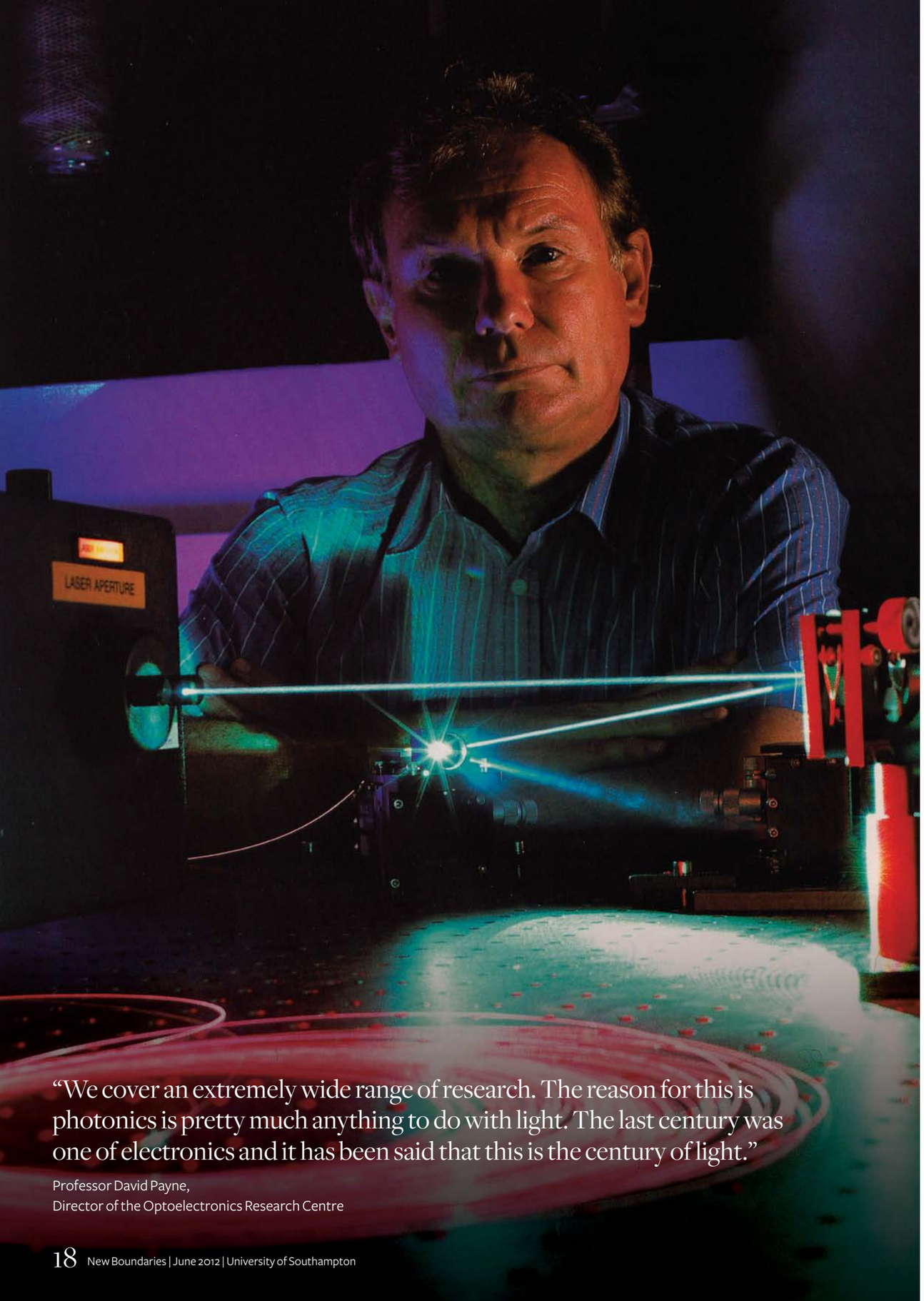
As a postdoctoral researcher in 1961, Bob worked in the electronics department under Professor Alec Gambling. By basing his laser on the American design, Bob operated one of the first ruby lasers in the UK. "It was centred on a piece of ruby crystal with a flash lamp to put power into it. Both ends of the crystal were polished flat and coated in silver," he explains. "The light would bounce backwards and forwards between the two flat ends – nearly all the first lasers were like that."

Bob explains that the laser research was blue sky thinking. "We talked about a range of applications from optical communications to possible medical applications – lasers are used extensively in eye surgery these days along with many other treatments," he says.

In Autumn 1964, Alec presented a paper to the Southampton meeting of the British Association for the Advancement of Science, in which he suggested that optical fibres – flexible, transparent fibres made of silica that transmit light between the two ends – could be used for high-speed communications. ▸

"There is enough optical fibre installed globally today to circle the world over 30,000 times."

Professor David Payne, Director of the Optoelectronics Research Centre



"We cover an extremely wide range of research. The reason for this is photonics is pretty much anything to do with light. The last century was one of electronics and it has been said that this is the century of light."

Professor David Payne,
Director of the Optoelectronics Research Centre

The team started collaborating with a military unit in Christchurch, in the New Forest, as the development had great potential for battlefield communications. "On the battlefield there is lots of electrical interference, but light is not an electrical signal so wouldn't be interfered with," Bob says. By 1966 the group was focusing on trying to make long-distance light communication a practical reality.

Making the impossible possible

"There is enough optical fibre installed globally today to circle the world over 30,000 times," says David. At the time of starting his PhD at Southampton the thought of covering the world with optical fibres that carry a global internet never occurred to him. "We thought at the time that it would be good to get from Southampton to London and even that seemed impossible," he adds.

David explains that when he was an undergraduate and postgraduate student at Southampton, it was a very young university and the environment in the UK was that the impossible could be achieved. "We were in an interesting situation of being the only low-loss fibre developers outside of big, heavily protected corporate research labs and as a result the world literally beat a path to our door," he says. By 1969 the first optical fibres were being drawn using the unique fibre drawing tower at the University. "They just couldn't believe that they could come to our labs and see kilometres of low-loss optical fibres being made."

Today, the impact of the ORC spreads way beyond global telecommunications with the research penetrating many industries, especially manufacturing. David explains that every single 'special' optical fibre in the world today apart from one type was developed in the ORC. These optical fibres are used in a variety of applications, such as high-powered lasers for machining, cutting or welding and medical devices. "They are also found in the Moon Rover and Mars Explorer among other things," he says.

The ORC has 64 laboratories and the leading fibre manufacturing clean rooms in Europe. As well as fibre, it carries out research on new concepts relating to silicon interconnects on microchips, light-emitting devices involving silicon, next-generation nanotechnology and investigating new materials that can be manipulated to behave in ways that nature has not intended. "We cover an extremely wide range of research. The reason for this is photonics is pretty much anything to do with light," says David. "The last century was one of electronics and it has been said that this is the century of light."

Looking to the future

Research at the ORC now has changed massively since the 1960s, but the ethos of blue sky thinking and pushing the boundaries of the field is still very much a part of the culture. Dr Anna Peacock is aiming to revolutionise optical communications still further with her research. The age of optical communications has been enabled by semiconductor-based chips used to process optical data and the low-loss optical fibres used to transport the data, she explains.

"The aim of my research is to combine these two technologies by incorporating semiconductor materials inside the fibres. This will enable the fibres to act as processors as well as transmitters of light, transforming the way information is distributed," she says. Anna hopes to develop fibres that will increase the speed and capacity of telecommunication systems, while at the same time offering reduced energy consumption. "The broad wavelength range over which these fibres can transmit light means that their applications also extend beyond communications and into areas such as medicine, sensing, imaging and security monitoring. For example, compact mid-infrared laser sources could be used in tissue imaging and drug analysis."

Anna explains that the reason she wanted to work at the University was because of the ORC. But more recently she has been exposed to more of the multidisciplinary research that goes on at Southampton. "The amount and quality of the interdisciplinary research that is carried out at the University is very impressive," she says. "We also have access to many instruments and facilities that we can use in our research in other areas of the University, such as Chemistry, which is a great benefit."

Enterprising edge

As well as developing cutting-edge technology the ORC has been instrumental in commercialising products and supporting local business. "There are at least 10 companies in the local area that owe their existence to the ORC and they are selling globally and employ large numbers of people," says David. "For example, the world's premier special fibres supplier, Fibercore, trades on the University of Southampton Science Park," he adds.

Bob believes that the University now has a very interesting phase ahead because global competition is getting much tougher. "The ORC is an example of the University nurturing an idea which has now become a world-leading research centre. It is about consistency," he says. "Southampton is very clear, even when I was an undergraduate student that it had a research mission, as well as an educational mission," he adds.

"The work that we do here at Southampton, not just in the ORC, but in the whole University, is very focused on creating wealth for the nation," says David. "We are an entrepreneurial and agile university that loves to work with industry and take real tangible things forward for the benefit of the economy and mankind. And long may it continue," he adds.

For more information, visit **www.southampton.ac.uk/60** and **www.southampton.ac.uk/research**

The Southampton biometrics tunnel studies gait to help identify individuals. The SuperIdentity project is going further to analyse online behaviour as well

Combating identity fraud

Dr Sarah Stevenage, Acting Head of Psychology at the University, is the principal investigator on the SuperIdentity project and coordinates the activities of some of the most influential minds in the country on identity fraud. She talks to *New Boundaries* about her research.

Q *What is the focus of your research?*

My research focuses on 'who you are' – a rapidly changing concept given our capacity to represent ourselves in the real world and online in quite different ways. From the perspective of the law, who you are refers to your physical or biological identity, and it is revealed through measures that, in combination, are unique to you. But at another level, our identity is not discrete or fixed. Some prefer the notion of a fluid identity through which we show different sides of ourselves in different situations or social contexts. With this understanding, our identity in any one context is only part of the whole – a piece in the puzzle.

Q *What is the aim of the SuperIdentity project?*

Every individual has different roles contributing to their identity and these can be revealed through different measures, each of which can help to identify that individual. The SuperIdentity project recognises this and aims to improve identification processes and quantify certainty, by combining unique biometrics across both real and cyber domains. Our aim is to get a more complete sense of how people express their identity.

However, we will also explore the capacity to use what is known about an individual to predict other useful information, and this has clear benefits for intelligence and criminal investigation.

Q *What impact does your research have on society?*

Identity in today's internet world is changing and our digital identity can be described as being akin to a new currency. In the same way that pounds and pence might have bought services or goods in the past, verification of a digital identity can now be used to enable access to a whole host of services online. As a result, the need to protect privacy and identity is a critical emergent issue.

In this context, it is worrying that levels of identity fraud are so great. Identity fraud is estimated to cost £1.96bn per year in the UK alone (Annual Fraud Indicatory, 2011) and the threat to cyber security is named in the top five threats to national infrastructure. The more that we can understand identity in this technologically sophisticated age, the more we can protect against the emotional and financial costs associated with identity theft.

Q *What sparked your interest in this topic?*

As a portrait artist, I have always been fascinated by the human face and my doctoral work in psychology explored the face as a means of identifying the individual. My teaching has sparked an interest in forensic psychology and these two topics are intertwined in the area of criminal identification. For me, this work represents a perfect mix of ingredients – academic fascination, and real world, civic value – it's an exciting combination.

Q *What do you see as your biggest challenge?*

The issues that surrounded UK plans to introduce a national ID card highlights some of the challenges that face the SuperIdentity project. The national ID card scheme was eventually abandoned as a result of a significant expression of public discontent. While the concept may have been well articulated, and indeed has been successfully introduced in a number of European countries in recent years, the scheme was not well accepted here because individuals did not have trust in the system.

As a result, issues of legal acceptability and social responsibility are pivotal in the SuperIdentity project so that we are guided by consideration of what we can and what we should do.

Q *Why is Southampton a good place to do this type of research?*

The reputational value of the University is key and recognises the hard work of colleagues across all disciplines. Southampton is also home to a broad set of allied disciplines bidding for recognition as a Centre for Excellence in Cyber Security, and this provides a valuable context for the research that we describe.

Q *How important is multidisciplinary collaboration in your research?*

A multidisciplinary approach enables the generation of innovative and ambitious ideas. In this sense, multidisciplinary collaboration on the SuperIdentity project is critical. The work we are engaged in draws on expertise spanning forensic anthropology, human and automated biometric recognition, social psychology, cyber psychology, human-computer interaction, digital security and law, each of which contributes a unique perspective on identity in the modern age.

Q *What have been your biggest achievements since joining the University?*

I have been fortunate to be involved in a number of activities and am grateful to have worked with highly skilled colleagues along the way. I am delighted to be contributing to the SuperIdentity project alongside academics who I now count as some of my closest colleagues. I also remain proud of my contribution to teaching within Psychology, and I have been honoured to receive the Vice-Chancellor's Teaching Award on two occasions. I have also recently put my teaching skills to the ultimate test – delivering a Crime Scene Investigation day for 12 year-olds as part of the Learn with US outreach programme.

For more information, visit **www.southampton.ac.uk/research**

Reducing risk of bone disease

In the UK, low levels of vitamin D are relatively common. While severe deficiency leading to bone disease such as rickets is usually only seen in individuals with darker pigmented skin, researchers at Southampton have found that, in the general population, less marked deficiency during pregnancy may predispose the offspring to osteoporosis and fractured bones when they are adults.

Health risk

Osteoporosis is a major public health problem costing the UK economy in the region of £2.1bn annually. At 50 years old a woman's risk of future bone fracture is 50 per cent, while the figure for a 50-year-old man is 20 per cent. "There is a growing body of evidence suggesting that poor growth in the womb and in early childhood might increase the risk of osteoporosis in later life," explains Dr Nicholas Harvey from the Medical Research Council (MRC) Lifecourse Epidemiology Unit (LEU) at the University.

Nicholas is principal investigator on the Maternal Vitamin D Osteoporosis Study (MAVIDOS), which forms part of a wider programme of research led by Professor Cyrus Cooper, the Director of the MRC LEU, into how factors acting during pregnancy and early childhood might have long-term influences on bone development. "Our particular interest is osteoporosis – previous work from our unit has shown that if you grow poorly in early life, you have an increased risk of weak bones and fracture in adulthood," says Nicholas.

Vitamin D helps the body absorb calcium from food, in order to ensure optimal calcium mineral content, and thus strength, of the skeleton. In humans, the body can synthesise vitamin D in the skin when sun exposure is adequate and it is also present in a few foods such as oily fish. Since most people's diets are low in vitamin D in the UK, the majority is derived from sun exposure.

Individuals who have darker pigmented skin are at highest risk of symptomatic vitamin D deficiency as the darker skin reduces the ability to synthesise vitamin D; those individuals who are housebound are also at increased risk. Across the general population levels tend to be lower in winter than summer as a result of fewer daylight hours. "Current guidance suggests that repeated short periods outdoors over the summer months should help maintain reasonable levels of vitamin D, but it is difficult to be sure exactly how much you are getting from sunshine exposure," says Nicholas.

Measuring bone shape using ultrasound is done in the first two weeks of life

"MAVIDOS and other investigations underway at MRC LEU will, we hope, pave the way for potential future strategies aimed at improving childhood bone strength and thus making them less at risk of osteoporosis and broken bones in later life."

Professor Cyrus Cooper, Director of MRC LEU

Vital evidence

In previous studies the Southampton team has found several factors which influence offspring bone development in the womb, including maternal smoking, physical activity and nutrition during pregnancy. These studies have followed the offspring of women into childhood and identified that the most important single factor is the level of maternal vitamin D level during pregnancy.

"Children assessed at birth or nine years old born to mothers who have low levels of vitamin D in pregnancy tend to have lower bone mass than children born to mothers who have good levels of vitamin D," says Nicholas. He explains that as the past studies were observational, they cannot be sure that the low levels of vitamin D in pregnancy actually caused the reduced bone mass in the offspring and therefore MAVIDOS is designed to provide this vital evidence.

MAVIDOS is a clinical trial that was started in September 2008 and aims to recruit almost 1,000 women over three centres – Southampton, Sheffield and Oxford. Funded by Arthritis Research UK, MRC, Bupa Foundation and the National Institute for Health Research (NIHR), MAVIDOS has recruited over 650 women so far and has recently seen the birth of the 500th baby. "We are delighted with our progress and we are grateful to the women of Southampton for giving up their time to take part in this study," says Nicholas. "The centres in Oxford and Sheffield will help us look at the different populations in different parts of the country."

The study's 500th baby, Rowen Stephen Hall, was born on 18 February 2012. "I think it is really important to do research like this. Nothing is ever going to change without research and we knew it would be perfectly safe," says his mother Verity Hall. "Hopefully it will help children in the future," she adds.

Measuring bone mass

Women are recruited at 12 weeks of pregnancy when they attend hospital for their dating scan. If they agree to take part and have vitamin D levels in the low to normal range the women are randomised to either 1,000 units of vitamin D daily or to a matched placebo tablet for the duration of the pregnancy, explains Nicholas. The study tests, in a controlled double-blind setting, whether maternal supplementation with vitamin D during pregnancy will lead to improved bone mass in the offspring.

"The woman takes the tablet every day through pregnancy and the primary outcome is a measurement of the baby's bone mass – the amount of calcium in the bone – using a bone density scan within the first two weeks after birth," says Nicholas.

He explains that as well as bone mass data, the team collect information on each woman's diet and past medical history as well as taking blood and urine samples. They can also look at the babies when they are in the womb using high-resolution ultrasound scanning.

Aiming high

By using ultrasound to study the femur bones of developing babies, the team may gather further evidence that vitamin D can lead to changes in the shape of bones and bone mass of offspring. "In another Southampton study, the Southampton Women's Survey, we found that if you look at the babies in the wombs of women who have low levels of vitamin D in pregnancy, you find that the baby's femur is widened at the end, compared to its length – this is a similar shape to femur bones that you see in infants who suffer from rickets," says Nicholas.

The team hopes that if the study shows that supplementing vitamin D in pregnancy leads to an increase in the bone mass in infants, the evidence will inform government policy on supplementation. "At present government guidance suggests that a low dose of vitamin D should be given in pregnancy and early infancy, but at the moment the evidence underpinning this is limited," says Nicholas. "This study is likely to be of critical importance in helping the government decide the optimal strategy nationally regarding vitamin D supplementation," he adds.

"MAVIDOS and other investigations underway at MRC LEU will, we hope, pave the way for potential future strategies aimed at improving childhood bone strength and thus making them less at risk of osteoporosis and broken bones in later life," says Cyrus. "If MAVIDOS demonstrates that maternal vitamin D supplementation results in optimised bone development of the baby and subsequently the child, it will be the first trial in any area of medicine which clearly demonstrates that a developmental intervention in the mother is associated with an outcome of wide health relevance in the offspring," he adds.

"MAVIDOS also provides a unique opportunity to explore whether vitamin D deficiency actually contributes to illnesses such as diabetes and asthma, and furthermore, whether supplementation with vitamin D will reduce the risk of such diseases occurring," Nicholas explains.

For more information, visit **www.southampton.ac.uk/research**

Key facts

- Severe vitamin D deficiency can lead to bone diseases such as rickets.
- Osteoporosis is a major public health problem, costing the UK economy £2.1bn annually.
- Evidence suggests that a low vitamin D level in pregnant women is linked to poorer bone growth in their babies.

Musical techniques revealed

Researchers at Southampton are pioneering a new way of using motion capture technology to examine the way different piano playing techniques affect the sound quality of the music produced.

"In essence we are able to bottle the musician and show how they use their wrist and hands to play the piano and develop the techniques they use to create music."

Dr Cheryl Metcalf, Health Sciences

Our hands are important in every aspect of what we do, whether it be gesturing and communicating, lifting and carrying or interacting generally with the world around us. By using a unique kinematic measurement technique known as HAWK (Hand And Wrist Kinematics), researchers will be able to look at individual pianists' playing techniques to gain an insight into the posture of their hands on the keys and the movements they use to produce music.

The researchers hope that the data will also provide new information on the hand health of musicians to combat wrist injury in the form of repetitive strain injury – a common problem for pianists.

Unique expression

The project is being led by world-renowned pianist and Southampton Music Professor, David Owen Norris and Health Sciences researcher Dr Cheryl Metcalf. "Measuring human hand function is complex given the many different ways we can complete a task. Creativity is fundamental to hand function and to self-expression. HAWK analysis will enable us to understand the biomechanics of how musicians achieve their unique expression," says Cheryl, who designed, developed and validated the HAWK technique.

The process works by capturing the movements of a pianist's hands as they play. "Twenty six 3mm reflective markers are placed on specific parts of the wrist, hand, fingers and thumb – they are tiny and don't interfere with the hand movement," says Cheryl. The positions of the markers are picked up by infrared Vicon cameras while the pianist plays. "If a marker is picked up by more than two cameras the movement can be reconstructed in three-dimensional space. This is done for all 26 markers."

Cheryl and her team then tell the system which part of the hand each marker is from and then the 3D data is used by HAWK to define the relationships between the markers. "It calculates, to a precision of less than one degree, the joint angles of the wrist, the curvature of the palm and all the movements of the thumb and fingers," says Cheryl.

Bottle the musician

"When I saw how Cheryl's system can analyse exactly what we are doing with our hands, I realised that together we could find answers to some fundamental questions by making an archive of piano-playing," says David. "Pianists could appear in a dual archive of sound recordings and HAWK data and we could then see exactly how the sounds are made," he adds.

"What is really exciting is breaking down hand movements to see how the hand functions – with HAWK you can break down an automatic response into its component parts," says Cheryl. "In essence we are able to bottle the musician and show how they use their hand and wrist to develop the techniques they use to create music," she adds.

One of the aims of the project is to be able to bring pianist injury to the attention of students at the University. By recording their playing technique when they arrive at Southampton and then a year later, David hopes to draw their attention to good and bad practice. "When playing the piano using the HAWK technique, the very fact of having my attention drawn to particular aspects of flexibility reminded me of aspects of piano playing that I might not have thought about," he says. "It didn't change the way I play, but it did change the way I think," he adds.

At this stage the team has studied David playing an electric keyboard to prove that the technique works. But he explains that an electric keyboard is not very responsive to the subtleties of touch. "These subtle distinctions in sound produced by small changes in touch are only observable on a really high-quality instrument like a grand piano," says David. For the experiment to be successful and useful a fully equipped recording studio, a high-quality grand piano and the HAWK system are needed, he says.

Teaching tool

David believes that a piano-playing archive could be an internationally renowned asset to the University. "Whenever a great pianist came to Southampton we could record them playing, analyse their hands and listen to the sound produced," he says.

The piano-playing archive could also be used as a teaching tool for students. By slowing each recording down, you could see how a pianist plays. "In theory you could select how you would like to play and learn that way of doing things," says David.

The team believes that in the future HAWK could be used by other musicians. David suggests that they could look at how different violinists use their hands to put pressure on the strings in order to produce notes.

For more information, visit **www.southampton.ac.uk/60** and **www.southampton.ac.uk/research**

In brief

Improving solar power

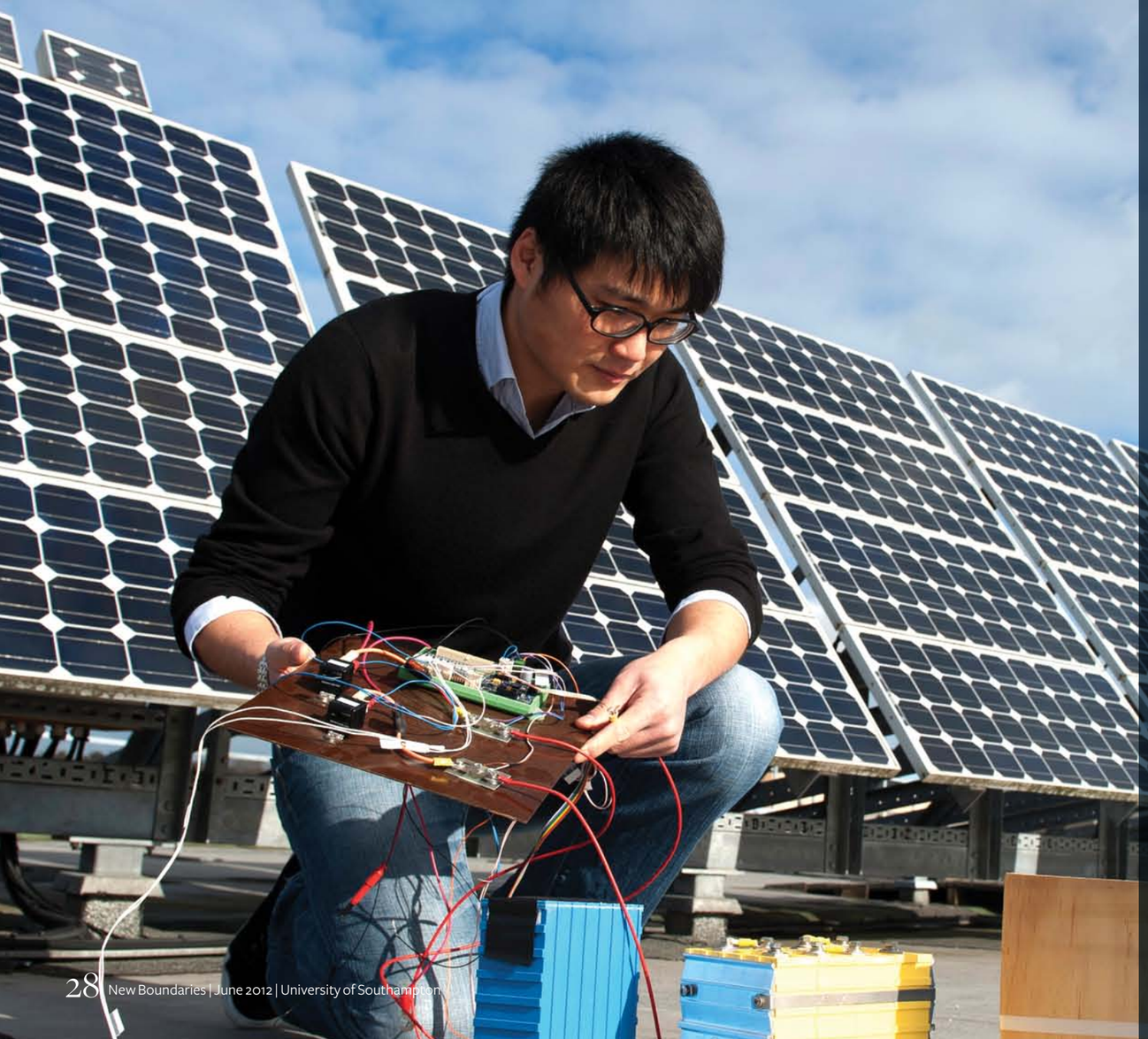
A joint research project between the University of Southampton and lithium battery technology company REAPsystems has found that a new type of battery has the potential to improve the efficiency and reduce the cost of solar power.

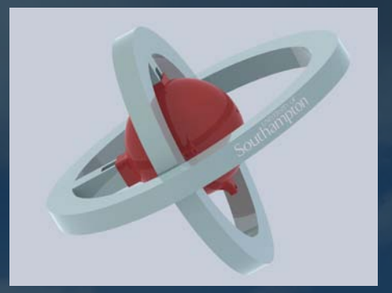
The research project, led by MSc Sustainable Energy Technologies student, Yue Wu and his supervisors Dr Carlos Ponce de Leon, Professor Tom Markvart and Dr John Low, looked specifically into the use of lithium batteries as an energy storage device in photovoltaic systems.

"Lead-acid batteries are traditionally the energy storage devices used for most photovoltaic systems. However, as an energy storage device, the lithium battery, especially the lithium iron phosphate battery we used, has more favourable characteristics," says Yue.

The research showed that lithium batteries have an energy efficiency of 95 per cent whereas the lead-acid batteries commonly used today only have around 80 per cent efficiency. "The weight of the lithium batteries is lower and they have a longer life span than the lead-acid batteries," says Yue.

Although the battery will require further testing before being put into commercial photovoltaic systems the research has shown that it has the potential to improve the efficiency of solar power systems and help to reduce the costs of both their installation and upkeep.





ASTRA Atom

Southampton engineers have produced the world's first fully 'rapid prototyped' unmanned aerial vehicle for monitoring Earth's atmosphere. The bespoke high-altitude device is an example of the ability to design and manufacture vehicles quickly that can protect scientific instruments in extreme conditions.

Using conventional techniques to develop platforms that carry out atmospheric measurements can take months. But Dr András Sóbester, lead researcher on the Atmospheric Science through Robotic Aircraft (ASTRA) project, and his team have printed a balloon-borne pod – dubbed the ASTRA Atom – on a 3D printer that fabricates plastic objects by building them up layer by layer. Moreover, the on-board electronics have been constructed from an open-source rapid prototyping toolkit (.NET Gadgeteer).

The aircraft is protected by foam 'orbits' designed to absorb the energy of touchdown so the equipment inside is undamaged. "The bespoke high-altitude device is an example of a new development philosophy, whereby such vehicles can be designed and manufactured around a given scientific instrument in days." says András.

Platforms like the Atom could be developed, for example, for making observations of phenomena like volcanic eruptions or nuclear fallout. "In such cases, rapid prototyping translates into fast response and timely measurements," András adds.

Sport reduces reoffending rates

A new research project into the role of sport in rehabilitating young prisoners has found that sports-based interventions can be effective in reducing the reconviction rate of offenders.

The research project led by Dr Rosie Meek, a lecturer in psychology at Southampton, was part of her evaluation of the Portland Prison Sports Academy, an initiative developed by Bristol-based organisation, the 2nd Chance Project.

Rosie has been working with 81 young male adult offenders at Portland Young Offender Institution in Dorset, who took part in football and rugby academies, accompanied by intensive resettlement casework which aimed to improve their opportunities after completing their sentence. The research has involved monitoring inmates' improvements during and after participation in the scheme, and tracking their progress after release.

"I have devoted much of my research to exploring the psychological and social processes involved in the transition from prison to the community," says Rosie. "Young offenders have one of the highest rates of reconviction after release, with around three quarters reoffending within a year."

Despite representing a high risk group of challenging young people with complex needs, of the 50 participants who have been released over the past 18 months, nine have reoffended or been recalled to prison, representing a promising 18 per cent reconviction rate. However, Rosie will continue to monitor the progression of the participants as part of her wider investigation into reoffending among young men after release from prison.

Enhancing speech recognition technology

New research led by the universities of Southampton and Cambridge is hoping to understand how the human brain hears sound to help develop improved hearing aids and automatic speech recognition systems.

Hearing impairment affects about 10 per cent of the UK population and today's speech enhancement systems can reduce noise and increase speech quality, but they are not good at improving speech intelligibility, especially in noisy situations where users have to concentrate to pick out single speakers.

Dr Stefan Bleeck, from the Institute of Sound and Vibration Research at Southampton, is looking to create algorithms based on neuronal responses to give insights into how sound is coded within the brain. Researchers will then be able to select the parts that code speech and the ones that code unwanted noise and ultimately resynthesise sound in hearing aids with reduced noise, but with quality intact, to enhance speech intelligibility.

"My vision is to build a brain-inspired speech enhancer in the next five years, which will be able to identify sound sources and to enhance speech intelligibility. This should be useful in everyday situations, for hearing impaired as well as normal hearing people, so that it ultimately reduces the stigma that hearing aids have today," he says.

In brief

Vital food security research

The University of Southampton has joined together with four other institutions to provide vital research in food security as part of the new Doctoral Training Partnerships scheme, announced by the Universities and Science Minister, David Willetts.

The initiative, which is funded by the Biotechnology and Biological Sciences Research Council will build on the excellent research training offered by universities and foster greater sharing of good practice to ensure the next generation of bioscientists develop the skills that the UK needs.

Southampton is part of the consortium with the universities of Reading, Surrey and Lancaster and Rothamsted Research. The consortium has been awarded approximately £1.8m for 18 PhD students who will address the challenges of feeding the globe's population healthily and in a sustainable way.

Southampton and partners are matching the BBSRC investment from their own budgets to increase the number of PhD students that will be trained under the programme.

Professor Guy Poppy, Director of Multidisciplinary Research at the University who led the bid from Southampton, says: "Food security requires multidisciplinary research and the breadth of coverage required and research approach to addressing food security is a good example of what Southampton can do well."

Helping hairdressers go green

Research at Southampton is helping hairdressers change the way they work in order to benefit the environment and cut costs by introducing sustainable business practices at salons.

Every day hairdressers deal with strong chemicals in the form of bleaching agents and dyes and disposal of these can have environmental implications. They also use large amounts of electricity and water, so Dr Denise Baden from the Southampton Management School has secured almost £100,000 from the Economic and Social Research Council for a 12 month project to investigate whether hairdressers can be encouraged to adopt environmentally friendly procedures.

Denise will work with companies and training colleges to highlight new ways of working. She explains that many hairdressers are already very interested in finding out how to introduce more sustainable practices, because they are more environmentally aware and they want to save money. "We will stage events to introduce them to new techniques and processes and explain the benefits," says Denise.

The research will also look at how hairdressers can pass on information about sustainability to the public. "Of all occupations, they spend the most time generally chatting to a wide variety of people, therefore it is of interest to explore the extent to which the hairdressers involved may act as diffusers of more sustainable practices to their customers," she adds.

Secrets of Roman coins revealed

Archaeologists and engineers from Southampton are collaborating with the British Museum to examine buried Roman coins using the latest X-ray imaging technology.

Originally designed for the analysis of substantial engineering parts, such as jet turbine blades, the powerful scanning equipment at Southampton's µ-VIS X-ray Imaging Centre is being used to examine Roman coins buried in three archaeological artefacts from three UK hoards.

The Centre's equipment can scan inside objects – rotating 360 degrees while taking thousands of 2D images, which are then used to build detailed 3D images. In the case of the coins, the exceptionally high energy and high resolution combination of the Southampton facilities allows them to be examined in intricate detail without the need for physical excavation or cleaning. For those recently scanned at Southampton, it has been possible to use 3D computer visualisation capabilities to read inscriptions and identify depictions of emperors on the faces of the coins.

"Excavating and cleaning just a single coin can take hours or even days, but this technology gives us the opportunity to examine and identify them quickly and without the need for conservation treatment at this stage," says Southampton archaeologist, Dr Graeme Earl. "It also has potential for examining many other archaeological objects."

New type of black hole

Research at Southampton is helping to reveal vital clues on how galaxies evolve by examining how a newly discovered type of black hole, the intermediate mass black hole, forms.

Black holes are objects where the matter is so dense that gravity is strong enough to stop light escaping. Astronomers classify black holes as either stellar mass black holes – up to 20 times the mass of the sun – or supermassive black holes – millions to billions of times the mass of the sun.

The first intermediate mass black hole, called HLX-1 is around 20,000 times the mass of the sun. A research team that includes Dr Tom Maccarone and Professor Christian Knigge from Southampton has used NASA's Hubble and Swift space telescopes and new modelling techniques to show that HLX-1 is in a cluster of young stars.

"Stellar mass black holes form in the deaths of massive stars. We think supermassive black holes probably grow out of stellar mass black holes, but we aren't 100 per cent sure. The intermediate mass black holes are the missing link, and learning about their environments gives us vital clues for understanding how black holes grow," says Tom.

For more information on these stories, visit **www.southampton.ac.uk/research**