UNIVERSITY OF Southampton

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New Boundaries | Issue 16 | June 2013

Lifelong cancer care

Treatment and support benefiting patients of all ages

Powering society
Providing economical and sustainable power

Origins of flight
Challenging the established view of bird evolution

Developing the strongest, lightest material
Pioneering the development of the strongest silica nanofibres

In this issue

Welcome to *New Boundaries*, the University of Southampton's research magazine. In this issue, you will discover how our researchers are addressing some of the most challenging issues facing society today, from the global need for sustainable energy to innovative treatments for cancer and degenerative diseases such as Alzheimer's disease.

As a pioneer in health and healthcare research, the University has adopted a lifecourse approach to investigating healthy development and disease, from conception to old age. On page four, learn how our researchers are developing lifesaving treatments for cancer, for both adults and children, and how we influence healthcare policy to improve the support available for cancer survivors.

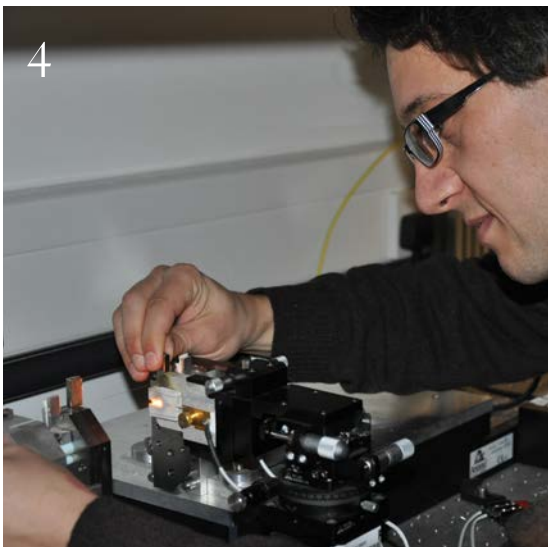
The University is a world-leader in energy and sustainability research and our links with global industry enable our research to have an impact on society. On page 10, discover how we are working with major energy providers to deliver new economical and sustainable power cables so that future generations will have access to electricity regardless of how or where it is generated. And on page 26, read how our researchers are set to transform the aviation, marine and safety industries with their development of the strongest, lightest material.

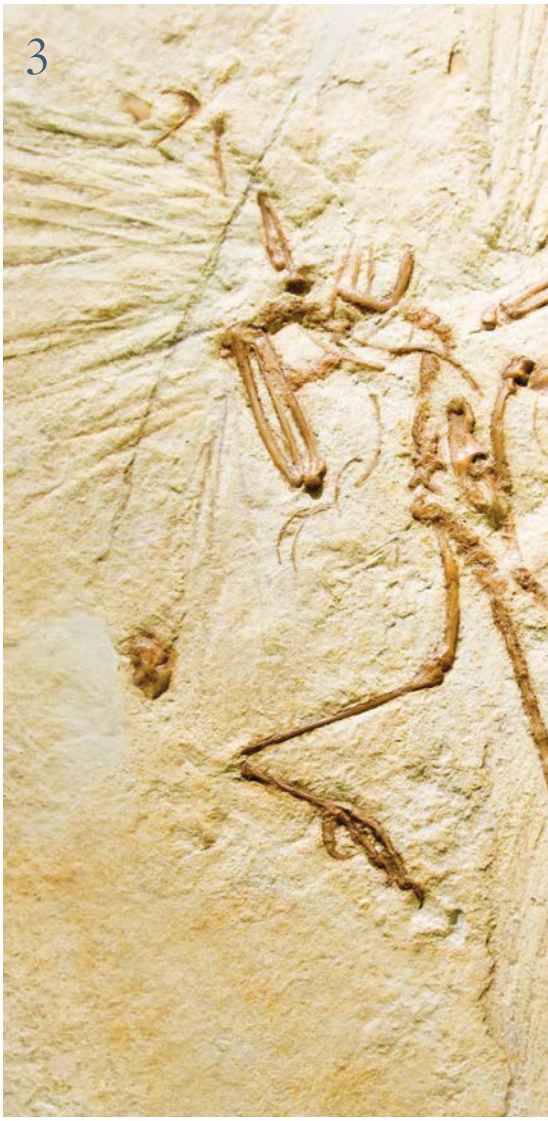
Moving from the work our engineers are doing to secure energy supplies for future generations, find out on page 16 how our palaeontologists at the National Oceanography Centre Southampton are challenging the established view on bird evolution, and learn how our archaeologists are uncovering a Neolithic settlement in Greece in order to understand more about contemporary society, on page 22.

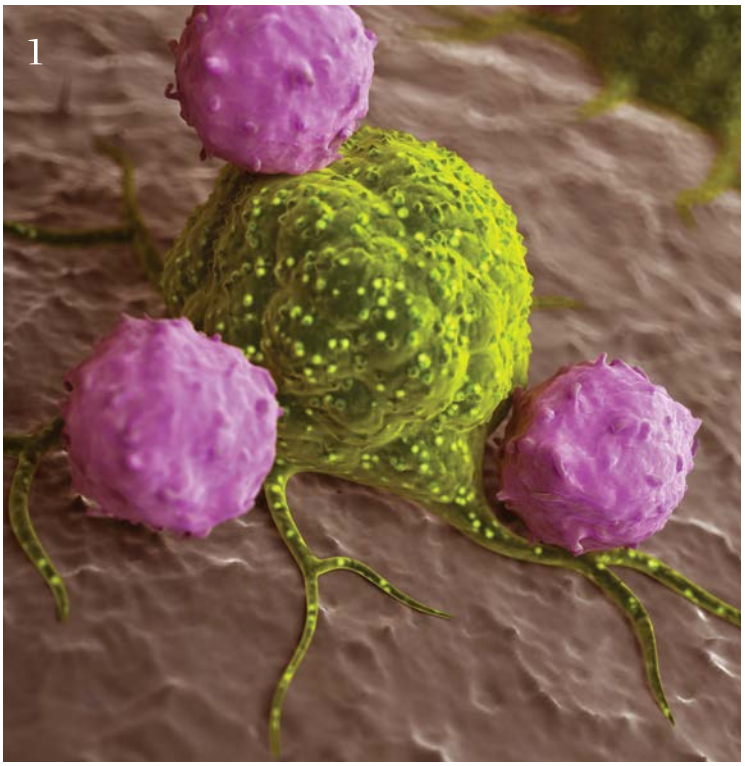
For more research stories, visit our website **www.southampton.ac.uk/research/latest_research**

Please send us your feedback
You can view past issues of *New Boundaries* online at **www.southampton.ac.uk/research**

We are keen to receive any feedback you have about *New Boundaries*. If you have any comments or suggestions, or would prefer to receive the magazine electronically, please send them to **newboundaries@southampton.ac.uk**





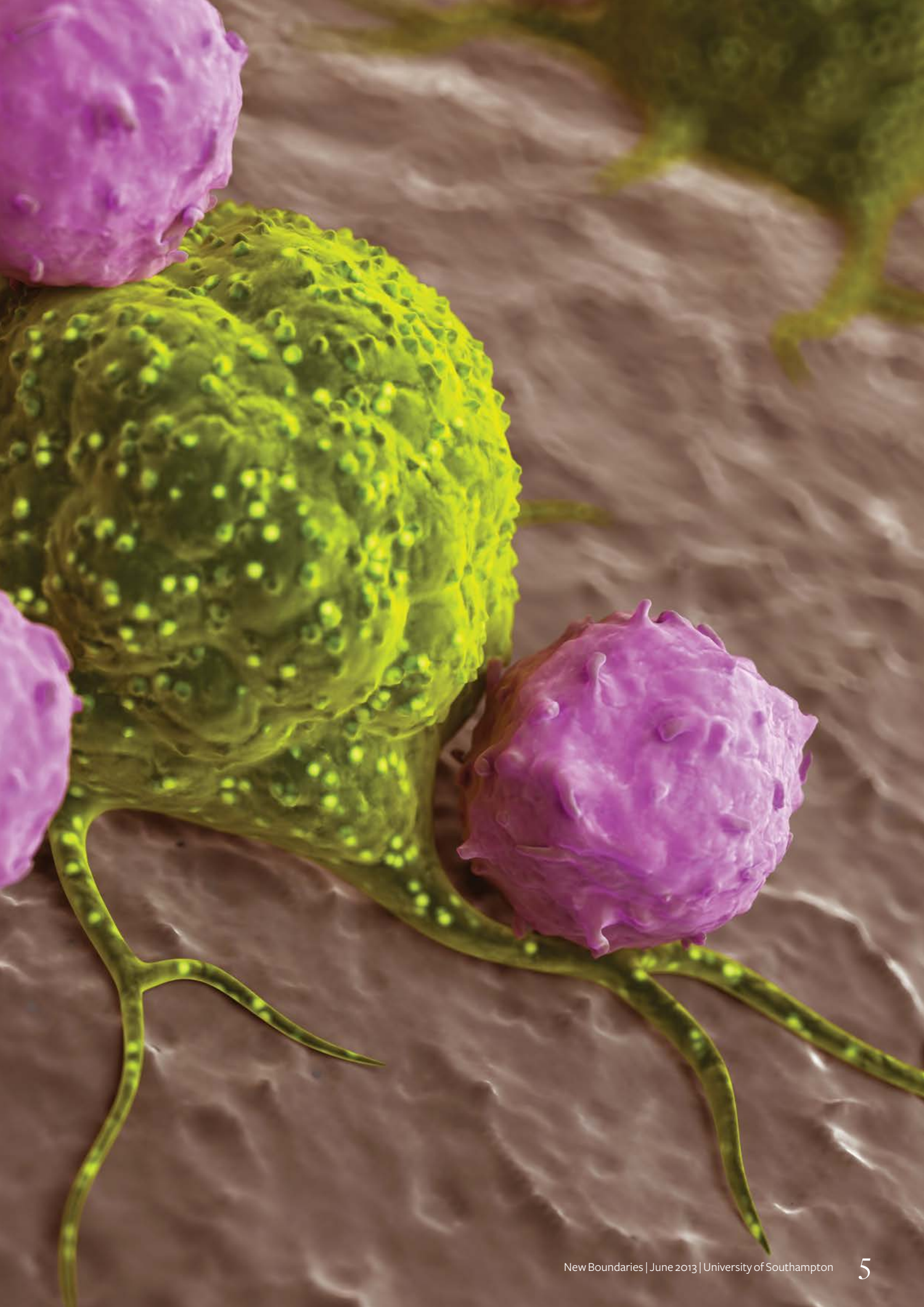


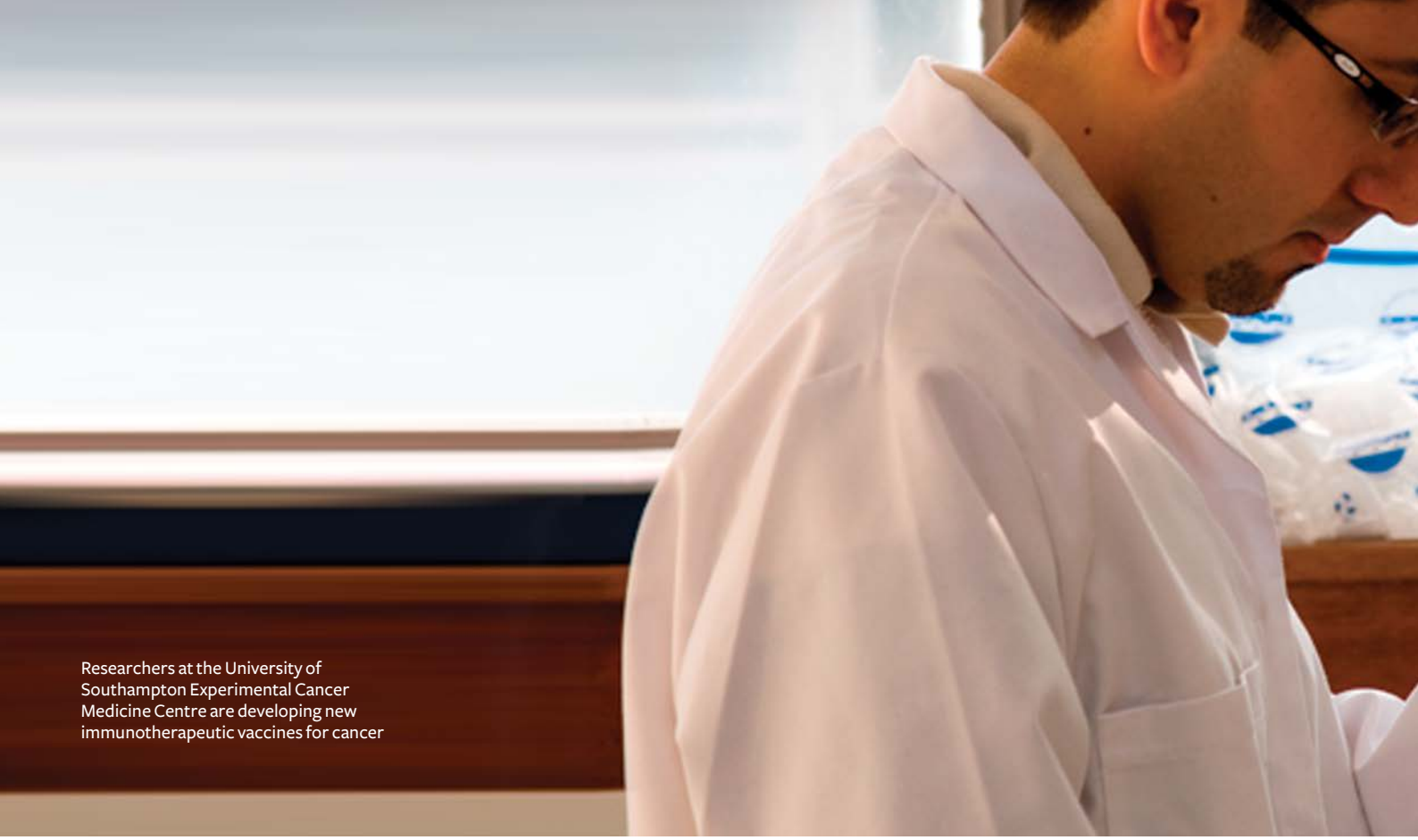
More highlights

Lifelong cancer care

According to the World Cancer Fund there were an estimated 12.7 million new cases of cancer around the world in 2008 and this number is expected to increase to 21 million each year, by 2030. Researchers at Southampton are investigating revolutionary treatments for cancer as well as investigating how to improve the lives of the growing numbers of people living with and beyond cancer.

Leukocytes (white blood cells that form part of the human immune system) attacking a cancer cell





Researchers at the University of Southampton Experimental Cancer Medicine Centre are developing new immunotherapeutic vaccines for cancer

"We have much evidence that the immune system is critical in not only the development of cancer, but also in how we can overcome it."

Professor Martin Glennie, Head of Cancer Sciences

Cancer treatments researched and developed at the University that use the immune system are revolutionising treatment of the disease and may someday allow tumours to be managed or eliminated in millions of patients.

In recent years scientists in Southampton have made important advances in the development of antibodies that stimulate certain cells of the immune system to attack cancerous tumours. "Our research, largely funded by Cancer Research UK, focuses on trying to use the body's immune system to fight cancer," says Professor Martin Glennie, Head of Cancer Sciences. "We have much evidence that the immune system is critical in not only the development of cancer, but also in how we can overcome it."

Recruiting the immune system

Antibody research at the University dates back to the 1970s when the founders of the Immunochemistry Laboratory, Professor Freda Stevenson and Professor George Stevenson, described how antibodies could be utilised as treatments. It was not until the 1980s that researchers were able to get special antibodies to attack cancer cells. Since then, researchers have been engineering and developing these antibodies so that they can actually be used for patient benefit.

A key goal of the University's antibody research is to activate and recruit the body's own immune system so that it may control and ultimately eliminate cancers. In the late 1990s Southampton researchers started to investigate a group of antibodies known as immune-stimulating antibodies. These don't attack the cancer cell itself, but instead bind to cells of the immune system and stimulate them to make a strong response to the cancer, so boosting and revitalising a patient's immune system. Antibody cancer therapies can also activate the patient's immune defences and alert them that there are cancerous cells to be destroyed.

At the same time, a group of scientists in the USA were learning more about antibodies known as checkpoint blockers. These also boost the body's immune response against cancer, but rather than directly stimulating the immune cells they act by removing molecular brakes which the cancer applies to the immune response.

The drug ipilimumab, developed by Bristol Myers Squibb, is an example of this type of antibody. After showing real promise in the treatment of melanoma in clinical trials at Southampton and other leading cancer centres, it has now been licensed and recently approved by the National Institute for Health and Clinical Excellence (NICE) for use in the NHS.

"For the first time, we are seeing a proportion of melanoma patients who receive ipilimumab surviving longer than expected," says Martin. "With this, and other antibodies that boost anti-cancer immunity, we will soon be able to direct the body's natural defences more effectively and hopefully trigger responses to a level where they can control cancer for the long-term."

Other members of ipilimumab's family of checkpoint blocker antibodies may hold even greater promise in the treatment of a wide range of cancers. "The beauty of immune stimulating and checkpoint blocker antibody treatments is that they are not confined to one type of cancer," says Martin. "They are able to stimulate immunity against a wide range of cancers." Recent results even show some limited success in the treatment of lung cancer which is notoriously difficult to control.

Paediatric trials

While adult trials for many cancer immunotherapies are proceeding, paediatric cancer researchers face a unique set of challenges in bringing these more specialised treatments to trial. Paediatric Oncologist Dr Juliet Gray, at the University, is developing two antibody treatments for children with neuroblastoma, one of the more aggressive childhood cancers, as a less toxic alternative to chemotherapy.

"There are a number of things that make conducting this type of clinical trial in children very challenging. Therefore, it is important that we learn as much as we can in the laboratory, in advance of clinical trial, about how this type of therapy can best be used in childhood cancers," says Juliet.

Juliet is hopeful that a paediatric trial of immune-stimulating antibodies can begin within the next five years. She is also examining how Anti-GD2 antibodies work to kill neuroblastoma cells. These antibodies directly target neuroblastoma cells, and are already used clinically in children. Her work is focused on monitoring the effects of these antibodies in children, and developing ways of making them more efficient.

The promising results of immunotherapy trials suggest that harnessing the healing power of the immune system is the future of cancer treatment. While chemotherapy and other treatments narrowly target the cancer, it often develops new ways of growing. ▸

"The CREW study is important in helping us learn more about bowel cancer patients and their different needs after treatment. The information gained through research will help us support and improve the lives of the increasing numbers of people who are living with and beyond cancer."

Ciarán Devane,
Chief Executive of Macmillan
Cancer Support

A key part of the CREW study is for researchers to hear directly from patients about their experiences of cancer, its treatment and consequences, and how this changes over time so that support for survivors can be improved

Support after cancer treatment

Advances in prevention, diagnosis and treatment such as immunotherapy mean more and more people are surviving cancer; it is estimated that around two million people are living with, or beyond, cancer in the UK, with this figure expected to double by 2030. Therefore, researchers from the Macmillan Survivorship Research Group (MSRG), at the University, funded by Macmillan Cancer Support, are conducting a programme of research to understand the needs of cancer survivors, identify what helps or hinders their recovery of health and wellbeing, and identifying and testing new ways to support them. The team has developed the first study of its kind looking at the experiences and needs of people after primary treatment of colorectal cancer.

The University of Southampton has a long standing history of cancer research and has established the ColoREctal Wellbeing (CREW) cohort to look at a number of factors influencing recovery which takes into account the disease itself, the level of treatment patients receive, the type of problems they are experiencing, the support available to them and how they can be supported to manage problems for themselves.

Factors influencing recovery studied within the research include the time it takes a patient to return to feeling 'well', the length of time symptoms of treatment last and the range of things people can do to help return to 'normal' more quickly, explains Dr Claire Foster, Chief Investigator and Head of MSRG. "The idea of the CREW study came from some research we did several years ago, also funded by Macmillan, involving cancer patients and people that were affected by cancer, across the UK. We asked them what was important to them in the sorts of research that we should be doing" says Claire. "And the priority for them was for us to start thinking about the impact of cancer on everyday life," she adds.

The sorts of questions that the study asks participants range from how they cope with everyday tasks, how side-effects and consequences of treatments impact on their lives, the kind of support that they and their families get from healthcare services, and how confident they feel in coping and self-managing their condition.

More than 1,000 participants have been recruited to the study from 30 cancer centres across the UK. Cancer tends to affect people in later life, so the average age of people in the cohort is 68. "So many participants are retired. We are also asking whether they are living with other conditions such as arthritis and heart disease, that might complicate their recovery," says Claire.

The longitudinal study follows participants over a number of years to establish the natural history of their recovery and wellbeing to assess how quickly they recover. "At the moment, we don't really know what the pattern of recovery is for patients. A real strength of this study is that we are asking people to tell us how they feel even before they have started their treatment, in order to map a typical course of recovery of health and wellbeing," says Claire.

Results from this rigorous theory-based study will, for the first time, inform healthcare providers and professionals across the country about what helps or hinders rapid and effective recovery and who has the confidence and ability to manage their own challenges. It will also help identify areas for the development of interventions to aid the recovery process of those who may be at risk of experiencing problems.

The Southampton MSRG collaborates with researchers internationally, so that comparisons can be made between different groups of patients across the world. Claire believes that the CREW study will have international significance because colorectal cancer is the most common cancer that affects both men and women. "Some of the experiences of our participants will be similar to people in other healthcare settings; it is not just the impact on the NHS, it is the impact on healthcare systems globally and the impact on the patients' everyday life."

Ciarán Devane, Chief Executive of Macmillan Cancer Support, says: "The CREW study is important in helping us learn more about bowel cancer patients and their different needs after treatment. The information gained through research will help us support and improve the lives of the increasing numbers of people who are living with and beyond cancer."

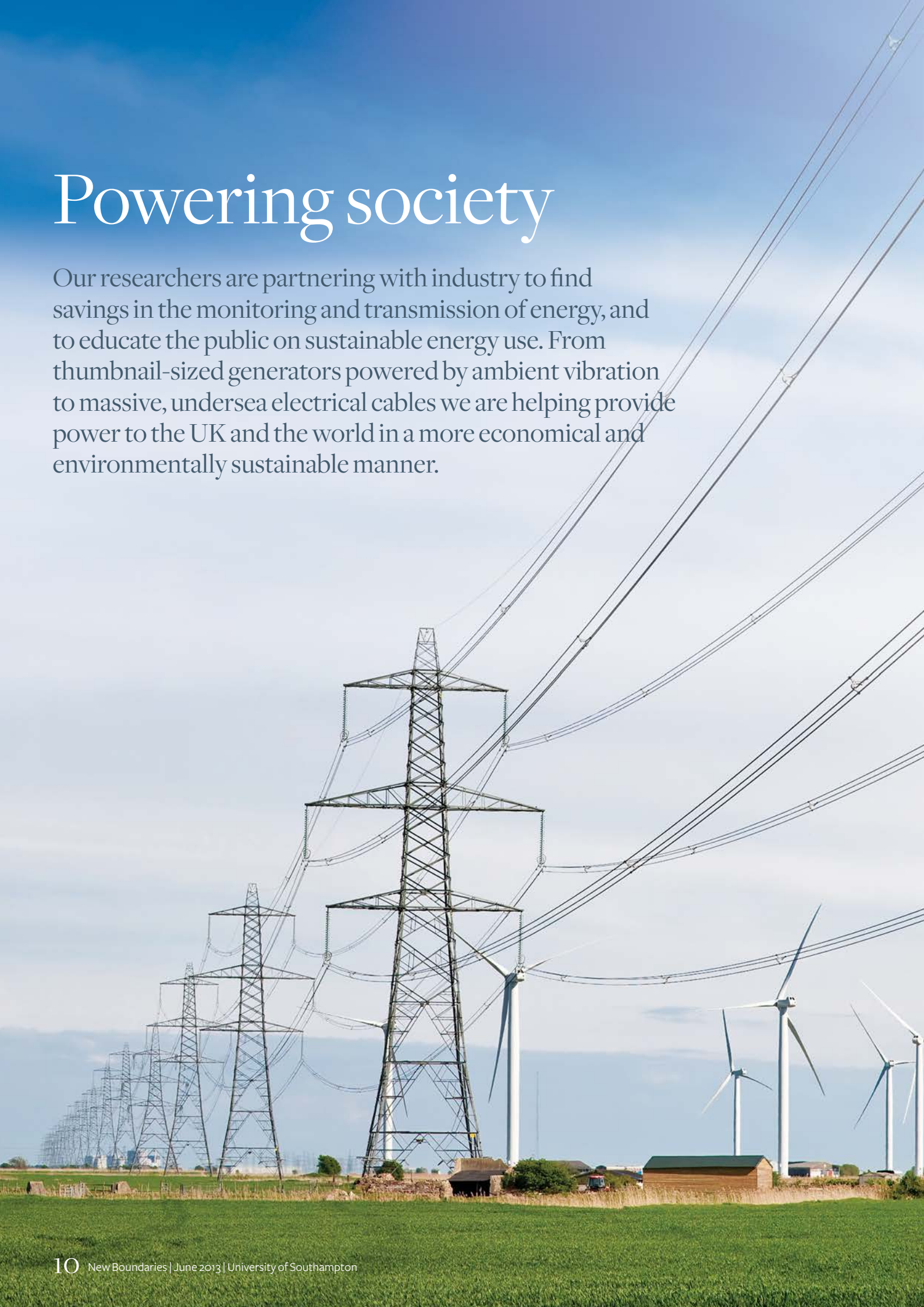
For more information on this research, visit **www.southampton.ac.uk/crewfilm**

Key facts

- There are an estimated 12.7 million new cancer cases around the world every year, with this number expected to increase to 21 million by 2030
- Cancer immunotherapy stimulates the patients' immune system in order to attack the malignant tumour cells that are responsible for the disease
- Two million people are living with, or beyond, cancer in the UK. This figure is expected to double by 2030

Powering society

Our researchers are partnering with industry to find savings in the monitoring and transmission of energy, and to educate the public on sustainable energy use. From thumbnail-sized generators powered by ambient vibration to massive, undersea electrical cables we are helping provide power to the UK and the world in a more economical and environmentally sustainable manner.



"The outcomes from this testing programme could ultimately lead to improved international standards for the rating of offshore wind farm export cable circuits."

Professor Paul Lewin,
Electronics and Computer Science

Delivering greener energy

In 2011, total electricity generation in the UK increased by 33 per cent, to 34,410 GWh, with certain renewable sources of energy, such as wind power increasing by as much as 45 per cent. From 2011, investment in offshore wind power alone has increased more than 60 per cent to £1.5bn, while planning approvals for onshore wind farms are at a record level.

Despite these changes, key aspects of the technology relating to power transmission and distribution systems – underground coaxial cables and overhead lines – have not significantly changed since the national electrical grid was created in the 1960s. Professors Paul Lewin and Alun Vaughan in Electronics and Computer Science (ECS) have been working with major industrial organisations and the UK transmission system operator National Grid to address important problems related to the design of high-voltage cables and their operation to reduce operational costs, minimise risk of network failure and cut carbon emissions.

Alun explains: "When the National Grid was installed, many of the design principles were based on the premise that things should not go wrong, so a degree of over-engineering was the rule and this has served us well since the middle of the last century. In principle this is fine, so long as you are prepared to pay for it but, as we go forward, the key things we need are efficiency, resilience and adaptability in our infrastructure.

"In the future, we are going to be less reliant on conventional forms of energy generation and more reliant on renewable forms, which are by definition intermittent. If you install cables to transmit the maximum of power, you will inevitably build in redundancies and higher capital costs, due to having more copper in the cables than you need. Most of the time, the wind farm will be generating useful amounts of power and very occasionally it will be generating its maximum possible output. The ideal cable would be something that allows you to run at peak capacity for short periods of time and operates under normal conditions the rest of the time."

With significant funding from the Engineering and Physical Sciences Research Council (EPSRC) and the Technology Strategy Board (TSB), and collaborating with a range of industrial partners, including National Grid and GnoSys Global, Paul and Alun are working towards the manufacture of sophisticated materials that adequately insulate new, high-voltage cables, are less energy intensive in their production, are fully recyclable at the end of their life, and have been shown to offer network businesses enhanced operational flexibility. Additional funding from EPSRC is being used to explore the development of related high voltage direct current (HVDC) cables for use at extremely high voltages (up to 1 MV), which will greatly increase the efficiency of energy transmission over long distances, such as from an offshore wind farm to shore. ▸

"The ideal cable would be something that allows you to run at peak capacity for short periods of time and operates under normal conditions the rest of the time."

Professor Alun Vaughan,
Electronics and Computer Science

Behavioural changes in the home are needed to make houses more energy efficient in order to prevent heat escaping in to the environment

In addition to the new cable technology, Paul and Alun have proposed more accurate rating methods for existing cables that could save National Grid more than £1.2m annually. They have also recommended new techniques – such as improved modelling of ventilated tunnels for existing cables – that deliver an estimated cost saving of 85 per cent.
A recently announced contract between Southampton's world-class Tony Davies High-Voltage Lab (TDHVL) and Centrica plc Renewables Division to test HVAC offshore wind farm export cable highlights how these savings can be implemented in the burgeoning renewables sector.

"This is extremely important work for the UK offshore wind farm industry as a whole," Paul says. "The outcomes from this testing programme could ultimately lead to improved international standards for the rating of offshore wind farm export cable circuits. When you look at wind energy and the interconnectors in the North Sea, places like Ireland and Scotland have vast amounts of resource, but they haven't got the local demand to match that resource. In the future, these places will export wind energy to Europe, and that will be done by cable. That is why what we are doing at Southampton is so important."

Micro-generator: no batteries required

Another area where Southampton researchers are creating more efficient and greener delivery of electricity is energy harvesting, or the process by which energy is derived from external sources, captured and stored for small, wireless device sensory networks. Monitoring the conditions of industrial equipment is costly to the transportation, aeronautical, energy and military sectors. Whether done remotely with wireless devices or via manual inspection by service personnel, condition monitoring is also time-consuming and uses large numbers of batteries which must be replaced at irregular intervals. Each year, we throw away 300 million batteries, often sending them to landfills where they leak poisonous cadmium, lead, mercury, copper, zinc, manganese, lithium, or potassium into the soil, groundwater and surface water.

To help solve this problem, researchers at Southampton have invented a micro-sized energy harvester powered by ambient vibration. The energy harvester – models range from the size of a thumbnail to one the size of a coffee mug – uses four magnets and a coil to create an electromagnetic field for power generation when it shakes, converting linear (up and down) motion into energy. Using the vibration from machinery upon which it is mounted, the energy harvester can last up to 25 years without replacement, a characteristic that allows it to be placed in inaccessible or hazardous locations.

The harvester was created by Professor Steve Beeby, EPSRC Leadership Fellow, and Dr Geoff Merrett, Lecturer, Electronics and Computer Science (ECS), with underpinning research led by Professor Neil White and Dr John Tudor and funded by the EPRSC and European Union. A spin-out company, Perpetuum, has been formed that has attracted almost £10m in venture capital and has placed Southampton at the global forefront of energy harvesting research, and a market worth an estimated $700m in 2011.

The energy harvester is being developed for use by at least one industry partner, Scotia Gas. The devices will facilitate wireless condition monitoring at Scotia's power plants, replacing expensive (£120 each) sodium-lithium (NaLi) batteries. Shell UK is also using Perpetuum's generator. Previously, if the company wanted to monitor machines around a several hectare petrochemical plant, a worker had to go around with a probe to check each machine sensor's batteries once a month or observe its infrared spectrum for hotspots, using a wireless human monitoring solution.

Behavioural change

Steve notes that the energy harvester is not a replacement for all batteries, but he is optimistic about its application: "It is quite an elegant role for the device when you consider that you are monitoring the health of a machine by looking at its vibrations, while collecting energy from those vibrations."

As well as looking at how our energy infrastructure can become more efficient, our engineers are encouraging households to change their behaviour with regards to energy consumption. In collaboration with the universities of Westminster and Reading, researchers in the Sustainable Energy Research Group are investigating whether community action on climate change and energy security issues can lead to new social practices.

The team is monitoring the energy usage of 200 households split between two distinct areas in Southampton, over a period of three years, in exchange for free cavity wall insulation and loft insulation. The aim is to understand people's views on energy and sustainability.

"We are looking to identify whether supporting a Greening Group – a community group interested in green and sustainable methods – by providing them with information and advice on energy use, has an impact on energy use at a household level," explains Dr Patrick James, a Research Investigator from Southampton, on the Energy and Communities project funded by the Economic and Social Research Council (ESRC).

In one of the areas, our researchers are supporting a Greening Group by helping them set up activities in the community that educate people on energy use. The other area involved in the venture is not helped at all in order to provide a comparison group.

"All the households are fitted with an AlertMe device that plugs into their broadband network," says Patrick. "These send over nine billion readings to us a year – we measure energy consumption, the temperature in the living room, the temperature on the boiler casing so we know when the house is burning gas and the number of occupants in the home, to build a profile of the energy behaviour in each house."

In the UK, there is a housing stock heritage where energy consumption is a big issue. Patrick explains that it is relatively easy to build a new, low energy house, but most of the population live in older houses that will still be used in 50 years' time. "In order to make these buildings efficient, we obviously need to improve insulation, but we also need behaviour to change," he says.

"The aim of our research is to provide the UK Department of Energy and Climate Change (DECC) with evidence as to whether supporting Greening Groups could kick-start a new understanding of energy saving in the home. Depending on the results the DECC will then decide whether to fund a more widespread project," says Patrick.

For more information on these projects, visit **www.highvoltage.ecs.soton.ac.uk** and **www.southampton.ac.uk/energycommunity**

Key facts

- In 2011, total electricity generation in the UK increased by 33 per cent, to 34,410 GWh, with certain renewable sources of energy, increasing by as much as 45 per cent
- The University's Tony Davies High Voltage Laboratory has a range of specialised equipment, some capable of generating one million volts
- UK government policy states that in 2016 all new-build housing should be zero-carbon in operation

Future of UK high streets

The British Retail Consortium found that over 11 per cent of retail units in UK town centres were vacant in July 2011. This underlines that significant challenges lie ahead for UK high streets. *New Boundaries* talks to Professor Michelle Lowe, Associate Dean for Enterprise in Business and Law and Professor Neil Wrigley, Fellow of the British Academy, about their research in the area.

What are the challenges facing UK high streets?

The shock wave of the global economic crisis exposed forces of change – the progressive rise of online retail, the shift to a 'convenience culture', and complex regulation-constrained effects of out-of-town development – which were profoundly reshaping the retail landscape. Increasing alarm about the economic health of town centres and high streets has seen these issues placed high on the agenda of policy debate and the commissioning by UK government of an independent review led by 'Queen of Shops' Mary Portas.

What are the main aims of your current research on UK high streets?

Neil Wrigley, Professor of Human Geography at the University and I are working on the High Street Futures project, co-funded by the Economic and Social Research Council (ESRC) and industry. The aim of this project is to provide a forward-looking and agenda-setting study of the differential performances of UK high streets, and explore how alternative visions of UK high streets might be best supported by future policy interventions.

We are conducting analyses at the regional and urban area level exploring the drivers of the differential performance of high streets and how they have shown resilience by adapting. We are also considering exemplars of how innovative, high-performing retailers can generate positive effects onto the high street and we are convening expert panels to scope out alternative visions of the future configuration of high streets.

Why is it important to research this topic?

During a period when the UK retail industry is experiencing seismic changes as it adjusts to the challenges of the digital era, and when concern about the economic health of the traditional retail spaces of town centres and high streets is prominent on the policy agenda, it is important to ensure that high-quality research, informed by engagement between industry and the university research base, shapes evidence-based policy debate.

What impact will your research have on society?

The retail sector is a very significant part of the UK economy contributing 20 per cent of GDP and employing one in nine working people. Given the economic and social importance of retailing, it is a clear priority for academic research to understand its operations, strategies and wider socio-economic effects. Crucially, our High Street Futures project benefits from high levels of industry engagement. The project co-funders Tesco plc, together with other leading UK retailers, retail property companies, trade bodies and consultancies have been involved in the project's expert panel workshops.

The project has been highly welcomed by UK government departments – notably the Department for Communities & Local Government (DCLG) and the Department for Business, Innovation & Skills (BIS), and Neil is the sole academic member of the new National Future High Streets Forum.

What do you see as the biggest challenge for your research in this area?

Research within retail geography and on retail innovation has had considerable impact on evidence-based public policy debates on retail access, competition and planning. In particular, the reshaping of UK high streets as they adapt to changing consumer trends and the rise of online retail, is prompting new agendas which are focusing the attention of a wide range of social scientists.

The debates on the future of the high street, and especially the widely held public perception regarding the demise of small and independent shops are highly charged and emotive, and policy debate has got ahead of the available evidence base.

How important is multidisciplinary collaboration in your research?

The forces shaping UK high streets are very complex and as such our research has to look beyond the confines of retail geography and innovation studies/business management. By collaborating with retailers, retail practitioners, planners, economists and sociologists, we adopt an interdisciplinary approach that seeks to place our findings in a context that has real-world relevance and policy significance.

Are there any other exciting developments coming up?

Building on the work of the High Street Futures project we aim to develop a deeper and more interactive relationship with government departments and trade organisations, to identify priorities and develop research more applicable to the changing needs of the retail sector. In particular, it is our intention to work more closely with both DCLG and BIS in the future and establish a value adding position within public policy debate, which will inform both short and long-term strategic government responses to the changing nature of UK high streets.

Why is Southampton a good place to do this kind of research?

The retail team at Southampton has built a considerable reputation for producing world-leading and agenda-setting research on the retail sector. Through its pioneering research the team has fostered strong relationships with leading retailers such as Tesco and Sainsbury's, and hosts the ESRC Retail Industry Business Engagement Network (RIBEN) Capacity Building Cluster which includes the universities of Oxford and Leeds. Under the RIBEN initiative Southampton is developing what are acknowledged by BIS and the ESRC to be some of the strongest existing academic-industry research partnerships within the retail sector.

For more information on this project visit:
www.southampton.ac.uk/management/michellelowe
www.southampton.ac.uk/geography/neilwrigley

University of Southampton researchers are uncovering new fossils that are modifying our understanding of the origins of flight

Origins of flight

Discoveries by researchers at Southampton are modifying the established view that birds evolved from a group of dinosaurs called theropods that lived around 120-130 million years ago.

Over many years, it has become accepted among palaeontologists that birds evolved from theropods from the Early Cretaceous period of Earth's history and recent discoveries of feathered dinosaurs from the older Middle-Late Jurassic period, such as *Archaeopteryx* have reinforced this theory.

Challenging theories

Dr Gareth Dyke, expert in vertebrate palaeontology at the National Oceanography Centre Southampton and colleagues in Belgium, has recently uncovered a new bird-like dinosaur from the Jurassic period that challenges these theories on the origin of flight. Gareth's work focuses on early birds and dinosaurs with feathers in order to determine the early evolution of wing aerodynamics.

The new feathered dinosaur, known as *Eosinopteryx*, is about 30cm in length and pre-dates bird-like dinosaurs that modern birds were long thought to have evolved from. "This discovery sheds further doubt on the theory that the famous fossil *Archaeopteryx* – or 'first bird' as it is sometimes referred to – was pivotal in the evolution of modern birds," says Gareth. "Our findings suggest that the origin of flight was much more complex than previously thought."

The fossilised remains found in north-eastern China indicate that, while feathered, this was a flightless dinosaur, because of its small wingspan and a bone structure that would have restricted its ability to flap its wings. The dinosaur also had toes suited to walking along the ground and fewer feathers on its tail and lower legs, which would have made it easier to run, explains Gareth.

Gareth's discovery shows that not all of the species of birds were able to fly. Some had feathers, but the evidence suggests that there was a diverse range of ecologies in these groups of dinosaurs that used feathers for different things. "At present, we don't know what it was, but feathers would have been evolved for something other than flight. It could have been to attract a mate, keep eggs warm or to keep the body warm. And then much later, over millions of years, they were used by dinosaurs to generate lift for flight," he says.

"This discovery sheds further doubt on the theory that the famous fossil *Archaeopteryx* – or 'first bird' as it is sometimes referred to – was pivotal in the evolution of modern birds."

Dr Gareth Dyke,
National Oceanography Centre Southampton

Analysing isotopes

Gareth and his colleagues were able to determine the age of *Eosinopteryx* by looking at the decay of radio isotopes that are contained in the sediments around the fossil. When the animal died, it was buried in limestone that contains isotopes (an element with an unusual number of neutrons in its nucleus) of carbon, potassium and calcium that decay at different rates. Analysing these can date the limestone and therefore the fossil inside. "There can also be soft tissue and feathers, and quite often stomach contents can be analysed as well. All this information can help us understand how old the bird is and even what it ate," explains Gareth.

The team at Southampton has also uncovered a new kind of pterosaur, a flying reptile from the time of the dinosaurs, known as *Eurazhdarcho*. Gareth and colleagues, in collaboration with the Transylvanian Museum Society in Romania and the Museau Nacional in Rio de Janiero, Brazil, discovered the fossilised bones in the Late Cretaceous rocks of Sebes-Glod in the Transylvanian Basin, Romania, which are approximately 68 million years old.

The Transylvanian Basin is world-famous for its many Late Cretaceous fossils, including dinosaurs of many kinds, as well as fossilised mammals, turtles, lizards and ancient relatives of crocodiles.

Dr Darren Naish, from the University's Vertebrate Palaeontology Research Group, who helped identify the new species, says: "*Eurazhdarcho* belong to a group of pterosaurs called the azhdarchids. These were long-necked, long-beaked pterosaurs whose wings were strongly adapted for a soaring lifestyle. Several features of their wing and hind limb bones show that they could fold their wings up and walk on all fours when needed," he says.

"With a three-metre wingspan, *Eurazhdarcho* would have been large, but not gigantic. This is true of many of the animals so far discovered in Romania; they were often unusually small compared to their relatives elsewhere," Darren adds.

Complete fossil example

Gareth explains that the *Eurazhdarcho* fossil is quite different from that of *Eosinopteryx*. Pterosaurs have quite distinctive skeletons, because they are highly adapted for the certain kind of flight that they did. "They had really long elongated wing fingers – the fourth finger in the hand is elongated like the spar of a yacht sail and this supports the wing membrane," says Gareth.

The discovery is the most complete example of an azhdarchid found in Europe so far and its discovery supports a long-argued theory about the behaviour of these types of creatures.

"Experts have argued for years over the lifestyle and behaviour of azhdarchids. It has been suggested that they grabbed prey from the water while in flight, that they patrolled wetlands and hunted in a heron or stork-like fashion, or that they were like gigantic sandpipers, hunting by pushing their long bills into mud," says Gareth.

"One of the newest ideas is that azhdarchids walked through forests, on plains and other places in search of small animal prey. *Eurazhdarcho* supports this view of azhdarchids, since these fossils come from an inland, continental environment where there were forests and plains as well as large, meandering rivers and swampy regions," he adds.

University collaborations

Fossils from the region show that there were several places where both giant azhdarchids and small azhdarchids lived side-by-side. *Eurazhdarcho's* discovery indicates that there were many different animals hunting different prey in the region at the same time, demonstrating a much more complicated picture of the Late Cretaceous world than first thought.

Gareth collaborates with other researchers across the University in order to build up a picture of the lifestyles of these ancient animals. Analysing the fossils can be difficult without damaging them, he explains, therefore he has teamed up with colleagues at Southampton General Hospital to use X-ray computed tomography (CT scanning). This medical imaging procedure produces pictures of 'slices' of specific areas of the body, or in this case the fossil, without damaging it. "We can then look at the internal morphology of the bones and even the bone histology," says Gareth.

"My research focuses on understanding the aerodynamics of flight, so I also work closely with astronautic and aeronautic engineers at Southampton to test models of feathered dinosaurs in the wind tunnel facilities here, in order to understand how they may have flown."

The work carried out by Gareth and his team could eventually lead to a better understanding of how flight began in the animal kingdom. With every dinosaur discovery, we can learn more about evolution. Gareth explains that palaeontology is inherently interdisciplinary. "We can teach people about aerodynamics, evolutionary biology, ecology and some fields of geology. And Southampton is well positioned in terms of fossil discoveries. We have the Isle of Wight nearby – the rocks on the Isle of Wight are the same age as the rocks that *Eosinopteryx* was found in – and then of course it is a short journey to the UK's Jurassic coast."

For more information on Gareth's work, visit **www.southampton.ac.uk/oes/garethdyke**

Key facts

- At Southampton researchers are challenging the established view that birds evolved from a group of dinosaurs called theropods that lived around 120-130 million years ago
- Analysing the decay of radio isotopes of carbon and calcium in sediment around fossils can accurately date them
- Pterosaurs existed from the late Triassic to the end of the Cretaceous Period (220 to 65 million years ago)

An artists impression of what *Eosinopteryx* may have looked like

Multi-sensory rehabilitation

In 2010 there were an estimated 35.6 million people with dementia worldwide and this is set to double by 2030, according to Alzheimer's Disease International (ADI). Occupational Therapy research at Southampton has found that multi-sensory environments can help preserve cognitive and occupational behaviour. *New Boundaries* talks to Dr Lesley Collier about her work.

What does your research involve?

The cognitive deterioration we see in people with Alzheimer's disease and other dementias is not just due to the decline of the brain, it is also due to the environment around the person. We have found that by modifying the amounts of stimuli that people are bombarded with on a day-to-day basis and adjusting the sensory input to meet sensory need, Alzheimer's symptoms can appear less.

Multi-sensory rooms have traditionally been used for people with learning difficulties as a leisure activity; however they are now used extensively for people with dementia. By using a tool box of equipment that stimulates the senses of sight, sound, taste, smell and movement, the rooms can provide a large variety of activities that aid concentration and provide stimulation or relaxation dependent on sensory need. We are using the rooms to modify the level of sensory stimulation a person receives – limiting the large amounts of stimuli that people with Alzheimer's disease have to deal with, so that it is easier for them to concentrate on simple tasks.

Why is this area of research important?

With improvements in health care over the last century, people are living longer; the ADI estimates that 7.7 million new cases of dementia are diagnosed each year. Also it is acknowledged that it is hard to engage people who have moderate to severe dementia in conventional activity. Our work focuses on working with people with dementia to try and reduce their symptoms by allowing them to practice everyday tasks in a controlled, sensory stimulation environment.

What is the impact of your research on society?

The first time we observed a person with dementia in a multi-sensory room, we noticed he became more focused, would pick up equipment, smile and vocalise, and then move on. This was very different from the behaviour he exhibited normally; aggression and the inability to settle to any activity. Following this very early study, we collaborated with Rompa, the company that produces the Snoezelen room, a type of multi-sensory environment for use in hospitals, homes, schools, therapy centres and care homes and they provided us with equipment to develop this area of research.

My most recent research study has been looking at increasing a patient's independence in functional performance – how they use a knife and fork to eat independently or put on their shoes. We have found that when people spend time in a structured multi-sensory room and then carry out activities of daily living, they are more able to do it and make less performance errors than if they were left to try and complete the activity alone.

As a result of our work, the National institute for Health and Clinical Excellence (NICE) guidelines recommend the use of multi-sensory activities with people with dementia.

What is the global impact of your work?

A large proportion of my time is spent working with health care providers around the world in order to introduce multi-sensory environments into their treatment regimes for people with dementia. For example, I have worked with representatives of the royal family in Saudi Arabia, Hong Kong's health department and the ministries of health in Thailand, Malaysia, Brunei and Singapore to establish treatment regimes in each country.

I also work with therapists in these different countries to highlight cultural differences so that multi-sensory treatments can be adapted for maximum benefit to the patient.

What sparked your interest in this topic?

Before joining the health sciences, I was a clinical Occupational Therapist. My colleagues and I found it very challenging to engage people with severe dementia in activities. As a result, I worked with a psychologist looking at ways we could reach these individuals and we heard about the use of multi-sensory activity at a local children's centre. This led us to try a multi-sensory approach with some of our patients before instigating the first piece of research in this field in the UK.

Is multidisciplinary collaboration important in your research?

Working as part of a multidisciplinary team is essential for this type of work. As such, multi-sensory approaches are now part of the Occupational Therapy and Physiotherapy curriculum within the health sciences. Also the close working relationship I have with the researchers in the Institute of Sound and Vibration and Ship Science has also allowed me to further develop my sensory work with other client groups. For example, with the Royal National Lifeboat Institution (RNLI), we are working to decrease the amount of stimuli on vessels to reduce confusion in emergency situations.

Why is Southampton a good place to do your research?

It is important to me that my research is translated into practice. The Occupational Therapy programme at Southampton is recognised as being at the forefront of Occupational Therapy and is acknowledged as pioneering evidence-based interventions. As such, Southampton is a prime location to move multi-sensory research into practice.

What is your next project?

Understanding how sensory stimulation effects occupational performance is a compelling question and I would like to further explore how specific sensory input influences performance. What I would like to do next is to monitor the brain activity while a person with dementia is using the multi-sensory room. This would give us a greater understanding of how the different sensory activities stimulate the brain.

For more information on Lesley's work, visit **www.southampton.ac.uk/healthsciences/lesleycollier**

Uncovering a different past

Archaeologists from the University studying a Neolithic archaeological site in central Greece have helped unearth over 300 clay figurines, one of the highest density for such finds in south-eastern Europe.

The Southampton team, working in collaboration with the Greek Archaeological Service and the British School at Athens, is studying the site of Koutroulou Magoula near the Greek village of Neo Monastiri, around 160 miles from Athens.

Hybrid human-bird

Koutroulou Magoula was occupied during the Middle Neolithic period (c. 5800 – 5300 BC) by a community of a few hundred people who made architecturally sophisticated houses from stone and mud-bricks. The figurines were found all over the site, with some located on wall foundations. It's believed the purpose of figurines was not only as aesthetic art, but also to convey and reflect ideas about a community's culture, society and identity.

"Figurines were thought to typically depict the female form, but our find is not only extraordinary in terms of quantity, but also quite diverse – male, female and non-gender specific ones have been found and several depict a hybrid human-bird figure," says Professor Yannis Hamilakis from Southampton, who is Co-Director of the Koutroulou Magoula Archaeology and Archaeological Ethnography project.

"We still have a lot of work to do studying the figurines, but they should be able to give us an enormous amount of information about how Neolithic people interpreted the human body, their own gender and social identity and experience," he adds.

Excavations at Koutroulou Magoula were started in 2001 by Dr Nina Kyparissi (formerly Greek Archaeological Service) and this latest project began in 2010. Using geophysical prospection, a ground-based remote sensing technique that analyses subsurface archaeological features and creates a map of structures and traces of human activity left in the soil, the team could build up a picture of what the settlement may have looked like.

"From the houses that we have uncovered, there is no evidence of a central authority to date, yet large numbers of people were able to come together and carry out large communal and possibly socially beneficial projects."

Professor Yannis Hamilakis,
Co-Director of the Koutroulou Magoula Archaeology project

300 clay figurines have been uncovered by Southampton researchers

Unique find

The site is roughly four times the area of a football pitch and consists of a mound up to 18 feet high featuring at least three terraces surrounded by ditches. The people who lived in the settlement appear to have rebuilt their homes on the same building footprint generation after generation, and there is also evidence that some of the houses were unusual in their construction.

Yannis comments: "This type of home would normally have stone foundations with mud-bricks on top, but our investigations at Koutroulou Magoula have found some preserved with stone walls up to a metre in height, suggesting that the walls may have been built entirely of stone, something not typical of the period," he says.

The team also found that different coloured stone had been used for different phases of buildings, suggesting that the people may have had an aesthetic preference for certain types of stone.

"The people would have been farmers who kept domestic animals, used flint or obsidian tools and had connections with settlements in the nearby area. The construction of parts of the settlement suggests they worked communally, for example, to construct the concentric ditches surrounding their homes," Yannis explains.

From the geophysical data, the team observed that the ditches and possibly a perimeter wall surrounded the site. This suggests that the community could have worked together to build these defences. "This is very interesting in terms of the social organisation of the settlement – some sort of communal organisation is likely, but we haven't found any evidence of leadership, says Yannis.

"From the houses that we have uncovered, there is no evidence of a central authority to date, yet large numbers of people were able to come together and carry out large communal and possibly socially beneficial projects."

Yannis explains that the Neolithic period can give us a lot of information about how societies formed which we can use in our own society. Early Neolithic settlements showed the beginnings of agriculture and the cultivation of the earth and the raising of animals. Archaeologists are really interested in why this change occurred as before this period people were living as hunter-gatherers for millennia. As for the Late Neolithic period archaeologists normally focus on the perceived emergence of hierarchical society. These however are not central questions for the Koutroulou Magoula Project.

"The main period at Koutroulou Magoula is the Middle Neolithic, so we can put aside the questions of origins of agriculture and institutionalised inequality. We are looking at the community and its way of life in minute detail. If we can work out how the people lived without leadership and hierarchy, we can learn lessons for our society," says Yannis.

In later centuries, the settlement mount became an important memorial place. For example, at the end of the Bronze Age, a 'tholos' or beehive-shaped tomb was constructed at the top and in Medieval times (12-13th c. AD) at least one person (a young woman) was buried among the Neolithic houses.

Contemporary relationships

In addition to excavation, the project has conducted ethnography among the local communities, exploring their customs and culture and their relationship to the site. It is well known that Classical Antiquity, a long period in history centred on the Mediterranean Sea, comprising the interlocking civilisations of Ancient Greece and Ancient Rome is often seen as the golden age of western civilisation. It is also the golden age for the national narrative and imagination in Greece, but the team wants to understand how the local communities around the site relate to the Neolithic past, 5,000 years before this golden age, and the building of iconic monuments such as the Parthenon.

The project has also engaged in a series of community and public archaeology events, including the production and staging of site-specific theatrical performances, which turn into communal celebrations with food, drink and dance. In part, this aims to examine the importance of Koutroulou Magoula to contemporary communities and make the site a central feature in the social and cultural life of the area.

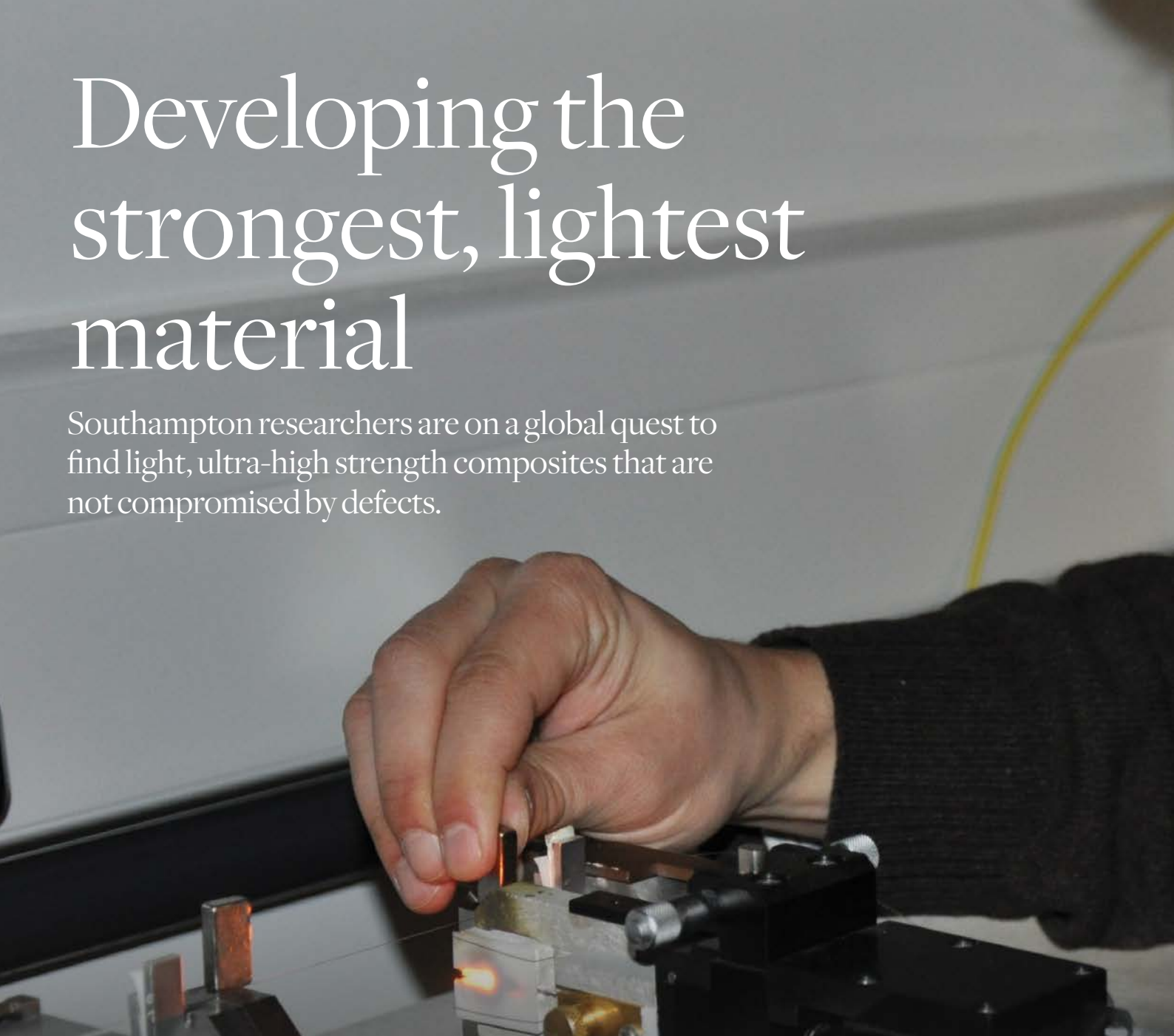
Yannis explains that it is also important to build a relationship between archaeologists and society. "Archaeologists are often seen as intrusive, because we dig up areas of the countryside to uncover the past and this can sometimes frustrate the people that live nearby, as we interfere with their own lives and routines" he says. "We hope that these public events will help convey to the local community the aims and purpose of our work and the importance of learning from past societies."

For more information on this work, visit **www.southampton.ac.uk/archaeology/yannishamilakis**

The clay figurines give researchers information about human identity in Neolithic civilisations

Developing the strongest, lightest material

Southampton researchers are on a global quest to find light, ultra-high strength composites that are not compromised by defects.



"Weight for weight, silica nanowires are 15 times stronger than high strength steel and 10 times stronger than conventional Glass Reinforced Plastic (GRP). We can decrease the amount of material used thereby reducing the weight of the object."

Professor Sir David Payne, Director of the Optoelectronics Research Centre

Scientists at the University of Southampton's Optoelectronics Research Centre (ORC) are pioneering research into developing the strongest silica nanofibres in the world.

Historically, carbon nanotubes were the strongest material available, but high strengths could only be measured in very short samples, just a few microns long, providing little practical value.

Now research by ORC Principal Research Fellow Gilberto Brambilla and ORC Director Professor Sir David Payne has resulted in the creation of the strongest, lightest weight silica nanowires that are 15 times stronger than steel and can be manufactured in lengths potentially of thousands of kilometres.

Industry interest

Their findings are already generating extensive interest from many companies around the world and could transform the aviation, marine and safety industries. Tests are currently being carried out globally into possible, future applications for the nanowires.

"With synthetic fibres it is important to have high strength, achieved by production of fibre with extremely low defect rates, and low weight," says Gilberto.

"Usually, if you increase the force that a fibre can withstand, you have to increase its diameter and, thus, its weight, but our research has shown that as you decrease the size of silica nanofibres their strength increases, yet they still remain very lightweight. At lighter weights, they can withstand stronger forces than other, comparable materials. To date, we are the only researchers who have optimised the strength of these fibres in the world.

"Our discovery could change the future of composites and high strength materials and have a huge impact on the marine, aviation and security industries worldwide. We want to investigate their potential use in composites and we envisage that this material could

be used extensively in the manufacture of products such as aircraft, speedboats and helicopters."

Environmental and economic impact

Future use of silica nanowires may have huge economic and environmental benefits.

David explains: "Silica and oxygen, required to produce nanowires, are the two most common elements in the Earth's crust, making their production sustainable and affordable. Furthermore, we can produce silica nanofibres by the tonne, just as we currently do for the optical fibres that power the internet.

"Weight for weight, silica nanowires are 15 times stronger than high strength steel and 10 times stronger than conventional Glass Reinforced Plastic (GRP). We can decrease the amount of material used thereby reducing the weight of the object."

Gilberto adds: "In a few years the amount of composite materials used in machines such as aeroplanes, boats and high specification cars is likely to increase. Using silica nanowires as the composite material reinforcement means the vehicles will be lighter, thereby reducing their energy consumption and fuel costs.

"If silica nanowires are used for wind turbine blades, the blades will be stronger and lighter, thereby increasing the amount of energy that the turbines can produce. Overall, the development of silica nanowires could have a very positive impact on the future of our environment as well as on our economy."

Hands-on research

In five years of research by Gilberto and David, funded by the Royal Society, the pair encountered challenges working with the materials. "It was particularly challenging dealing with fibres that were so small. They are nearly 1,000 times smaller than a human hair and I was handling them with my bare hands," explains Gilberto.

"It took me some time to get used to it, but using the state-of-the-art facilities at the ORC I was able to discover that silica nanowires become stronger the smaller they get. In fact, recent research shows that when they become very, very small they behave in a completely different way. They stop being fragile and do not break like glass, but instead become ductile and break like plastic. This means they can be strained a lot.

"Up until now most of our research has been into the science of nanowires, but in the future we are particularly interested in investigating the technology and applications of these fibres."

To learn more about nanofibre and metamaterials research visit: **www.orc.soton.ac.uk/omfds.html**

In brief

Ransom – a money spinner

Research at Southampton has uncovered that ransom in war provided a valuable source of income for all classes in the Late Middle Ages, not just for kings, knights and higher orders, as was previously thought.

Dr Rémy Ambühl, Leverhulme Early Career Fellow in Humanities at the University, has examined a large number of historical sources to find that contracts which drew-up the terms and conditions of ransom were commonplace between individual soldiers or small groups on opposing sides.

"Patriotism was not the driving force to encourage enrolment and ordinary men would have been reluctant to join armies willingly if they faced death upon capture. However, under the terms of ransom, prisoners were less likely to be harmed and additionally the practice provided them with an opportunity to make money – another incentive to enlist," says Rémy.

He explains that from the moment of capture, prisoners became the individual responsibility of their masters. The master had to work out the appropriate value of their prisoners and enter negotiations with them, their family and friends. In turn, prisoners, or their connections, would raise funds or arrange an exchange for their release.

Records show that the earliest evidence of a set scale of ransom payments for the bottom of the social hierarchy dates from the battle of Agincourt. Rémy concludes this may reflect an evolution of the ransom system in the first decades of the 15th century.

Repairing bones

Scientists at Southampton have created a new method to generate bone cells which could lead to revolutionary bone repair therapies for people with bone fractures or those who need hip replacement surgery due to osteoporosis and osteoarthritis.

The research, funded by the Biotechnology and Biological Sciences Research Council (BBSRC) was carried out in collaboration with the University of Glasgow. Dr Emmajayne Kingham cultured human embryonic stem cells on to the surface of plastic materials and assessed their ability to change.

The team was able to use the nanotopographical patterns on the biomedical plastic to manipulate human embryonic stem cells towards bone cells, without any chemical enhancement. The materials, including polycarbonate plastic, which has many applications including in bullet proof windows and CDs, offer an accessible and cheaper way of culturing human embryonic stem cells and presents new opportunities for future medical research in this area.

Professor Richard Oreffo, who led the University of Southampton team, explains: "Our research may offer a whole new approach to skeletal regenerative medicine. The use of nanotopographical patterns could enable new cell culture designs, new device designs, and could herald the development of new bone repair therapies as well as further human stem cell research."

Coral sunscreens

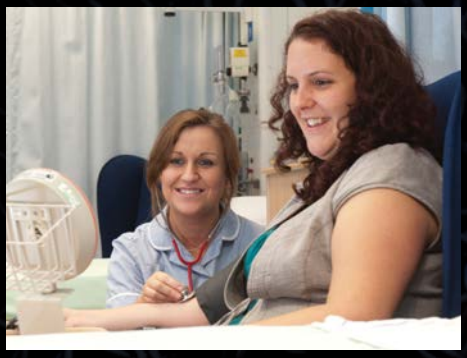
New research at Southampton has found out how corals use their pink and purple hues as sunscreen to protect them against harmful sunlight.

Many reef corals need light to survive, as they benefit from sugars and lipids that are produced by their light-dependent symbiotic algae. However, in the shallow water of coral reefs, light levels are often higher than required; light stress is a major driver of coral bleaching – the loss of the symbiotic algae that represents a threat to coral reef survival.

Dr Jörg Wiedenmann, Senior Lecturer of Biological Oceanography and his team have produced experimental evidence that the pink and purple chromoproteins in corals can act as sunscreens for the symbiotic algae by removing parts of the light that might become otherwise harmful.

"The beautiful pink and purple hues that are produced by the coral host are often evoked by chromoproteins; pigments that are biochemically related to the green fluorescent protein (GFP) of the jellyfish *Aequorea victoria*. In contrast to their green glowing counterpart, the chromoproteins take up substantial amounts of light, but they don't re-emit light," he says.

"GFP-like proteins were suggested to contribute to the protection of corals and their symbionts from excess sunlight. This hypothesis has been controversially discussed as the mechanism as to how these pigments function remained unclear. At least for the chromoproteins we know now that they have indeed the capacity to fulfill this function," he adds.



Nurse satisfaction survey

A survey of nearly 34,000 nurses across Europe has revealed that the decrease in nurse staffing levels and workforce issues have a significant impact on both staff satisfaction levels and patient care.

The English arm of the international RN4CAST study, led by researchers at the University of Southampton and the National Nursing Research Unit at King's College London, surveyed nurses in over 400 general medical and surgical wards at 31 Trusts, as part of a research programme looking at links between nursing workforce issues and patient outcomes across 15 countries.

Professor Peter Griffiths, Chair of Health Services Research at Southampton, explains that the survey highlights how staff shortages can affect patient care because some tasks, including talking to patients and monitoring their condition, are omitted due to lack of time and resources.

"The survey showed that nurses in England had high levels of stress and job dissatisfaction compared to nurses in other European countries. It seems that they can't always perform their job to the level they'd like", Peter says. Less than half of the nurses who responded to the survey felt that they receive praise and recognition for good work and just over a quarter stated that they receive verbal abuse from patients or their families a few times a month.

"This highlights both the importance and potential benefits of both managers and the public supporting nurses to ensure that they can deliver excellent care in the face of these challenges," Peter adds.

In brief

Tidal power potential

New research from a global group of scientists and engineers that includes Southampton supports the use of tidal power, which has the potential to provide more than 20 per cent of the UK's electricity demand.

While the predictable nature of tides makes them an ideal renewable energy source, the ability to effectively harness their energy has proved elusive. Although the potential for marine energy conversion clearly exists, the technology is presently still in a commercial prototype phase and only a handful of devices have so far been tested at full scale in the ocean.

AbuBakr Bahaj, Professor of Sustainable Energy at Southampton, explains that the energy from tides is harvested using two main techniques. One involves building barrages across tidal estuaries so that the flowing waters turn turbines. The other involves placing turbines underwater in areas of the sea where there are fast flowing tidal streams.

In collaboration with the global group, several companies plan to deploy arrays of tidal turbines in UK waters; MeyGen is planning to deploy tidal stream technology in Scotland's Pentland Firth that will initially generate enough to power about 38,000 homes.

"This is a crucial milestone for technology development and deployment. Such deployment will give a boost to the industry as it will also provide the needed data of operation in one of the most energetic areas of the sea," says AbuBakr.

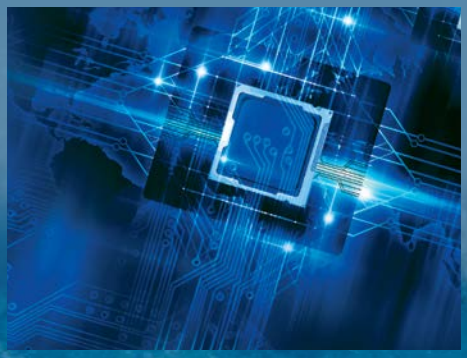
Reducing obesity in children

Southampton researchers have demonstrated that mothers who have higher levels of n-6 polyunsaturated fatty acids (PUFAs) that are found in cooking oils and nuts, during pregnancy have fatter children.

The study, part of a larger programme of research directed by Professor Cyrus Cooper at the Medical Research Council (MRC) Lifecourse Epidemiology Unit at the University, assessed the fat and muscle mass of 293 boys and girls at four and six years, who are part of the Southampton Women's Survey (SWS), a large prospective mother-offspring cohort. Their assessments were compared to the concentrations of PUFAs which were measured in blood samples collected from their mothers during pregnancy.

Dr Nicholas Harvey, Senior Lecturer at the MRC Lifecourse Epidemiology Unit, who led the research with Dr Rebecca Moon, Clinical Research Fellow, comments: "Obesity is a rising problem in this country and there have been very few studies of mother's fatty acid levels during pregnancy and offspring fat mass. These results suggest that alterations to maternal diet during pregnancy to reduce n-6 PUFAs intake might have a beneficial effect on the body composition of the developing child."

Results from the study also showed weaker associations between a mother's levels of n-3 PUFAs, more commonly known as omega 3 and found in fish oil, and muscle mass in their offspring – the higher the level of n-3 the less fat and more muscle and bone in the baby.



Quantum computing

Scientists from the universities of Southampton and Oxford have developed the first experimental demonstration of a model of computation, which may pave the way to devices that could offer the first definitive quantum-enhanced computation.

Quantum computers harness the power of atoms and molecules to perform memory and processing tasks and have the potential to perform certain calculations significantly faster than any silicon-based computer.

Photons can be described as bosons; they exhibit strong quantum level entanglement. If two sufficiently identical photons come together they behave in a connected way, almost as if they 'clump' together. When scaled up to multiple input photons these entanglements cause the outputs of a boson-sampling circuit to clump together in a characteristic way, predictable by quantum mechanics, but difficult to calculate using conventional computers.

Boson sampling, by taking advantage of recent advances in photonics, offers a promising route to building a quantum computer device, providing convincing evidence for the computational power of quantum mechanics.

The Southampton team, led by Professor Peter Smith and Dr James Gates from the Optoelectronics Research Centre, developed the photonic chip on which the experiment was performed. "The chip offers a scalable route, perhaps the only scalable route, to build large linear systems required for larger boson sampling machines. The move to optical processing on a chip format can be likened to the shift to integrated silicon chips in electronics," says James.

Increasing airline efficiency

In the transport industry reducing carbon emissions and increasing sustainable practices can be costly. Airlines in particular are under pressure to be more efficient and now research at Southampton is set to revolutionise plane scheduling in order to cut costs.

Dr Güneş Erdoğan from the Southampton Management School has received funding from the University's Annual Adventures in Research (AAIR) scheme to investigate how airlines can save money and burn less fuel by being more efficient in the way they schedule their planes and crews on routes around the world.

Güneş' research focuses on the management of aircrew through joint fleet assignment and crew pairing. He is using publicly-available European aviation data to develop an algorithm that works out the most efficient way aircrews and flight schedules can be managed without affecting the number of passengers flying, and applying it to real-life situations.

"This is a problem that has been considered before, but previous attempts have been unsuccessful," explains Güneş. "It is worth tackling again because if we can manage to fly the same number of people on fewer planes, using less fuel, there are considerable savings to be made."

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

www.southampton.ac.uk/research
newboundaries@southampton.ac.uk
+44 (0)23 8059 2070