

A young child with dark skin is sitting on a bed, looking towards the camera. They have a thin, clear nasogastric tube inserted into their nostril. The child is wearing a light-colored, short-sleeved shirt. The background shows a bed with white sheets and some colorful clothing (red, white, and blue) on it.

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New Boundaries | Issue 17 | October 2013

Tackling malnutrition

Influencing policy to change
attitudes to nutrition

Protecting our underwater environments
Sustainable use of our oceans

Renewable revolution
A step change in energy production

Safe from cyber attack
Safeguarding our data and infrastructure

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 problem of malnutrition to the growing need to provide sustainable energy for future generations.

As a pioneer in health and healthcare research, the University is working with governments in developing countries and here in the UK to tackle malnutrition, a problem that contributes to a third of child deaths worldwide. Find out more on page four.

The University also has a global reputation for groundbreaking research in the marine and maritime sector. Our researchers are investigating how we can use our oceans in a sustainable way, while protecting ecosystems and our underwater heritage. Discover more on page 12.

From using the oceans in a sustainable way to providing next-generation sustainable energy solutions, our research is leading the way. Read about the latest renewable energy technologies to be developed at the University on page 18.

Much of the research that is carried out at the University is in partnership with global businesses and helps solve commercial problems across a huge breadth of industries. On page 24, you can find out the University's impact on the UK economy in relation to spin-outs and partnerships.

As well as partners within industry, we are also partnering with UK intelligence agencies to tackle the threats to online security, an issue that costs the UK economy an estimated \$18bn a year. Read more on page 32.

For more research stories, visit our website
www.southampton.ac.uk/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, please send them to newboundaries@southampton.ac.uk





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Tackling malnutrition

According to the World Health Organization (WHO), malnutrition is estimated to contribute to more than a third of all child deaths around the world. Researchers at Southampton are influencing public policy to change healthcare practices and public attitudes to nutrition.





Professor Guy Poppy's research on sustainable pest control is helping to alleviate poverty in Africa and Asia

Nyovani Madise, Professor of Demography and Social Statistics at the University, explains that the lack of access to highly nutritious foods and problems such as inappropriate patterns of breastfeeding, contribute to malnutrition in developing countries.

“Introduction of supplementary food can occur as early as the first month. Infection caused by contaminated water used in baby foods can lead to persistent diarrhoea, which also undermines a child’s nutritional status,” she says.

Malnutrition is not just an issue in developing countries; it is also a clinical and public problem in the UK, explains Marinos Elia, Professor of Clinical Nutrition and Metabolism at the National Institute for Health Research (NIHR) Southampton Biomedical Research Centre (BRC) in

nutrition. Malnutrition affects more than three million people in Britain, costs an estimated £13bn a year or more and continues to go under-detected. When people are malnourished, their basic health and social care outcomes are significantly affected, making malnutrition an important patient safety issue.

“Our latest National surveys suggest that in England, at least 29 per cent of adults admitted to hospital, 18 per cent in mental health units, 12 per cent in sheltered housing and 35 per cent in care homes are malnourished, or at risk of malnutrition,” he says. “In the whole country this equates to five per cent of the population being malnourished or at risk of malnutrition and expenditure on malnutrition is the same, if not greater than expenditure on obesity in the UK,” he adds.

In order to prevent malnutrition, a joined up approach is needed, both at home and abroad. Nyovani explains that good quality research into the reasons behind malnutrition is vital to understand the problem. “We also know that poor infant feeding patterns are closely linked with poverty, so we need to address the causes of poverty, tackle disease and collaborate with local and national governments to educate the public and change people’s attitudes towards nutrition.”

Changing attitudes

Researchers at the Medical Research Council (MRC) Lifecourse Epidemiology Unit (LEU) at the University are indeed changing attitudes towards nutrition in the UK. In the landmark Southampton Women’s Survey (SWS), a study of 12,500 women aged between 20 and 34 recruited before they became pregnant, the team, led by Professor



Tackling food poverty

Based on innovative technology invented and developed through research at Southampton, sustainable pest control products by spin out company Exosect are being used around the world to preserve the global food supply.

Exosect's success since 2008 has had a positive impact on global food supply chains and contributed to efforts to meet two of the UN Millennium Development Goals: eradicating extreme poverty and hunger, and ensuring environmental sustainability.

The company's bio-control products are being used in diverse ways: by Sainsbury's in response to consumer pressure to reduce chemicals in food, by Bayer CropScience to conserve bee populations and protect crops, and by English Heritage to preserve the UK's cultural heritage.

"The technology has inspired a \$1m Gates Foundation grant for poverty reduction efforts in sub-Saharan Africa and raised

awareness among conventional pesticide manufacturers of the environmental and economic benefits of bio-control solutions," says Guy Poppy, the University's Director of Multidisciplinary Research and Professor of Ecology.

Exosect has attracted more than £12m from investors and gained more than 60 patents and 30 national product registrations, as well as successfully test-marketing the technology and products. It is well-positioned to commercialise its unique patented platform technology across the food supply chain.

Growing recognition of the environmental benefits of Exosect's products resulted in them winning 'Best New Product' for Exosect SPTab at the Society for Food Hygiene and Technology Awards in 2008, and winning their category in *The Guardian* Global Cleantech 100 awards in 2009 and 2010.

For more information on Exosect, visit www.exosect.com

Cyrus Cooper, Director of the MRC LEU, found that lifestyle considerations such as diet, employment, social factors and levels of fitness and exercise have an influence on foetal and infant development.

The SWS also indicated that women with lower educational attainment may suffer from health problems such as obesity and often do not prepare for pregnancy by changing their diet and lifestyle. As a result, their children are less likely to have a diet that conforms to the government's guidelines for nutrition and are at higher risk of having problems in later life. "This large collaborative study demonstrates the impact of population science on health policy for future generations. The survey continues to yield invaluable insights into maternal health," says Cyrus.

In developing countries, Nyovani has also

found that more educated women are more likely to have healthy children. "If they are more educated, they are more likely to have a good job, be knowledgeable about the right foods for infants and children, and negotiate the right medical care for them when they are sick," she says.

Nyovani and her team work with policy makers to educate women on the appropriate foods for them during pregnancy and for their babies as they grow. Her research on the socio-economic situation and characteristics of undernourished children in six African countries, found that there was a correlation between poor feeding practices, disease and child mortality.

"Feeding practices of infants in developing countries usually include starting babies as young as one or two months old on a cereal-based porridge as a supplement to

breastfeeding. The porridge is made using contaminated water which causes infection and disease," says Nyovani. "Our research on child health has contributed to changes in policies in Malawi, Kenya and the WHO."

In the slums of Nairobi, Nyovani and her collaborators have set up a counselling support scheme that teaches pregnant women about what they should be eating during pregnancy to give their babies the best start. "We also educate the women on the importance of breastfeeding for building up the immune systems and cognitive development of infants, and we encourage them not to introduce supplementary feeding too early because we know that this can cause serious illness from contaminated water," she says.

So far the team has recruited 800 women on to the scheme and counsellors follow ►



Professor Marinos Elia and his team have developed a tool to assess the nutrition status of a patient

the progress of their babies up until they are one year old in order to advise them on the early development of their children.

Simple solutions

In the UK, Marinos and his team at the BRC in association with BAPEN, a charitable association that raises awareness of malnutrition, have developed a bedside tool that assesses whether a patient is malnourished or not. “The Malnutrition Universal Screening Tool (MUST) is based on three criteria: whether the patient has experienced weight loss, what the patient’s weight is now and whether the patient is likely to lose more weight in the near future,” says Marinos.

MUST measures a person’s body mass index (BMI) and is a tool based on a simple scoring system between zero and two. If the patient has a very low BMI, they score a two. Similarly, if the patient has lost a lot of weight they get another high score, and if they are acutely ill or unlikely to receive nutritional intake over the next five days, then again they score two. “The three scores can then be added up and if the score is two or higher they are at a high risk of being malnourished,” he says.

Based on the score from MUST, using a simple chart system, healthcare professionals can then decide the best course of treatment for the patient. Over the last few years, MUST has been incorporated into the majority of hospitals and care homes in the UK. “Supported by the Department of Health, the Royal College of Nursing, the Royal College of Physicians, the Registered Care Home Association and the National Institute for Health and Care Excellence (NICE), MUST is now in use by over 80 per cent of healthcare institutions in the UK,” Marinos explains.

“The advantage of using MUST is that it can be used in different care settings, and we have created electronic versions and apps to simplify the technique to reduce the workload and move towards an automated system that patients can use themselves,” he adds.

Influencing policy

Nyovani explains that educating the public is the key to tackling malnutrition. “In Africa, interventions on their own can only go so far, and that is why we

collaborate with local governments on every project we do. This is vital as local government help is what is needed to improve social services, educate women on nutrition and to improve water quality.”

In the UK, policy development and quality standards around malnutrition can only be built on a sound platform of solid and consistent evidence. In Southampton at the BRC, the work that Marinos and his colleagues have carried out has greatly influenced the National Institute of Health and Care Excellence (NICE) quality standards for nutrition support in adults. Marinos chaired the Quality Standards Committee providing the essential research knowledge, experience and leadership to develop the new standards that will transform the delivery of care.

The BRC, which illustrates the importance of collaboration between the NHS, the MRC and the University, has also played a key role in developing the International Malnutrition Taskforce (IMTF), a major influencer and developer of global malnutrition policy and practice. Using research from the BRC, the IMTF has identified two key research priorities that focus on the needs and care of children with severe acute malnutrition and moderate malnutrition across the world. The research priorities are: the need to be able to accurately determine the pattern of growth in children recovering from malnutrition, and the need to better understand the nutritional requirements of children recovering from malnutrition.

Going forward researchers in Southampton will continue to work with healthcare providers to identify the research priorities of importance to clinicians and patients so that better studies can be designed and delivered that more effectively address malnutrition issues, and work with industry to develop therapeutic pathways to maximise the quality and effectiveness of nutritional care.

For more information about Southampton research on nutrition, visit www.southampton.ac.uk/medicine/research/centres.page

Key facts

- Malnutrition is estimated to contribute to more than a third of all child deaths around the world
- In the UK, at least 29 per cent of patients admitted to hospital are malnourished
- MUST is in use by over 80 per cent of healthcare institutions in the UK
- Our researchers work with government and policy makers to tackle malnutrition

“Our research on child health has contributed to changes in policies in Malawi, Kenya and the WHO.”

Professor Nyovani Madise,
Professor of Demography and
Social Statistics



Mapping the population

Information acquired from the census that is taken every 10 years in the UK, is used by local government, community groups and businesses to develop infrastructure and services for the population. Research by David Martin, Professor of Geography, ensures that the geographical patterns in these data can be interpreted correctly.

Q *What is your research about?*

You could describe my research as creating the geographical units by which we try and understand the population and where people are located.

When a census is taken, lots of people in society are interested in the results. Community groups are interested in how they fit in to society, and local authorities want to use the data to decide how to distribute local resources. There is also interest in understanding neighbourhoods that might be suffering from deprivation, or looking at which areas feed particular schools or higher education institutions.

My research is looking at how best to draw the boundaries for these areas, because this has a big effect on how the data can be interpreted. I am interested in the science of how we draw these population boundaries and how we place them in the most neutral way, which allows the data to be interrogated by everyone without bias.

Q *Who uses census data?*

As well as local government and local community groups, a lot of businesses use census data. My research group has lots of interaction with communities of business users such as the Demographic Users Group and the Market Research Society that use the data on a daily basis, because they want to understand how best to locate shops, facilities, public transport, healthcare and emergency services.

Q *How do you work with the Office for National Statistics (ONS)?*

In the 1990s, I spent a term of study leave from the University as a researcher at the ONS. At that time, the ONS was starting to use geographic information systems to digitally create and manipulate spatial areas in the lead up to the 2001 census. I developed a prototype where a completely new set of geographical areas could be created that covered the whole area of England and Wales that contained a couple of hundred people in each area. The ONS adopted this approach and these areas became known as the output areas that were used in the 2001 census.

We continuously work with the ONS on the census. We use the results of each census to study and refine the geographical units used. We also work with the ONS to help process the raw data so that they can be interpreted by users in order to improve people's lives.

Q *What is the impact of the research on society?*

One of the key features of our research is that it has contributed massively to the fact that many more people are able to access these kinds of data. Anyone can use census information to understand neighbourhoods in order to deliver a service, and this can be traced back to the fact that we have created these geographical units.

Before these small units of population existed it was very hard for people to access the information about small localities and it was also very difficult for people to interpret the data. Our work has meant that the data are more useful. For example, now statistical agencies can more reliably calculate how much deprivation a particular area has and allocate resources to improve conditions.

Q *What got you interested in this topic?*

I was attracted to this area of research when I was a geography undergraduate and became interested in creating maps with computers. The concept that we could represent all the geographical areas in the country using a computer and generate virtual maps with all the data, led me to study for a PhD investigating healthcare planning.

Q *What motivates you?*

How cities develop and how the population of a city is structured has an enduring fascination for me. I am motivated by the need to find better ways of representing that reality and finding better ways of displaying population data so it can be used to improve people's lives.

Q *Why is Southampton a good place to do the work?*

I have had the privilege of working at Southampton for most of my career and we have built up a very good Geographical Information Group. Within the University there is a great strength in Geography and

Social Statistics, and we are based near the ONS and Ordnance Survey, with both of which we have very fruitful partnerships.

Q *What is your next project?*

Since the 2011 census, we have been looking to better understand where people travel to in the day. We want to build dynamic representations of the movement of population through the day, through term-times and through the seasons. We are doing this so that we can better respond to the questions that planners ask when they are interested, for example, in how we are exposed to environmental hazards and how to respond to emergencies.

For more information on David's research, visit www.southampton.ac.uk/geography/davidmartin

“One of the key features of our research is that it has contributed massively to the fact that many more people are able to access these kinds of data.”

David Martin,
Professor of Geography

Protecting our underwater environments

Our underwater world is the last unexplored frontier on Earth and with our growing demand for resources we are starting to turn to our oceans as a source of renewable energy and minerals. Southampton research is looking at how we can use our oceans and seas in a sustainable way, while protecting ecosystems and our underwater heritage.

“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.”

Dr Jon Copley,
Marine ecologist

Our researchers have explored the deepest known ‘black smoker’ vents, so-called for the smoky-looking hot fluids that gush from them





Exploring the deep ocean

As precious metal resources on land increasingly become a cause for concern, we are looking to the oceans to provide the means to support our technology-led society. Pioneering Southampton researchers have discovered deep-sea vents teeming with new species and valuable metals such as gold, platinum and copper. They were the first to discover such deep-sea vents in the Caribbean and the Antarctic.

During expeditions to the Caribbean aboard the *Royal Research Ship James Cook*, marine geochemist Dr Doug Connelly and marine ecologist Dr Jon Copley led teams that discovered and explored the deepest known 'black smoker' vents, so-called for the smoky-looking hot fluids that gush from them. These undersea hot springs lie 0.8km deeper than any seen before. They are thought to be hotter than 400°C and shoot jets of mineral-laden water more than a kilometre into the ocean above.

"More than half of our planet is deep ocean and we are increasingly using its resources, such as fishing and extracting oil and gas from deeper waters. We are also starting to see interest in mining 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 understand deep-sea environments" he adds.

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 active deep-sea 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." The most recent expedition of the *RRS James Cook* to the Cayman Trough was accompanied by the BBC's Science Editor, David Shukman, to improve the public awareness of the oceans.

Then in June 2013, Jon and PhD students Verity Nye and Diva Amon also joined a Japanese expedition to the Cayman Trough, led by the Japan Agency for Marine-Earth Science and Technology. This expedition undertook the first manned missions to the deep-sea vents of the Cayman Trough, using Japan's *Shinkai6500* submersible—one of the few vehicles in the world that can carry people so far into the ocean depths. During the expedition, the Southampton team broke several records: Jon became the first British person to journey more than 5km deep in the ocean, while Verity undertook the first manned mission to vents 2.3km deep and international student Diva became the deepest diving Trinidadian to date. ►

“It is a privilege to be the first people to see and visit these places and I am very conscious that we need to share this with the public,” says Jon. “Our everyday lives have an impact on the ocean depths, so we all share the responsibility for its stewardship. It’s very important for as many people as possible to be aware of our exploration and see what is down there, so we can make informed choices about our use of ocean resources,” he adds.

Discovering new species

As we become more dependent on the oceans for food, energy and resources, we need to understand more about the species living in them. Southampton researchers have discovered numerous new species in recent years.

Professor Paul Tyler, who led the expedition to the vents in the Antarctic, 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.”

Earlier this year, Southampton researchers including Jon published an investigation of the first whale skeleton ever found on the ocean floor near Antarctica, giving new insights into life in the sea depths including at least nine new species of deep-sea organisms thriving on the bones.

The research team from the University of Southampton, Natural History Museum, British Antarctic Survey, National Oceanography Centre and Oxford University surveyed the whale skeleton using high-definition cameras to examine the deep-sea animals living on the bones and collected samples to analyse ashore.

Samples revealed several new species of deep-sea creatures thriving on the whale’s remains, including a ‘bone-eating zombie worm’ known as *Osedax* burrowing into the bones and a new species of isopod crustacean, similar to woodlice, crawling over the skeleton.

Diva says: “Examining the remains of this southern Minke whale gives an insight into how nutrients are recycled in the ocean,

which may be a globally important process in our oceans.”

Protecting our underwater heritage

As well as a rich source energy and minerals, the seabed also holds many insights into our past, be it shipwrecks or evidence of our earliest ancestors. The ability to survey a wide range of archaeological sites underwater is vital to both an enhanced understanding of our past and our potential to protect this extensive cultural resource.

“Submerged landscapes across the globe give us vital clues to where we have come from; our earliest ancestors would have lived in and migrated across them during periods of lower sea levels, so it is in our interests to protect them,” says Dr Justin Dix, Head of the Geology and Geophysics Research Group.

Justin and colleagues have developed a high-resolution 3D imaging system (3D Chirp) for looking at the top few tens of metres of the seabed. This method can identify and characterise objects as small as 30 centimetres and can be used for identifying unexploded ordnance buried in the near surface, the virtual reconstruction of whole buried shipwrecks and even studying the internal structure of submerged landslides. The 3D Chirp system and its 2D equivalent are now being commercialised with Kongsberg Geoacoustics Ltd.

Although originally developed to investigate archaeological sites, these techniques are now being used by the research team to investigate a wide range of other problems. “As well as producing new technologies, we are providing advice directly to the UK government on how to best preserve our undersea environment and we are working with providers of nuclear power, wind power and trans-national energy connectors to help them develop sustainable infrastructure for their energy sources,” says Justin. “Our methods have even been used to assist national and international police forces’ underwater search teams.”

Mapping lost landscapes

Studying coastal towns that have been lost to the sea helps us to better understand our past and the forces of nature. David Sear, Professor

of Physical Geography, and his team recently carried out the most detailed analysis ever of the archaeological remains of the lost medieval town of Dunwich, dubbed ‘Britain’s Atlantis’. Present-day Dunwich is a village 14 miles south of Lowestoft in Suffolk, but it was once a thriving port – similar in size to 14th-century London. Extreme storms forced coastal erosion and flooding that have almost completely wiped out this once prosperous town over the past seven centuries.

Funded and supported by English Heritage, and using advanced underwater imaging techniques, the project has produced the most accurate map to date of the town’s streets, boundaries and major buildings, and revealed new ruins on the seabed.

Peter Murphy, English Heritage’s coastal survey expert, says: “The loss of most of the medieval town of Dunwich – one of the most important English ports in the Middle Ages – is part of a long process that is likely to result in more losses in the future. Everyone was surprised, though, by how much of the eroded town still survives under the sea and is identifiable.

“While we cannot stop the forces of nature, we can ensure what is significant is recorded and our knowledge and memory of a place doesn’t get lost forever. Professor Sear and his team have developed techniques that will be valuable to understanding submerged and eroded terrestrial sites elsewhere.”

For more information on our research in the oceans, visit www.southampton.ac.uk/oes

Key facts

- Over 50 per cent of our planet is deep ocean and is still relatively unexplored
- We are starting to turn to our oceans as a source of renewable energy and minerals
- Submerged landscapes across the globe give us vital clues to where our earliest ancestors would have lived and migrated across during periods of lower sea levels



Preserving Venice

Southampton researchers have shown that the sea surface temperature in coastal regions of Venice is rising as much as 10 times faster than the global average of 0.13 degrees per decade.

The team, led by Professor Carl Amos, believes that this is partly as a result of a process known as the urban heat island effect, where regions experiencing rapid industrial and urban expansion produce heat, making the area warmer than its surroundings.

“Massive urbanisation of the coastal zones means urban heat islands represent an

acute problem, particularly for the fishing industry and also for the maintenance of coastal infrastructure,” says Carl.

This research has highlighted the tension between tourism’s economic benefits and environmental repercussions. Analyses of seawater temperature trends in the Venice Lagoon have suggested an increase throughout the year at rates higher than that predicted globally by the Intergovernmental Panel on Climate Change – a result directly linked to tourism.

For more information, visit

www.southampton.ac.uk/oes/venicelagoon

The future of the Web

New Boundaries talks to Bryan Glick, Editor-in-Chief of *Computer Weekly* and his former tutor Professor Dame Wendy Hall from the University about the challenges facing the computer industry.

Bryan Glick (Computer Studies, 1987), Editor-in-Chief of Computer Weekly:

In 1987, all the technology we have now, from smartphones and wireless networking, to tablet computers and social media was just science fiction.

Today, the Web is integrated into people's lives. We use it to communicate, whether that is socially through networking sites or professionally in our jobs. The Web is continuously growing and evolving as more people add to the content that is available. The majority of people use the internet to source information, plan journeys and holidays, buy products and services, set up businesses and even manage their money.

Technology disconnect

One of the issues that the computer industry faces at the moment is that over the last 10 years the proportion of people in IT under the age of 30 has plummeted. The problem seems to be that we are not enthusing young people about a career in computer science. Children are brought up in a world full of technology, but there is disconnect between them using the technology and them wanting to make a career out of computing.

Linked with this is the perceived problem that there is a shortage of career-ready graduates in IT. The industry believes that universities should be doing more to prepare students for their careers in

computing, so that they can drive the next-generation of web technology forward.

In my role as Editor-in-Chief at *Computer Weekly*, I am responsible for the managing and development of the team that produces the editorial content, including the web site, weekly digital magazines, blogs, videos, podcasts, web seminars, social media and face-to-face events.

When I started at *Computer Weekly*, there was a print magazine and a web site, but the two were not integrated. We went through a two-year process to change the magazine into a web-based product and in the last 18 months web traffic to our site is up 50 per cent, while other technology magazines have down-sized or folded completely. The Web has been vital in the publishing sector; the benefits of publishing stories online, getting instant feedback from consumers and obtaining user statistics to inform future development of the magazine are highly valuable and more and more magazines are leaving print behind and turning digital.

Privacy and transparency

However, with the huge increase in user data on the Web, the biggest issue for the industry is privacy and ownership of data. People are educated enough to know that through their use of the Web, they give large amounts of personal information to companies, but as consumers, we do

not understand what those companies do with these data. I believe that the answer to this is greater transparency with data.

Gender gap

The last issue facing the computing sector is the fact that there are very few women in the industry. At *Computer Weekly*, we run the UKtech50, a subjective list of the 50 most influential people in IT in the UK. Alongside this, we also run The 25 Most Influential Women in IT, to promote women in the industry. But more needs to be done to encourage women to study computer science at university.

The University of Southampton is a world-leader in research around the internet and the World Wide Web, but what is the institution doing to tackle the issues I have highlighted above?

Dame Wendy Hall (BSc Mathematics, 1974; PhD Mathematics, 1977), Dean of Physical Sciences and Engineering and Professor of Computer Science at the University:

The University of Southampton has fully embraced the World Wide Web and not merely as a tool for education and research. The University's own story is inextricably linked to the emergence of both the Web and the internet. Southampton made the breakthrough in developing the low-loss optical fibres which now 'drive' the internet.



And the University continues to lead applied research into the power of the information that the Web holds.

Maximising social benefit

Bryan's graduation year, 1987, was a seminal year for me as I started building the groundbreaking Microcosm hypermedia system, which pre-dated the Web, with the aim of digitising all the documents, films and photos from the Mountbatten Archive at the University. My career has paralleled the history of the Web and now I am focused on understanding what the Web is and how we might engineer its future to ensure maximum social benefit.

With Professor Sir Tim Berners-Lee, the inventor of the World Wide Web, who holds a Chair of Computer Science at the University, and Professor Sir Nigel Shadbolt, Head of the University's Web and Internet Science Group, I have created the academic discipline of Web Science. Web Science not only looks at the technological changes to the Web, but also how the world is changing around the Web and how people's behaviours change as a result.

Supporting global development

I think one of the biggest challenges we face today is that people don't fully understand the impact that computers have had on the world and that this impact is on-going. We need to understand how people use the

internet and what we need to do to develop effective tools, languages and standards to ensure its continuing, creative use.

That is why, together with some of my colleagues, I have been involved in setting up the Web Science Trust, a charitable body that aims to support the global development of Web Science through its international network of research laboratories.

At the University, we are also looking at the concept of a Semantic Web. This is essentially a more intuitive Web. At the moment if you do a search online, your web browser will display lots of sources of information that you then need to sift through. In the next decade, we will see computers sifting through this information for us and providing the exact answer needed.

Open data

In terms of privacy and transparency regarding data online, Sir Tim and Sir Nigel have pioneered the open data concept. They have led the way for an unprecedented amount of government data to be made freely available. This led to the launch of the Open Data Institute in London last year, co-directed by Sir Tim and Sir Nigel, which incubates new businesses to exploit these data. The data are now being used to create innovative services from apps that avoid accident black spots to finding the nearest empty car park space.

Career ready

The issue of providing the industry with career-ready graduates is taken very seriously at Southampton. Our students have the opportunity to do work placements throughout their time here and we are also discussing introducing industrial placements into our degrees, either as summer placements or as a year in industry. This should give students real experience of the industry so that they are equipped for the global jobs market.

Similarly to Bryan, I am passionate about encouraging more women to forge careers in computing, and I am a big admirer of Bryan's work to promote the most influential women in IT. Thanks to his work female students have genuine role models to look up to. However, the issue of women in computing is not really a women's issue, it is something that everyone must get involved with.

There are many men in the industry that would like to see a more balanced workforce. However, at the moment, the vast majority of people in control of decision making in the industry are men and this is where attitudes need to change. Businesses need to work in partnership with universities to bring about this change.

For more information on Dame Wendy's work, visit www.southampton.ac.uk/ecs/wendyhall



Key facts

- Over the next 50 years, human kind is going to be limited by three factors – energy, food and water
- Southampton research has been incorporated into the UK Department of Energy and Climate Change's 2050 Energy Pathways report
- Our researchers are part of a £6.1m transatlantic research project to improve the process of photosynthesis

Our researchers are investigating the potential of new sustainable sources of energy such as woody plants

Renewable revolution

With an ever-growing population coupled with depletion of fossil fuels and concerns about carbon emissions, we are looking to renewable sources to fuel the future. *New Boundaries* looks at how the University is contributing to this step change in energy production.

“Over the next 50 years, human kind is going to be limited by three factors – energy, food and water,” says Professor Gail Taylor, Chair of the University’s Strategic Research Group (USRG) for Energy. She explains that it is predicted that there will be a 40 per cent rise in the demand for energy, a 60 per cent increase in the demand for food, and a 50 per cent increase in the demand for water.

Against this backdrop, research teams from across the University of Southampton are tackling the issue of increasing demand for energy with technologies that minimise the production of harmful emissions.

Efficiency gains

One problem with existing sources of renewable energy is their low efficiency; this will need to be overcome if renewables are to replace fossil fuels in a low-carbon future.

“At present solar panel efficiencies are between 10 and 20 per cent, and for high-end use – such as energy conversion on satellites – you could obtain solar cells with 30 per cent efficiency,” says Tom Markvart, Professor of Energy Conversion, at the University.

“But thermodynamic calculations suggest that we should be able to reach efficiencies of 50 to 60 per cent and this is what we are working towards.”

Tom’s team is looking to nature to try to develop new and more efficient photovoltaic materials, for example at plants, which harness the power of light to fuel their growth through photosynthesis. “We are working

with collaborators in the UK and Europe to construct similar materials synthetically to the chloroplasts of plants that could be used in our photovoltaic devices,” he says.

Smart integration

As well as improving solar panel design, Tom and his team are showing how solar panels can be integrated into energy infrastructures around the world.

Solar generators are much smaller than traditional power stations and produce direct current (DC), rather than the alternating current (AC) that is delivered to houses and businesses from the power grid. Electrical power converters called inverters are needed to convert DC to AC, but until recently these had not been tested for solar power.

“At Southampton, we worked with electricity suppliers to design a testing procedure that would satisfy them that photovoltaic devices were safe for the distribution network,” says Tom. “Working with colleagues in Electrical Engineering and industry we developed a test for the inverters, and we are still the only independent test facility in the UK to test inverters for solar panels.”

Demand for renewable power will continue to grow and Tom’s team is responding to this challenge by looking at how existing energy infrastructure can be adapted to cope with this.

For example, the UK power system is based on centralised generation from large coal power stations; power stations were built ►

near coal mines, because it was cheaper to transport the electricity around the country through cables, rather than the coal.

“We have been looking at what kind of energy system we would have if we started from scratch,” Tom says. “There is no reason why we should have large power stations any more – renewable energy sources such as solar power and wind power could lead to decentralised smaller micro grid systems where districts as small as 100 houses could be powered by smaller energy systems,” he adds.

Evidence-based energy

With growing enthusiasm for renewable sources, an evidence-based approach is needed to ensure we are harnessing the most efficient methods.

Our researchers recently assessed the efficiency of micro-wind turbines on houses, which have recently grown in popularity in urban areas. They found that in most instances such turbines on buildings have very poor performances.

Dr Patrick James, who led the Energy Savings Trust funded project, says: “We have monitored around 80 turbines at various sites in the UK. The analysis of the performance of these turbines has resulted in a halt to a significant number of installations in the built environment and an extension of this study has been incorporated into the UK Department of Energy and Climate Change’s 2050 Energy Pathways report.”

Following the research, manufacturers have released revised performance data or reclassified their devices and the UK market has fundamentally shifted to pole mounted turbines on rural farms.

Plant and algae power

To meet future energy demands, we will need to look to new sustainable sources of renewable energy. Gail and colleagues are investigating the potential of other sources of energy such as woody plants and algae, which won’t compete for land with food crops. The cell walls of woody plants contain cellulose, a carbohydrate that can be broken down and used to make the biofuel bioethanol. Gail and her team are examining the mechanisms

that control the cell wall composition and disassembly in poplar trees.

The research involves testing wood samples from the University’s unique collection of over 6,000 poplar trees, to find out which break down and release the cellulose easily. The researchers can then identify the genes that control these cell wall traits.

Gail says: “We have developed a pioneering genotyping chip that enables us to quickly screen trees to establish the presence or absence of particular forms of the genes.” The overall aim is to develop sustainable bioenergy trees that produce an optimum yield but have a small carbon footprint.

Our researchers are part of a £6.1m transatlantic research project to improve the process of photosynthesis. Photosynthesis allows biological systems to convert sunlight into chemical energy and is the source of all the fossil fuels we burn today. However, nature’s way of capturing energy from the sun in plants, algae and other organisms has some fundamental limitations of efficiency.

Four research teams from the UK and the USA are now exploring methods to overcome these limitations. The funding has been awarded by the UK Biotechnology and Biological Sciences Research Council (BBSRC) and the US National Science Foundation (NSF) in a pioneering programme designed to draw on knowledge from both sides of the Atlantic.

The teams are working in two areas: improving the ability of algae to convert sunlight into energy – and biofuel – by photosynthesis, and minimising the cost and energy inputs needed for large-scale algae cultivation.

Dr Tom Bibby, lecturer in biological oceanography, who is leading the Southampton research team, says: “This exciting project aims to bring a step-change in our knowledge. By working with researchers from diverse backgrounds and employing new integrative bioscience techniques – including functional genomics and synthetic biology – we hope to significantly improve the efficiency of life-fundamental processes such as photosynthesis.”

“It is not surprising that a university like Southampton would be heavily involved in tackling global challenges such as future demand for energy,” concludes Gail. “With our science and technology background, our researchers are actively finding technical solutions as well as social solutions so that we can become a more sustainable society integrating renewable energy easily with demand for power.”

For more information, visit www.southampton.ac.uk/energy_futures

“It is not surprising that a university like Southampton would be heavily involved in tackling global challenges such as future demand for energy.”

Professor Gail Taylor,
Chair of the University’s Strategic
Research Group (USRG) for Energy

“At Southampton, we worked with electricity suppliers to design a testing procedure that would satisfy them that photovoltaic devices were safe for the distribution network.”

Tom Markvart,
Professor of Energy Conversion



A man in medieval armor is shown in a close-up, leaning against a tree. He has a bloody forehead and a bloody hand, suggesting a recent battle. The armor is made of metal plates, and the lighting is dramatic, highlighting the textures of the armor and the man's features.

Medieval soldiers: wealth and status

World-leading research at Southampton gives insight into how modern society was formed. Dean of Humanities, Professor Anne Curry, tells *New Boundaries* how medieval soldiers emerged as the middle classes.

Q *What is your research about?*

My research is about the working conditions and social status of soldiers of the English Crown in the Hundred Years War particularly the period from 1369 to 1453.

Historians have often believed that paid armies were a creation of the 16th and 17th centuries, but we have shown that professional soldiers existed earlier. They made their living and forged careers from the army. We also see military families where several generations served. It was common to find a man-at-arms and his son, an archer, in the same retinue. Young men joined as archers and in time were promoted to men-at-arms. Some even went on to become lieutenants and captains.

Q *What did your research involve?*

We transcribed thousands of muster rolls where serving soldiers were listed. From these we created a database of 250,000 service records, creating what is probably the largest online database of medieval people in existence.

The soldiers were in the pay of the English Crown, funded by taxation voted in parliament. This made war the concern of the public at large. There had to be checks that the money was properly spent. Fraud was a big concern. Captains entered into contracts to provide a certain number of soldiers. In order to check the men had turned up, their names were listed and checked. This is revealed by the dots entered against the names by officials carrying out the muster.

Our database reveals repeated service across many different theatres from Scotland to Spain, often spanning well over 20 years. We can reconstruct soldiers' lives and experiences.

Q *What was the social status of soldiers in the period?*

Our most important findings concern the social status of soldiers. Archers, often listed under the heading 'yeomen', were paid six pence a day, which was higher than many craftsmen. Their status is confirmed by the fact that 'yeoman' became the standard term to describe a rich peasant. Similarly,

men-at-arms, meaning soldiers who had full plate armour and a range of weapons, were paid 12 pence a day. In the late 14th century, all men-at-arms were called esquires, but by the 1430s this title became more exclusive, restricted to the leading members of a retinue. This is important for English history because it shows the emergence of a middle class or lower gentry just below that of knights. Being in the army gave men a wealth and social status that was unrivalled in normal society.

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

Our research shows the differences in the lives of soldiers between then and now. In the late 14th and early 15th century many MPs had military experience as men-at-arms or knights. In society today, this link has disappeared and has had an effect on how parliament and the general population view the armed forces. The military does not have such a high status as it did then. However, family traditions of service and the relationships that develop through the military are still important today.

Q *How did you get interested in this area of research?*

My interest started when I studied Henry V in my final undergraduate year. By studying the king, I wanted to know more about his armies. I started with an in-depth analysis of his army at Agincourt (1415). This research came out of my looking at late medieval warfare more generally, and discovering that thousands of lists of soldiers in garrisons and in expeditionary armies still survived in archives in the UK and France.

Q *Is Southampton a good place to do your research?*

Southampton is an amazing place for me to do my research because many of the armies that invaded France, including that which won at Agincourt, gathered in Southampton and were shipped out from here. It is great to do the research in the place where much of it happened, and I am looking forward to celebrating the 600th anniversary of Agincourt in 2015 with a conference and special events in Southampton.

Q *What is your next project?*

I have just completed a study of the armies of Richard III and Henry VII at Bosworth. Now I am aiming to understand more about English society and the growth of royal power under the Tudor kings, when army sizes grew considerably. Henry VIII, for instance, invaded France in 1513 with about three times as many soldiers as Henry V had done in 1415. Military power was crucial in the forming of England as a modern state. Our taxation systems came about as a result of the need for an army. But you can also argue that democracy itself resulted from the having an army – parliament was constantly debating whether the King should be given funds to invade other countries.

We are aiming to extend our database from 1453 to 1558 and even beyond into the English Civil War. This will take us to the birth of the modern regiments after 1660.

For more information on Anne's work, visit www.southampton.ac.uk/history/annecurry



“We’ve established our niche and our expertise: we produce the best molecular diagnostic kits of their type. It’s a \$5bn market, so the sky’s the limit – there’s no reason why we can’t double or triple our revenues from where we are now.”

Jim Wicks,
Managing Director of PrimerDesign

Commercialising success

With a financial crisis and recession in recent years, it is more important than ever to encourage innovation to boost the UK’s economy. *New Boundaries* looks at the part the University is playing through business collaborations and high-profile spin-out companies.

In today’s tough financial climate, new businesses need help to flourish. The University is part of the SETSquared Partnership, which supports new business opportunities through incubation and business acceleration of start-up companies. SETSquared has been ranked the fourth best university business incubator globally and the best outside the USA.

“Through SETSquared we work with businesses on three key areas: helping them develop a compelling business plan, the management of the business and raising funding to make things happen; in fact we have helped businesses in our incubators secure £34m in investment this year alone,” says Alan Scrase, Centre Manager at SETSquared in Southampton.

Primer Design, a company that designs and creates DNA testing kits for a range

of applications, is just one example of a company that has benefited from SETSquared at Southampton.

Jim Wicks, Managing Director of PrimerDesign, says: “The biggest example of where SETSquared helped us was in 2009, when we produced the world’s first swine flu detection kit. SETSquared and the University press office foresaw the impact of the story, and helped us handle the enormous press interest. This massively raised our profile globally, and is a big part of why we now have customers in 104 countries.”

Primer Design has started an apprenticeship scheme that is providing employment opportunities for young people in the local area.

“We’ve established our niche and our expertise: we produce the best molecular diagnostic kits of their type. It’s a \$5bn

market, so the sky’s the limit – there’s no reason why we can’t double or triple our revenues,” adds Jim.

New companies need a physical base to grow and develop, and the University provides this through its Science Park, located in Chilworth in Southampton, which has provided a nurturing home for many start-up and rapidly growing businesses over the past 30 years. Owned and operated by the University, the Science Park provides not only flexible space for growing businesses but also provides the networking and close connections to the University’s research base. Currently more than 50 companies are based on the Science Park, from fledgling enterprises to businesses that lead the world in the fields of pharmaceuticals, optical fibre, software design, satellite broadcasting and mobile telecommunications. ►

Spin out success

Creating companies from our own research excellence is part of the University's heritage, and this type of innovation is vital for the UK economy. We have an impressive record, having spun out thirteen companies since 2000, four of which have been floated on London's Alternative Investment Market (AIM) with a combined market capitalisation value of £180m at the time of floatation.

Just one example is Ilika, a science-based discovery company developing new materials for use in applications such as energy conversion, electronics and biomedical. Ilika was recently listed in the CleanTech 100 acknowledging them as one of Europe's most innovative clean technology companies.

The University supports companies of all sizes through schemes such as Knowledge Transfer Secondment (KTS). One company that has benefited from this scheme is Covesion, an innovative optoelectronics company which spun out from Stratophase, itself a University spin-out company. They produce wavelength conversion crystals which are used to transform the colour of laser light. In March 2010, Corin Gawith joined Covesion as part of an Engineering and Physical Sciences Research Council (EPSRC) funded KTS.

Mark Middleton, the former Managing Director of Covesion, says: "The KTS has provided an invaluable link with the University and has expanded what we could have achieved on our own. It's given us access to cutting-edge facilities, such as the University's cleanrooms, and Covesion will continue to benefit after the secondment is finished because of the skills and knowledge that have been imparted to our staff."

Supporting SMEs

The University of Southampton is one of the top universities in the UK for collaborating with small – and medium-sized businesses SMEs. Through programmes such as Knowledge Transfer Partnership, in which a skilled graduate works on a set project within a company with support from the facilities and expertise from the University, we have helped many local businesses to flourish.

We recently completed a KTP with manufacturing company CJR Propulsion to help them use computational fluid dynamics to improve their products. Mark Russell, Managing Director of CJR Propulsion, says: "The high level of support we received from the University provided quick results and kept the project ahead of schedule. The result was a huge improvement to our products. I am pleased to say that Simon Lewis, the Southampton graduate who worked with us, is now a member of our team."

The University is also working with the Royal National Lifeboat Association (RNLI) on an Advanced Technology Partnership (ATP) to improve lifeboat safety by validating structural repair techniques, assessing the fire resistance of the composites used in lifeboats and extending the life of the existing fleet.

Paul Boissier, Director of the RNLI, says: "How many universities can say that every day of the year their work is directly and repeatedly saving people's lives? This is exactly what the ATP between the RNLI and the University achieves every time a lifeboat is launched, some 9,000 times a year."

As well as supporting small businesses, the University is working closely with the Local Enterprise Partnerships (LEPs) in the south of England. "We are supporting the LEPs to help them achieve their aims – enabling existing businesses to grow, creating new jobs, creating the infrastructure to support businesses," explains Alan.

High-profile partnerships

Links with leading technology companies produce groundbreaking research that improves the UK's competitiveness on a global scale.

In the past few years, the University has developed or expanded strategic partnerships with EADS, Airbus, IBM, Rolls-Royce, BAE Systems, DePuy, Lloyds Register, RNLI, Philips, Vitacress, Microsoft and GlaxoSmithKline (GSK).

With Lloyd's Register, for example, the University has established the Southampton Marine and Maritime Institute (SMMI). The creation of the SMMI has been stimulated

by the University's ever strengthening relationship with Lloyd's Register over the last 40 years. This relationship has resulted in an investment of around £120m in a new campus, the largest such business-focused endeavour in any UK university.

"The vision for SMMI is to be the world leader in education and research in the marine and maritime domains and to work towards a safer and sustainable planet Earth through better understanding of the marine environment and better management and stewardship of assets in the maritime domain," says Professor Ajit Sheno, Director of the SMMI. "The dream is to create something that is akin to Silicon Valley in California for the marine industry here in Southampton. Already between one in three and one in four jobs in the south-facing Solent region are maritime-related, so this is a huge part of the economy and we can really build on these strengths. Marine and maritime activity also underpins a very significant element of the UK economy."

For more information on our commercial success, visit www.southampton.ac.uk/business/success_stories



SETSquared helped PrimerDesign produce the world's first swine flu detection kit

Improving hearing screening

Hearing impairment is the most frequent sensory deficit in human populations, affecting more than 250 million people worldwide. Dr Ben Lineton, audiology specialist at the University, talks to *New Boundaries* about understanding the cochlea and using this to improve hearing tests.

Ben's work builds on influential research from Southampton's Institute of Sound and Vibration Research (ISVR), which contributed to the clinical appraisal of a test allowing deafness to be detected in newborn babies.

The test is based on the fact that healthy ears emit low level sounds called transient evoked otoacoustic emissions (TEOAEs), which can be detected by a microphone in the ear canal, usually within a few days of birth. This procedure has subsequently been adopted by the NHS, and more than six million newborn babies in the UK will have been screened by the end of 2013.

"My research involves trying to understand more about what happens in the cochlea, so that these hearing tests can be improved," says Ben. "We want to be able to identify the reason why someone can't hear, not just whether they can or not."

Ben explains that cells in the cochlea contain motor proteins – proteins that detect motion and produce TEOAEs. "By analysing the frequency of the TEOAEs, we believe we can

determine which part of the cochlea they came from and therefore which cells are functioning normally," he says.

"At the moment, the TEOAEs are picked up at very low levels and these can also be buried in a lot of noise so they are difficult to identify. We are looking to improve the test by removing this noise interference," explains Ben. "In addition, our hearing tests can be used to monitor hearing damage that may occur when people take medication – for example some antibiotics can affect a person's hearing. Patients can be tested at regular intervals to see if there is any deterioration over time."

With a background in acoustics and fluid mechanics, Ben was drawn to this intriguing area of audiology and finds it gratifying that his research will help change people's lives. "With the fantastic facilities and acoustic, signal processing and audiology experts all in ISVR, Southampton is the right place to carry out my research," he says.

Cross-collaboration with researchers in different areas of the University is also an

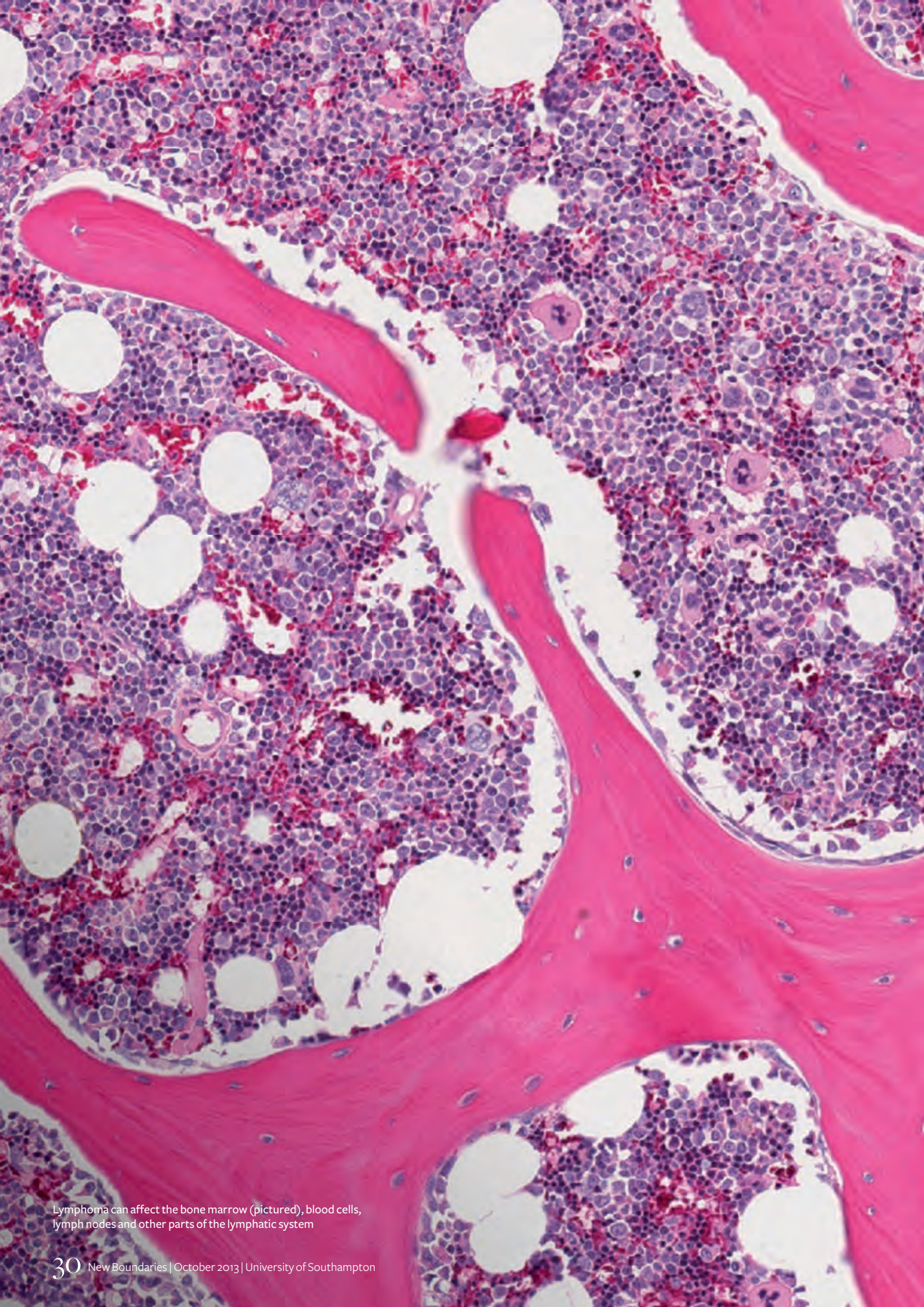
important part of Ben's work and is built into the ethos of the institution. "The ISVR has a history of collaboration with colleagues in the Faculty of Medicine," he says. "For example, one other project is looking at inflammation in the ear in older patients and whether this has an influence on hearing loss as you age."

For more information on hearing screening tests, visit www.southampton.ac.uk/engineering/newborn_hearing_screening

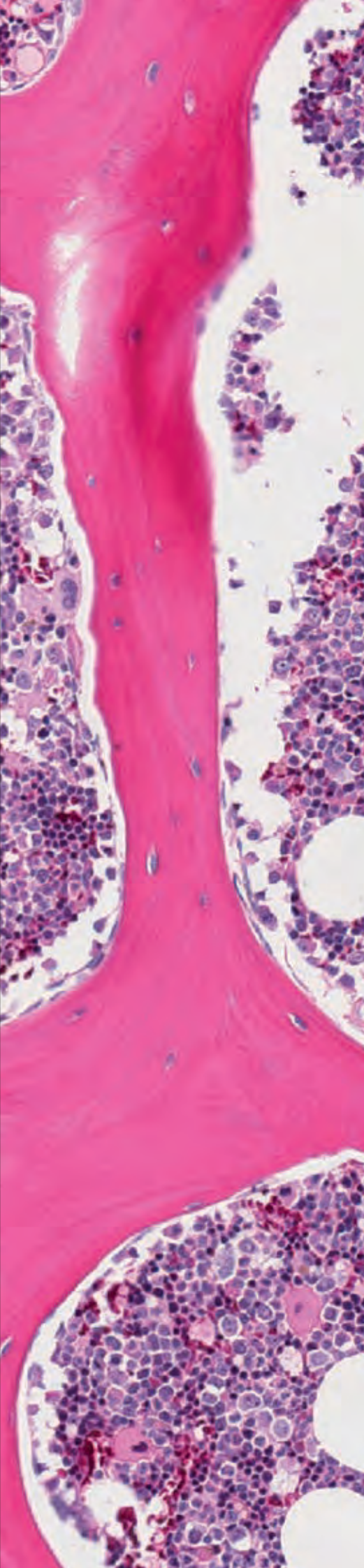
"We want to be able to identify the reason why someone can't hear, not just whether they can or not"

Dr Ben Lineton,
Audiology specialist





Lymphoma can affect the bone marrow (pictured), blood cells, lymph nodes and other parts of the lymphatic system



Pioneering new cancer treatments

Every year around 12.7 million people across the world are diagnosed with cancer and this number is expected to increase to 21 million by 2030.* *New Boundaries* talks to Peter Johnson, Professor of Medical Oncology, whose research looks at using the immune system to develop new cancer therapies.

Peter's research covers two broad areas: in translational research, the application of immunology to cancer treatment through the development of antibodies to modulate the body's immune system, and in clinical research, the development of better treatments for malignant lymphoma, a type of cancer that has its origins in cells of the immune system itself.

"These areas converge in that we frequently use monoclonal antibodies to treat lymphoma, and indeed they have provided some of the most significant improvements in survival rates in the last decade," says Peter.

"We are now building on this record to use antibodies to target not just the malignant cells of lymphoma but also the normal cells of the immune system, using the antibodies to stimulate or block the control pathways of immunity. This will give us a whole new generation of cancer treatments not just for lymphoma, but many other cancer types as well."

Peter explains that we are never going to find one treatment that cures all cancers; there are more than 200 different types, all of which need to be tackled in different ways. "The greatest challenge in cancer medicine is its complexity; even within a single cancer

there can be multiple sub-cancers that evolve as time goes on, often as a means to evade the effects of treatment," he adds.

"We are only just developing the methods for unravelling all this complexity. The next decade is going to see us grappling with the vast amounts of data that can now be generated to describe cancers at the molecular level. As we do this, we will have to devise ways to spot the weaknesses in cancers and target them for treatment."

As a clinician, Peter finds the health benefits to patients very rewarding. "There is no better feeling than seeing someone get better as the result of a new type of treatment you have helped to develop; it is what gives us all the energy to keep at the research," says Peter.

"We have a very active clinical trials group in the Experimental Cancer Medicine Centre, with great expertise in translating work directly from the laboratory into clinical testing. The combination of these two strengths puts Southampton in a great position to lead on this work."

For more information on Peter's research, visit www.southampton.ac.uk/medicine/peterjohnson

**World Cancer Research Fund*

Safe from cyber-attack

Cyber-crime costs businesses and consumers worldwide untold billions of pounds each year. With computer systems at unprecedented risk from hackers, organised criminals, rogue states and terrorists, Southampton researchers are working to safeguard our data and infrastructure.



“Cyberspace lies at the heart of modern society and impacts on our personal lives, our businesses and our essential services,” says Professor Nick Jennings, Head of the Agents, Interaction and Complexity Group in Electronics and Computer Science.

“And cyber-crime relating to theft, hacking or denial of service to vital systems has become a fact of life and industrial cyber espionage where a company attacks another to acquire high value information through cyberspace, is also very real,” he adds.

Lucrative business

The cost to the UK economy of cyber-crime is estimated at \$18bn. To the cyber criminals, it is a highly lucrative business and at present the barriers are very low. The ease of access and relative anonymity lowers the risk of being caught, while making crimes straight forward to conduct. The UK government has called for more understanding of the cyber criminals ‘business model’ so that more holistic approaches for countering cyber-crime can be developed.

Professor Vladimiro Sassone, Director of the Cyber Security Research Centre at the University focuses on analysing and improving security protocols. “With colleagues at the Cyber Security Research Centre, I aim to build software to represent normal behaviour and therefore to detect deviations pointing to possible malicious activity,” he says.

Centre of Excellence

The Centre was recently awarded Academic Centre of Excellence status by the Government Communication Headquarters (GCHQ), the British intelligence agency, making Southampton one of only 11 universities in the UK to hold this distinction. “We work closely with institutions such as the Information Commissioner’s Office, the police, the Ministry of Justice and GCHQ as well as with experts from Psychology, Law and Management within the University,” Vladimiro explains.

One such collaborator, Dr Sarah Stevenage, Associate Dean for Education in Social and Human Sciences at the University, has launched the Super-Identity project, a

collaboration between the universities of Southampton, Bath, Dundee, Kent, Leicester, Oxford, and Pacific Northwest National Laboratory (USA), that will provide an enterprising and unique solution to identity crime in the real world and online.

“The benefits from our research will be substantial as we will have better tools for human identification. We will be more able to successfully protect our personal privacy and data security, while improving our ability to identify the true suspect in crimes against society.”

The assumption underlying the Super-Identity project is that while there may be many dimensions to an individual’s identity – some more reliable than others – all should ultimately reference back to a single core identity or a ‘Super-Identity’.

By collating information about real-world and online identities (including biometrics, cybermetrics, psychological aspects and biographical details), the project seeks to find out how to recognise this core identity more effectively.

The £1.85m project is funded by EPSRC under the Global Uncertainties Programme, and is supported by the United States Department of Homeland Security’s Science and Technology Directorate, under its Visualization and Data Analytics Program.

Advising government

“We also have to be prepared for terrorists to attack or disable key systems through the internet,” explains Nick. One of Nick’s roles is as a Chief Scientific Advisor (CSA) supporting the Centre for the Protection of Critical National Infrastructure (CPNI) that protects national security by providing advice on physical security, personnel security and cyber security/information assurance.

The CPNI works with the Cabinet Office and lead government departments and agencies to counter these threats. “I ensure that the CPNI makes the best use of science and engineering to pursue its national security imperatives,” says Nick. “This involves looking at what we do now and also making sure we are prepared for the future. We commission research with companies and

universities that is pulled through into the advice we provide and the tools we exploit.”

Nick works closely with Government CSA Sir Mark Walport and other departmental CSAs. “I assist in providing advice and opinions to the government across a broad range of topics, from badgers to nuclear accidents,” he explains.

The results of CPNI’s research sees advice being given to the owners of the critical national infrastructure including communications, emergency services, energy, financial services, food, government, health, transport and water. This can change the physical, personnel and cyber security of key parts of the infrastructure that are central to our country’s operation.

For more information on Southampton research into cyber security, visit www.southampton.ac.uk/cybersecurity



Scientific diversity

The University attracts the most talented students who have the drive to make an impact in their chosen careers after graduating. *New Boundaries* talks to Dr Kate Sloyan about being Early Career Woman Physicist of the Year, and diversity in the sciences.

Q *What did your PhD research involve?*
My PhD and subsequent postdoctoral research position in the Optoelectronics Research Centre (ORC), funded by an EPSRC Doctoral Prize, focused on a crystal growth technique called pulsed laser deposition (PLD), which uses ultraviolet lasers to grow thin layers of crystal – from a millionth of a millimetre to hundredths of a millimetre thick.

While you can use the technique to grow many different sorts of materials, in our group in the ORC we concentrate on growing optical crystals to make compact lasers and other optical devices. My work involved enhancing the capabilities of the basic technique to make the process quicker, easier and more versatile, in order to make new materials with designer material properties.

Q *Why is your research important?*
My work has focused on the growth of sesquioxides, a class of crystals that are in high demand due to their excellent laser host properties, but which are extremely difficult to grow by conventional methods due to their extremely high melting points.

There are a whole host of applications for compact, efficient, but high-power lasers based on layers of such materials, including medicine for prostate cancer surgery, machining and welding, defence and sensing. At the moment though, there are very few examples of working devices due to the difficulties in producing useful sesquioxide crystals.

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

It turns out, that we can grow layers of these crystals via PLD and this has been the point of my Doctoral Prize project, to prove that PLD can be used to quickly and easily grow crystals that thus far look very promising for a range of applications, but have not yet been exploited.

We have demonstrated working devices, and we're now in the process of refining the growth process and improving our results. Obviously the direct impacts of the research have not yet been felt beyond academia, but we hope that within a few years we'll have enough evidence to convince industry to look to us to develop these high-power lasers.

Q *What do you see as the biggest challenges for research in your field?*

The biggest challenge is proving that the technique really can offer something to industry. Hopefully we are getting there with our sesquioxide growth because these materials can't be grown easily by many other deposition methods. If we can demonstrate repeatable fabrication of powerful and efficient devices then we should be in a place to satisfy existing demands in a range of fields, from medicine to machining.

Q *What was it like winning the Early Career Woman Physicist of the Year award?*

At the time it was rather a shock but very flattering, especially having met the other finalists. One of the best things about the prize was that it was awarded equally on the basis of academic achievement and outreach activities. It encourages people who are aware of, and are trying to respond to, the bigger issues in science outside of their lab, and who are able to combine them with their academic work.

Q *How important is diversity in science?*

It's pretty clear from the statistics that certain groups are not well represented in science, technology, engineering and mathematics (STEM) subjects generally and physics in particular, including women, but also people from lower income backgrounds, with disabilities and people from certain ethnic backgrounds. From a practical point of view if large sections of the population are missing from STEM careers then you're likely to have lost some excellent researchers, and scientific progress will be slowed as a result.

Given that STEM is so important for growth in the country, there's a business case for increasing diversity as well. It's important therefore that we as a society make sure that everyone has the opportunity to excel in STEM if they have the potential to do so. We also need to make sure that those who do go into science feel that they're able to stay, and that career structures and colleague behaviours don't drive people away.

Q *Is it important for scientists to engage with MPs?*

Yes, definitely. I attended a Department of Business, Innovation and Skills select

committee hearing on women in physics, which was part of the broader inquiry into women in the workplace whose remit included topics such as gender stereotyping, equal pay and pay transparency. MPs in general have very little experience of professional science, but they do want to make decisions based on evidence. So it was fantastic to be able to inform them on some of the issues we face.

Q *Why is Southampton a good place to do postgraduate research?*

The fact that there are so many groups in the ORC, doing so many varied and exciting things in all areas of photonics, was what drew me to Southampton. The concentration of expertise in STEM subjects generally makes Southampton a great place to study, and the support I've had from my supervisor and others has made my time a lot easier, and more fruitful.

For more information about research at the ORC, visit www.orc.soton.ac.uk



Combating hand-arm vibration syndrome

Southampton research into hand-arm vibration syndrome has influenced company practice and international policy around the world, providing health services with more effective diagnostic tools and helped control the risk for millions of workers.

In the UK there are about one million people at risk of developing hand-arm vibration syndrome – a combination of a vascular disorder known as vibration-induced white finger and the lack of the sense of touch.

Professor of Human Factors Michael Griffin, from the Institute of Sound and Vibration Research at the University, and his team have analysed how the disease affects individuals and developed diagnostic methods that are being used in medical clinics around the world.

“We have developed a unique machine that is used to measure the blood pressures in all five fingers simultaneously at different temperatures in order to assess the damage to the hands. We also carry out laboratory work to

try to understand how vibrations travel through the fingers in order to minimise vibration with gloves and other protective equipment,” says Michael.

The team is also involved in improving international standards for hand vibration and advise policy makers on vibration standards for gloves. “We also advise on the measurement and evaluation of hand-transmitted vibration, the testing of tools and the diagnosis of the disorder,” he adds.



Improving balance through dance

Researchers at Southampton are using ballroom dancing to improve the coordination and balance of people who have Parkinson's disease (PD).

It is estimated that 6.3 million people worldwide have PD, a progressive neurological condition that at present has no cure. Treatments are focused on reducing the symptoms, but the risk of falling among people with PD is a real issue as these can lead to serious injury.

Ann Ashburn, Professor of Rehabilitation at the University, is running a feasibility study on the effects of ballroom dancing on the mobility of people with PD. It is hoped that the enjoyable social activity will increase confidence, balance and mobility.

Ann explains that people with PD turn in a rigid way making them unsteady. "Dancing involves turning and stepping to a rhythmical beat. We are investigating whether dancing in-hold with a partner will help to increase mobility."

Ann and her team will measure people's mobility at the start of the study, and at three and six months to test the feasibility of providing dance classes for PD patients. "In the future, this might become something that enhances treatment regimes," she adds.

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Optimising railway design

Geomechanics research at Southampton is helping drive the intelligent design of railway systems globally, providing the industry with the tools to reduce costs and increase safety.

William Powrie, Professor of Geotechnical Engineering and Dean of Engineering and the Environment at the University, with colleagues Dr Joel Smethurst and Dr Derek Clarke, are leading the Geotechnical Railway Infrastructure project that focuses on understanding the way in which vegetation and climate affect embankments and cuttings, primarily through changing the moisture content of the soil, which makes the ground unstable and affects the geometry of the tracks it supports.

William explains that this can result in the imposition of temporary speed restrictions and in a period of wet weather the increased moisture content can lead to unsafe ground. In conjunction with MottMacDonald the team has already helped Network Rail and London Underground to develop guidance for the management of vegetation on embankment and cutting slopes so as to minimise both dry-weather settlements and the risk of slip failures in wet weather.

"We are also investigating how ground, ballast, sleepers and the rails work as a complete system," says William. "This has not really been considered in the past but as we demand more of our railway infrastructure through heavier, faster, tilting and more frequent trains, it is becoming more important that we consider the system as a whole to optimise its performance and minimise maintenance requirements."



Detecting methane deposits

Methane trapped in ocean sediments as ice-like methane hydrate has the potential to be a potent agent of global environmental change. Southampton researchers are using cutting-edge techniques they have pioneered to find out more about this phenomenon.

On a research cruise on the *Royal Research Ship James Clark Ross* last year, the team investigated such methane reserves around Svalbard in the Arctic. One of the methods used was controlled source electromagnetic (CSEM) surveying, which estimates the concentration of electrically resistive methane gas or hydrate present in the pore spaces of sediments.

Around a decade ago, the University played a pivotal role in developing CSEM, which became one of the greatest technological advances in this field since the development of 3D seismic techniques. Since then, oil companies have taken up this technology and it is still at the forefront of groundbreaking research.

"There is increasing interest in hydrates both as an agent of environmental change and as a potential resource," says Tim Minshall, Professor of Ocean and Earth Science. "It has been exciting to work with our international partners in using new geophysical tools to study hydrate systems. Through a mixture of observations and computer models, we are learning that these systems can release methane gas in complex and unexpected ways."



High-power lasers

Researchers at Southampton pioneered the high-power ytterbium-doped silica fibre lasers and amplifiers that have revolutionised the manufacturing industry.

Doping silica fibres with rare-earth metal ions allows active light sources and amplifiers to be integrated with passive fibre networks. This innovation famously led to the invention at Southampton of the erbium-doped silica fibre amplifier that is the underpinning technology of the internet.

Professor Anne Tropper, now leading the Ultrafast Semiconductor Laser Group in Physics and Astronomy, was among the first to identify the ytterbium ion as the optimum dopant for efficient high-power fibre lasers and amplifiers.

Anne explains that ytterbium-doped fibre is used to convert the raw infrared power from semiconductor diode lasers into bright coherent beams that can be tightly focused for cutting, welding and material processing.

The simple electronic structure of ytterbium is what makes it efficient under the intense light field present in a fibre core. "Ytterbium just doesn't have the extra excited states where wasted energy can accumulate, and leak into the surroundings as parasitic fluorescence or heat," she says.

"Today, the largest market for these high-power lasers is manufacturing, in particular the automotive industry, which is a consumer of large numbers of units. It means that resistant materials can be cut with high speed and precision and there is no edged tool to get blunt."



Engaging with the Holocaust today

The Parkes Institute is at the forefront of international Holocaust studies. It raises public awareness and understanding of the Holocaust, challenging audiences to reflect on the individual consequences of discrimination, and urging them to recognise and respond to the continuing contemporary dangers of genocide.

Dr Shirli Gilbert, Senior Lecturer in Jewish/non-Jewish Relations at the University, focuses on the role of music in understanding and remembering the Holocaust. Her book *Music in the Holocaust* (Oxford University Press, 2005) which has now been translated into Spanish and Japanese, documents songs created by Jewish, Polish, German and Czech prisoners in ghettos and concentration camps. "Music opens a unique window onto the internal world of those communities, showing the diverse ways in which they understood, interpreted, and responded to their experiences at the time," says Shirli.

Shirli has also produced a 'Music and the Holocaust' website (<http://holocaustmusic.ort.org>) in association with the international educational organisation World ORT, making her research on music in Nazi Germany accessible to a broad audience.

"We are encouraging audiences to think about music's value as a way to understand the responses of ordinary victims of genocide and to encourage teachers to incorporate music into lessons on history, social studies, language arts and citizenship," says Shirli.



Transforming asthma therapy

Southampton research has been central to the development and international licensing of the anti-Immunoglobulin-E (IgE) monoclonal antibody omalizumab, one of only two novel asthma therapeutics that have emerged over the last 30 years.

Asthma is one of the most chronic conditions in the developed world, affecting one in 11 children – and it is on the increase. Studies by Professor Stephen Holgate, Medical Research Council Clinical Professor of Immunopharmacology, and colleagues at Southampton have directly underpinned the role of IgE in asthma, leading to omalizumab as a treatment that has transformed asthma control and survival prospects for severe allergic asthmatics.

"We have demonstrated IgE's role in multiple inflammatory processes, including long-term airway inflammation, cellular infiltration and remodelling, identifying to the field IgE as a common upstream target for controlling a wide range of acute and chronic inflammatory mechanisms in asthma pathology," says Stephen.

Stephen explains that omalizumab provides an effective therapeutic option for those with severe, persistent allergic asthma including those for whom standard therapy provides only limited control. He led one of five key clinical trials that demonstrated omalizumab's safety and efficacy in severe allergic asthmas, leading to registration in the USA and Europe



Ecological engineering

Several fish populations have declined or become extinct due to poor river development practices, but engineers at Southampton are looking at environmentally sustainable solutions to help prevent this happening in the future.

Dams and barrages have affected over 60 per cent of the world's largest rivers. While these are essential to provide adequate water for human life, they can have a negative impact on freshwater ecosystem services such as fisheries that are worth up to \$70bn a year.

Traditional fish passes, designed to allow species to pass by hydroelectric dams and other structures, suffer from bias towards a few species of fish and their swimming capability, while ignoring the importance of behaviour. Funded by the UK Environment Agency, European Commission FP7 and Swedish hydropower companies, environmental engineer Dr Paul Kemp and his team at the University, have been working on innovative fisheries engineering that incorporates fish pass designs based on the understanding of

behaviour and performance of endangered and economically viable species.

“For too long the mitigation of environmental impacts of river infrastructure, such as dams, has been focused on developing fish passes for salmon. Today the drive is to develop multi-species fish passes taking into consideration other endangered species such as the European eel, populations of which have declined by over 90 per cent and are now protected by EU legislation,” says Paul.

In brief



Beating blood cancers

Each year around 30,000 people in the UK are diagnosed with a form of blood cancer; 12,000 people die annually from the disease. Southampton researchers are bringing hope by gaining a better understanding of the illnesses and paving the way for potential new treatments.

The quality of our research has been recognised by the charity Leukemia & Lymphoma Research. We are one of the charity's Centres of Excellence and it is

investing over £7m into studies at Southampton. The funds support a number of projects which are making significant breakthroughs in the understanding, diagnosis and treatment of blood cancers.

Chronic lymphocytic leukaemia (CLL) is the focus of two research projects. One aims to understand how the cancer cells proliferate, in order to enable the development of new drugs in the future. A second project is identifying genes that can predict how well patients with

CLL will respond to treatment, to help doctors identify suitable treatment pathways for patients and enable the design of more targeted treatments.

Cathy Gilman, Chief Executive of Leukaemia & Lymphoma Research, says: "The University of Southampton has proved itself to be truly world class in its research into blood cancers. Scientists here are consistently helping to improve treatment and diagnosis for patients in Southampton and across the UK."



Benefits of temporary migration

Research from Southampton has shown that temporary migration can have many positive effects on the country of origin.

Policy-makers in many developing countries have long considered migration of skilled workers to 'rich' countries a threat to development. The assumption has been that a 'brain drain' leaves developing countries under-skilled and poorer.

Research by Jackline Wahba, Professor of Economics at the University, has challenged these assumptions. Her work revealed that migrants return with more skills, money to invest and are more likely to set up businesses. Her findings highlight the positive impact temporary migrants have on home nations, countering the notion high skilled emigration is a loss to developing countries.

Jackline found that uneducated migrants return with savings, while for highly educated migrants returning with additional skills is as important as savings. "They use knowledge and experience gained abroad to set up enterprises back home," she says.

Temporary migration also benefits the individual. "Return migrants earn a wage premium relative to non-migrants," Jackline adds.

This research highlights the importance of return migration for the economic development of the home country and the need for policies to encourage migrants' investment and job creation in their home country.



Improving apprenticeships

Increasing the number of apprenticeships has been the goal of successive UK governments. However, the sustained research on apprenticeships at Southampton has critiqued policy-makers' preoccupation with quantity and generated a conceptual framework for evaluating quality.

The 'expansive-restrictive continuum' framework developed by Alison Fuller, former Professor of Education and Work, and Director of Research in the Southampton Education School, and her colleague at the University of London, has informed vocational and education training policy at the highest level.

"The framework identified the key pedagogical and organisational features that characterised different approaches to apprenticeship, including the relationship of the apprenticeship to the business and the qualifications as a platform for progression," says Alison.

Alison and her colleagues have served as special advisors to a select committee assessment of the Apprenticeship Bill and their oral and written evidence has been cited in parliamentary inquiries and government commissioned reviews.

Their practical guide to creating expansive apprenticeships is published and promoted to providers and employers by the National Apprenticeship Service and Learning and Skills Improvement Service, and the application of the framework has been extended to continued professional development (CPD) and the third sector.



Attitudes to health

A science and educational-based approach to diet and lifestyle will help young people improve their own health and the health of their future children, Southampton research has shown.

LifeLab Southampton is an innovative intervention run jointly by academics from the Education School and Faculty of Medicine, and part of the National Institute for Health Research Southampton Biomedical Research Centre in Nutrition, which aims to improve young people's health through education and first-hand experience of scientific approaches at the forefront of modern medicine.

A study, published in the journal *Health Education*, included a survey of 597 14-year-olds across Southampton, which gauged their views and behaviour in relation to their own health. A group of teenagers who took part in LifeLab were compared with those of their peers, six months after the intervention.

Results showed that LifeLab created a wider appreciation among students that their current lifestyle could affect not only their long-term health but also that of their future children.

Dr Marcus Grace, Head of Science Education Research at the Southampton Education School says: "LifeLab's innovative approach is helping the region's teenagers understand the science behind common health issues, which in turn is helping them make informed decisions about their own health-related behaviour."

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

Southampton's global impact

The city of Southampton has a history of innovation and exploration. As a forward-thinking university, we uphold these values in our education and research. Our research and partnerships span the globe and make an impact on millions of lives around the world.

UNCOVERING THE PAST

Southampton archaeologist Dr Jacobo Weinstock is part of an international team that has analysed the DNA from a 700,000-year-old horse, kept frozen in the permafrost of Yukon, Canada

Image credit: D.G. Froese



FIGHTING CANCER

An antibody developed at Southampton that fights cancer has been issued a US patent

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Professor Guy Poppy is working in the Amazon Basin to alleviate poverty



SENSING THE PLANET

Dr Kirk Martinez travels to inhospitable environments such as those in Iceland to monitor temperature, pressures, sense shocks and measure ice movement to the nearest millimetre

NUCLEAR DECOMMISSIONING

Professor Ian Croudace and Dr Phil Warwick are helping the nuclear industry to safely close down power plants that have reached the end of their lives

TEACHING TOOL

Our Health Science researchers went to South Sudan and devised a teaching tool for midwives to use

INFLUENCING POLICY

Professor Nyovani Madise is influencing maternal and child policies in resource-poor African countries



INVESTIGATING CLIMATE

With CO₂ levels rising in the atmosphere, our researchers are investigating the relationship between ice and CO₂ in Antarctica



SUSTAINABLE ELECTRICITY

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