BIG IDEAS FOR THE FUTURE

UK RESEARCH THAT WILL HAVE A PROFOUND EFFECT ON OUR FUTURE

ABOUT RCUK AND UUK

UNIVERSITIES WEEK is an annual event that demonstrates the benefits of universities within UK society. The campaign highlights the impact universities in the UK have on the individual, the local community, its businesses, and the future of the UK, just to name a few. The campaign is coordinated by Universities UK, working closely with a range of higher education institutions and organisations, including Research Councils UK, the University Marketing Forum, the National Union of Students, the Higher Education Funding Council for England, UCAS, the University Alliance and GuildHE.
www.universitiesweek.org.uk

UNIVERSITIES UK (UUK) is the representative body for the UK's universities. Founded in 1918, its mission is to be the definitive voice for all universities in the UK, providing high quality leadership and support to its members to promote a successful and diverse higher education sector. With 133 members and offices in London, Cardiff and Edinburgh, it promotes the strength and success of UK universities nationally and internationally.
www.universitiesuk.ac.uk

RESEARCH COUNCILS UK (RCUK) is the strategic partnership of the UK's seven Research Councils. We invest annually around £3 billion in research. Our focus is on excellence with impact. We nurture the highest quality research, as judged by international peer review providing the UK with a competitive advantage. Global research requires we sustain a diversity of funding approaches, fostering international collaborations, and providing access to the best facilities and infrastructure, and locating skilled researchers in stimulating environments. Our research achieves impact – the demonstrable contribution to society and the economy made by knowledge and skilled people. To deliver impact, researchers and businesses need to engage and collaborate with the public, business, government and charitable organisations.
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The seven UK Research Councils are:

- Arts & Humanities Research Council (AHRC)
- Biotechnology & Biological Sciences Research Council (BBSRC)
- Economic & Social Research Council (ESRC)
- Engineering & Physical Sciences Research Council (EPSRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Science & Technology Facilities Council (STFC)

For further information on the research featured in this report please contact communications@rcuk.ac.uk

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FOREWORD

LORD BILIMORIA, CBE DL
FOUNDER AND CHAIRMAN, COBRA BEER
PRESIDENT, UK INDIA BUSINESS COUNCIL
INDEPENDENT CROSSBENCH PEER, HOUSE OF LORDS

I AM DELIGHTED to be introducing this publication brimming with examples of UK research that have the potential to have an impact on all of our lives. Despite the challenging economic times that we have all experienced over the last few years, UK research continues to be a great success story. The research being conducted in UK universities will contribute to the UK's climb out of recession and future economic growth.

What is so special about research that it can help us achieve economic growth and return to prosperity? We have seen during this recession that we can not rely on the old growth sectors, such as financial services, to give us the economic growth and stability that we experienced for over a decade before the 'credit crunch'. The UK needs to investigate, discover and successfully exploit new sectors for growth. In UK universities something very special is going on – people are having big ideas… Big ideas for the future. The sort of big ideas that will, if invested in, nurtured and exposed to the right opportunities and collaborations with business and international partners, provide the foundation for future UK economic growth and prosperity.

But these big ideas aren't just about economic growth and prosperity they are also about the health and wellbeing of the nation too. With challenges facing society such as an ageing population, increasing obesity levels, as well as the impact of climate change, we need to be investing in initiatives that will help tackle these issues. Research being carried out in UK universities, as the case studies within this publication demonstrate, are proactively working on innovative solutions to these issues and others that, we may not yet be facing, but will confront society in the future.

This publication is a true celebration of the research being conducted in UK universities. You will also find some other familiar voices, such as

Professor Lord Robert Winston, Dr Alice Roberts and Professor Iain Stewart, introducing the individual chapters of the publication and exploring what their area of research means to them and why it is so important to the UK. But, it focuses on no individual research discipline as, if we are to meet many of the challenges of the future, then we need a broad mix of the physical, natural, biological, medical and social sciences alongside contributions from engineering, arts and humanities.

It is easy to take these discoveries for granted, as we switch on our iPod or log on to the internet, especially as the UK has a track record of research excellence, but together, all of these big ideas have had a profound influence on our lives. When you next see a road sign directing you to a university building, think about the ground breaking work going on in that building. Or if you hear a Professor talking about their research on the news, think about what the impact of their work will be. The exciting big ideas currently being worked on in UK universities, as showcased by this publication, will continue to have a profound impact on our lives and the growth, prosperity and wellbeing of the UK. UK research is, truly, essential to the future as our ground breaking and life changing research has demonstrated for decades, having a lasting impact not just for our own country, but the benefit of people across the globe.

If you hear a Professor talking on the news about their research, think about what the impact of their work will be.

CHAPTER 1

DELIVERING A HEALTHY FUTURE

PROFESSOR LORD ROBERT WINSTON

WE ARE FORTUNATE TO LIVE at a time of dramatic progress in medicine. We now live longer, healthier lives than at any point in the past and this progress has mostly been possible because of the excellent research which makes a major impact in our understanding of health and disease. This is an area of human welfare for which this country is recognised internationally. And importantly, our excellence in biomedical research is based essentially in Britain's outstanding universities.

Universities are the seeding grounds for developing our talented young people and provide a world-class environment which nurtures young scientists and physicians. This wealth of original and high quality research is made possible by the support of the Research Councils, charitable foundations and industry which focus their funding at higher educational institutions across the UK. And we continue to punch above our weight as no country in the world, except the United States, can match this extraordinary excellence.

The pursuit of good health has been a key endeavour throughout history. Yet the human body is immensely complex and also very fragile. Moreover, we change throughout life – indeed, from the moment we are conceived, whilst still invisible to the naked eye, epigenetic research shows that each of us respond to our environment in different ways. And these changes may have a profound effect on our health as we grow and as adults. Each of us is unique; we vary in our anatomy and physiology, the make up of our DNA and the way it is programmed to respond to the environment. Only continued investment in our universities will ensure that we can use such knowledge to undertake research that promotes health and protects this fragile and complex body in which we live.

This chapter introduces just some of the thousands of projects that our dedicated university researchers have pursued to improve health. They have the potential to have an impact on the lives of millions. So, for example, medical researchers are looking at innovative ways to improve the outcome

after a stroke, a condition which maims or incapacitates some 150,000 sufferers annually in the UK. Others researchers attempt to find ways to prevent such age-associated diseases. As health improves people live longer, and research to maintain the health of older people becomes increasingly important. One reason why I am delighted to support this initiative is that it gives the opportunity to read and understand some of the latest ideas in all areas of health research. Studies using robots to help autistic children engage and communicate; the use of stem cells to grow new tissues, and the use of antibodies to treat cancer are not only interesting and exciting, but also have huge potential to improve lives.

If the UK is to remain at the forefront of international health research, support for our universities is vital. And the continued investment of bodies like the Research Councils is particularly critical. I am actively involved with a number of universities and higher educational institutions. Not all are directly connected to medical schools, but many – even the amazing Royal College of Music – conduct research which has an impact on health. And so many institutions all over the country collaborate to play an important role in developing ideas and bringing the benefits of medical research to patients. For example, studies such as the TOBY study in Oxford and London, have brought researchers and clinicians together to develop life-saving interventions for premature babies. Although friendly rivalry between organisations exists, this does not prevent excellent research, and frequently serves to produce invaluable knowledge. This publication is a showcase of what we expect we may achieve next.

Much of the research we do – particularly in biotechnology – will not lead to improved treatments quickly. But even those endeavours taking a long time to come to fruition are valuable learning experiences. And increasingly we gain knowledge from other research areas. These are not merely the medical, physical, mathematical or biological sciences, but the social sciences, engineering, research in the arts and humanities are increasingly important. Learning from all disciplines increases our understanding, encourages innovation and underpins the social and ethical value of what we do. And as this book illustrates, we are increasingly conscious of another important responsibility – to communicate and engage with the public and respond to public ambitions and anxieties.

The importance of basic research cannot be overemphasised. Without the insight it provides, we would be unable to plan the work that will lead to the biggest advances.

The importance of basic research cannot be overemphasised. Without the insights it provides, we would be unable to plan the work that will lead to the biggest advances. I feel privileged to be a member of the Engineering and Physical Sciences Research Council, one of the seven councils in the UK that invest around £3 billion each year in academic research. These bodies, particularly the Medical Research Council, are vital for setting this agenda and producing the basic knowledge that has such value.

The decision to invest public money in health and wellbeing should be easy to make, even in times when budgets are severely threatened. So many lives can be changed by university researchers; our bright young scientists must be supported if we are to see the different world which they hope to help shape. It is not merely a matter of empty pride that we should wish to be at the international forefront. This country has a critical role in ensuring the healthy future of our own children, as well as the health of many humans around the globe.

HEALTHY FUTURE: TREATMENT

MEDICINE AND THE TREATMENT OF ILLNESS and disease has been constantly evolving for thousands of years. As we develop more and more advanced methods of treatment we are living longer, more active lives than even half a Century ago. The researchers who seek to find the solutions to the many new and existing illnesses we are faced with today are already thinking ahead to what we might face in the future.

A NEW TREATMENT FOR CHILDREN WITH AUTISM

Autism is a lifelong developmental disability that affects how a person communicates with, and relates to, other people. It also affects how they make sense of the world around them (The National Autistic Society). Whilst autism is incurable, there is mounting evidence that early intervention can bring benefits in terms of how the disorder develops in later life. Researchers led by Dr Kerstin Dautenhahn at the University of Hertfordshire are using interactive humanoid robots as therapeutic 'toys' to help children with autism.

The team have developed KASPAR (short for Kinesics and Synchronisation in Personal Assistant Robotics), a child-like robot.

KASPAR can be controlled and tailored to an individual child's development needs. While obviously non-human, it has simple human features, minimal expressions and predictable movements. The robot acts as a mediator, encouraging children to communicate with people, at first indirectly and then directly. So far, KASPAR has been trialled with over 300 children across the autistic spectrum. Parents and teachers are amazed at the transformation in their behaviour – some seeing the children make eye contact, seek to share experiences or mimic actions for the first time. These small steps are big breakthroughs for the children and their families and teachers. This research has the potential to transform the social and educational development of children living with autism in the future.

ARTIFICIAL INTELLIGENCE TO HELP DOCTORS

Today our hospitals are busier than ever creating more pressure on doctors time. New treatment ideas and research are published every week, so doctors have their work cut out if they are to make the right decision every time. Researchers based in Oxford think they can help by offering artificial intelligence technology that can suggest options for a wide range of medical decisions.

The Cognitive Science & Systems group (COSSAC), split between the University of Oxford and London's Royal Free Hospital, is a small team with big ideas. They aim to understand the complexities facing doctors, but also build software systems that use this understanding to support clinical decision making and patient care. The team's main project is CREDO, which uses software technology that applies medical reasoning to assess patients' circumstances and recommend appropriate care. Clinicians add data to a patient profile, from test results to images and current treatment regimes. The software then analyses the current situation against clinical guidelines to suggest the most suitable course of action.

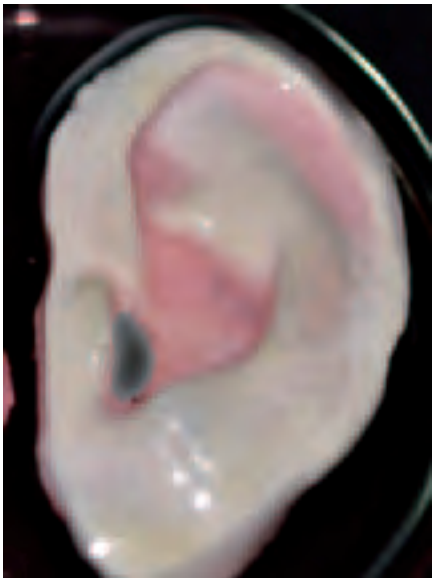
It is safe and ethical. Doctors and clinicians can act on or reject the suggestions as they see fit and recommendations are accompanied by patient-specific explanations in an easily understandable format. This technology will help time-pressed doctors decide on the best course of treatment and could potentially transform patient care across the UK and around the world.

GROWING REPLACEMENT HUMAN ORGANS

Today if a person needs a new heart, liver or kidney, they have to wait until a suitable donor can be found. More than 10,000 people in the UK currently need a transplant, but of these 1,000 will die waiting as there are not enough organs available (National Health Service Blood and Transplant).

A large team of researchers at University College London (UCL) are conducting groundbreaking work and are making human organs that can be used in transplant operations. They are doing this by using nanomaterials, nanocomposite biomaterials and stem cells. So far, the team have successfully developed coronary artery bypass grafts, a heart valve, nose, ear, trachea, vascular bypass and lacrimal duct. Some of these have already been successfully transplanted into patients and others are at various development stages, including preclinical trial. One example is the coronary artery bypass graft. Currently if a person does not have a suitable vein there is no alternative, but the team at UCL are able to tailor the organ to an individual patient.

The success of this work will have a huge impact on human organ treatment and our future quality of life.



COOLING NEWBORN BABIES TO SAVE LIVES

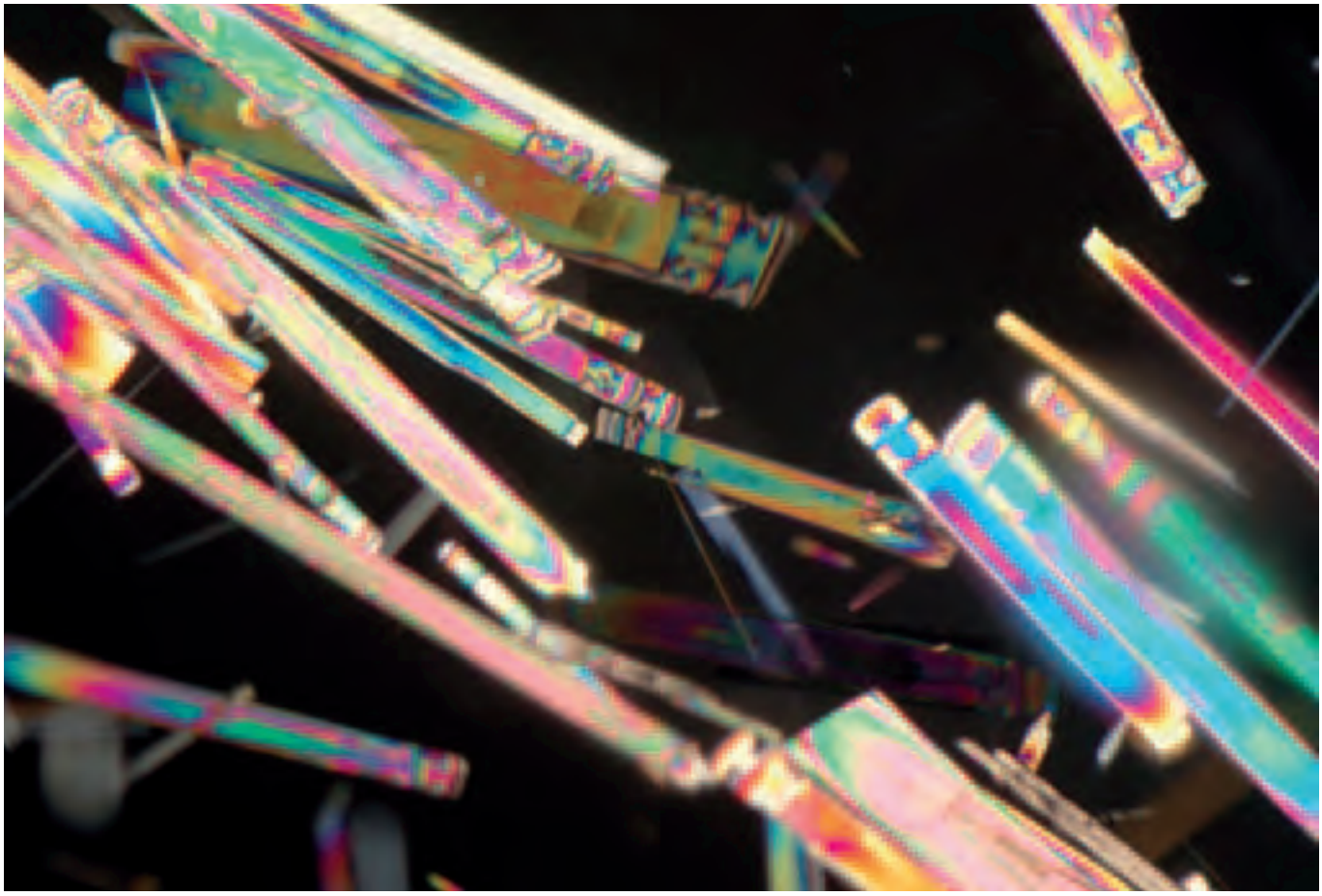
Birth asphyxia is a major cause of death and of acquired brain damage in newborn babies. It is caused by a lack of oxygen in the brain and causes death or severe neurological impairments like cerebral palsy, developmental delay or learning and behavioural problems. Few infants survive the condition without handicap.

In collaboration with the Hammersmith Hospital, Imperial College London, researchers at the University of Oxford have shown the success of a cooling treatment for birth asphyxia. The Total Body Hypothermia for Neonatal Encephalopathy Study (TOBY), led by the University of Oxford, has recently proven that cooling a suffering baby to 33°C for a number of days after birth is the only medical intervention which reduces brain damage and improves an infant's chances of normal survival after birth asphyxia. This new treatment has already begun to have an impact in hospitals in the UK and could change forever the way birth asphyxia is treated. The research was funded by the Medical Research Council (MRC) and is highly commended by doctors and healthcare practitioners. Dr Eleri Adams, Clinical Director, Neonatal Unit, John Radcliffe Hospital said: "As a result of the work done by NPEU and others, therapeutic hypothermia is now a standard part of treatment for newborn infants with severe hypoxic brain injury, significantly improving the chances of a normal neurological outcome."

NO MORE INJECTIONS FOR DIABETES

There are currently 2.8 million people with diabetes in the UK (Diabetes UK). Currently the only way to treat diabetes is by an injection of insulin. Now, thanks to work carried out by researchers at the University of Oxford, patients with a particular genetic form of diabetes can now be treated with an oral tablet instead. These patients have neonatal diabetes, a rare type of diabetes that usually develops within six months of birth. It results from a genetic defect in a protein known as a potassium channel, which is crucially important for ensuring that insulin is secreted when blood sugar levels rise. Professor Ashcroft at the University of Oxford, in collaboration with Exeter University, has shown how genetic defects in the potassium channel cause neonatal diabetes.

In the past, people with neonatal diabetes faced a life of insulin injections. However, the discovery that their diabetes is due to activating mutations in the potassium channel has enabled them to switch to tablet therapy. This has not only enhanced their blood sugar control and lowered their risk of developing the secondary complications of diabetes, it has also improved their quality of life and that of their families. This research will totally change the future treatment of people with neonatal diabetes.



GROWING MEDICINES

A team of researchers at Durham University led by Professor Jonathan Steed and Dr Sharon Cooper could revolutionise the pharmaceutical industry. The researchers are using a combination of chemically tailored low molecular weight gels and microemulsions to grow organic crystals of active pharmaceutical ingredients (drugs). By combining the use of gels and microemulsions this technology is a green, low temperature, recyclable alternative to traditional pharmaceutical development.

If the team is successful over the next five to 10 years we should see the development of a tailored crystallization gel and microemulsion system each time a new drug is produced. This will allow the drug to be quickly developed for effective manufacture and delivery in the body.

TACKLING RARE DISEASES

Although collectively infrequent, rare diseases affect five to 10 per cent of the population. In the UK more than 3.5 million people will develop a rare condition at some point in their life. There are more than 6,000 recognised rare conditions, 80 per cent of which have a genetic origin (Rare Disease UK). The University of Birmingham has international expertise in rare diseases and has recently launched the UK's first dedicated Centre for Rare Diseases & Personalised Medicine. The Centre is led by Professor Eamonn Maher and brings together researchers working in basic science and clinical medical research to understand the causes of disease and to develop novel therapeutic strategies to tackle them.

The Centre will conduct research into treatments and drugs for rare diseases and provide insights into basic biological processes and the pathogenesis and treatment of common diseases. According to Dr Maher: "There is hope of finding treatments for 200 rare diseases over the next decade or so, and the Birmingham Centre for Rare Diseases & Personalised Medicine will be at the forefront of this research."

IMPROVING TREATMENT OF STROKE

In recent years there has been considerable advances in stroke care and research, but it has not yet been determined what the optimum service level is for this care. There is robust evidence that stroke patients who receive organised care in a hospital (stroke unit) are more likely to be alive, independent, and living at home one year after a stroke. However, there is significant variation between stroke care services because each is unique in terms of the number of staff they have and how they provide rehabilitation care.

As part of a National Institute for Health Research (NIHR) Collaborative Leadership in Applied Research and Care (CLAHRC), researchers from the Universities of Leeds and York and Bradford Teaching Hospitals Trust are working together to routinely collect data on the care of patients admitted to hospital with a diagnosis of stroke. These data will then be used to investigate clinical practice and service variations, with a view to identifying measurable improvements in services. Regular reports can then be provided to managers to help quality monitoring, or to assess the effects of individual service improvements. Additionally, these data could be used to monitor how the National Strategy for Stroke is implemented. All this research has the potential to improve the care and rehabilitation of stroke patients in future years.

SWAPPING ORGANS FOR KIDNEY TRANSPLANT

For people with end-stage renal failure, the most effective form of treatment is transplantation. Although a kidney patient may have a willing donor, the transplant may be impossible due to a blood-type or tissue-type incompatibility. However such a patient could swap his or her donor with that of another patient in a similar position. A swap of this form (which may involve two or more patient-donor pairs) is called a kidney paired exchange (KPE).

The NHS Blood and Transplant (NHSBT) has already begun operating the National Matching Scheme for Paired Donation (NMSPD) in the UK to identify KPEs among the donors and patients currently on its database. However, to maximise the potential of this treatment computer science researchers at the University of Glasgow have been developing algorithms to construct a set of exchanges that satisfy a range of criteria, including the need to maximise the number of transplants and maximise the overall 'quality' of the transplants. There are still problems to be overcome including how to ensure the system can cope with larger sizes of input datasets as uptake of the scheme increases and the research team led by Dr David Manlove at the University of Glasgow will continue to work with the NHSBT to achieve this.

TACKLING PAIN

The World Health Organisation estimates several hundred million people worldwide suffer from arthritis. Arthritis is a leading cause of chronic pain which can affect our quality of life and ability to perform ordinary daily activities. Researchers at the University of Nottingham led by Dr David Walsh have a long-term goal of finding out why so many people with arthritis of the joints experience chronic pain and how we can improve the treatment of this pain.

A lack of understanding about what drives chronic pain in people with arthritis has hindered the development of more effective analgesics (painkillers) that have fewer side-effects. Many people only obtain pain relief following joint replacement and even then, a proportion of patients still report persistent pain following surgery.

The research being carried out at the Arthritis Research UK Pain Centre in Nottingham will give new insight into what drives pain and will identify targets for the development of new and better painkillers. Although it will take at least 10 years for this part of the research to benefit patients, this will result in reduced pain and disabilities associated with arthritis. In the shorter term, it will mean existing treatments can be tailored to fit patient groups most likely to benefit from them and will be a major step towards the better management of chronic arthritis pain. Overall, research will improve the quality of life of people living with arthritis and enable a substantial proportion of the population to live healthier for longer.

IMPROVING PHYSIOTHERAPY SERVICES

Patients with musculoskeletal problems such as back pain often experience long delays in accessing NHS physiotherapy and some patients find attending treatment appointments difficult due to work and family commitments. Some physiotherapy services in the UK have introduced a new treatment pathway called PhysioDirect, which involves initial telephone assessment and advice by an experienced physiotherapist. Patients are invited for face-to-face treatment only when necessary.

Before we know whether this type of service should be more widely rolled out across the NHS, we need high quality data on its clinical and cost effectiveness, safety and patient satisfaction. Researchers from Keele University and the University of Bristol, supported by the Medical Research Council (MRC), are now looking at whether or not PhysioDirect will be as clinically effective as usual care. They also want to find out if it will be more cost-effective, increase patient satisfaction and provide quicker access to treatment. If these results of the research are positive, the PhysioDirect service could be recommended as an option for making best use of the finite NHS resources and transform physiotherapy services in the UK.

NEW WAYS OF TREATING CANCER

Cancer claims many lives every year and our health service is constantly battling to fight the disease and its effects. Research is and will continue throughout our lifetimes to try and find answers to help prevent, treat and one day cure cancer.

Researchers at the University of the West of England (UWE) are investigating a rapid screening test that will predict how a patient will respond to cancer chemotherapy within hours. The research is seeking to solve the problem of why some patients do not respond to chemotherapy treatment first time round. At the moment a lack of response to the treatment can only been seen after some weeks when a patient may have suffered severe side effects. The very nature of cancer means it is vital to treat it as soon as possible and so a delay of weeks can have deadly consequences. The researchers at UWE are developing a quick and simple test based on a blood sample before chemotherapy treatment begins which shows a response to a range of drugs. The results of the test will ensure that a patient receives the right combination of chemotherapy drugs to meet their needs and therefore prevent any delay in treatment.

The researchers at UWE are developing a quick and simple test based on a blood sample before chemotherapy treatment begins which show a response to a range of drugs.

Researchers at the University of Nottingham are looking into treatment options for breast cancer. They have developed the Nottingham Prognostic Index Plus (NPI+) which is able to predict the long-term clinical outcome and the best therapeutic options for breast cancer patients. In doing so it can help both doctors and patients decide on the best course of treatment and lead to a more personalised medicine for breast cancer.

Another team of researchers at the University of Nottingham are looking at the use of Monoclonal antibodies (mAbs) to treat cancer. mAbs are less toxic and more effective than conventional cancer treatments, but so far clinical trials have only yielded 10 per cent of their potential. mAbs harness the patient's own immune response to attack and remove their cancer. The research team at Nottingham aim to discover cheap, patentable and effective ways to promote inflammation within tumours to improve the efficacy of mAbs targeting solid tumours. The team has 25 years of experience developing mAbs and their research could have a major impact on improving cancer patient survival rates in the future.

Using maths to fight cancer is an unusual concept, but researchers at the University of Nottingham are doing just that. They have developed new

mathematical modelling that can predict the success or failure of cancer therapy that uses a patient's own macrophages (a type of white blood cell) to kill the cancer cells that can be resistant to conventional therapies. Virtual cancer computer simulations show that combining conventional and macrophage-based therapies can produce greater anti-tumour effects than expected. This research seeks to solve the specific problem of targeting cancer cells that are resistant to many therapies due to their distance from the blood supply and vital nutrients. This research is groundbreaking and part of an international effort to use mathematical models to improve cancer therapies.

PERSONALISING HEALTHCARE

Healthcare has traditionally focused on providing the most effective treatment for a disease or illness and administering that treatment to any patient suffering from it. Now researchers are looking further into personalised healthcare where treatments are adapted to meet an individual's needs rather than simply taking a 'one size fits all' approach.

Researchers at the University of Reading are developing ways of personalising physical rehabilitation and speech and language therapies. This type of therapy is increasingly delivered with the aid of computers using enhanced Human Computer Interfaces (HCI). The research team at Reading are developing Brain Computer Interface (BCI) techniques to record and interpret the brain activity of a person during therapy. The aim is to monitor the individual's attention, vigilance and engagement during therapy. This information feeds back to the computer which responds to this brain state information by tailoring the therapy accordingly, changing presentation or activity style or duration, or determining the need to take a break. Tailoring therapy will make it more effective and should increase the benefits felt by patients.

Brain Computer Interface techniques record and interpret the brain activity of a person during therapy.

Researchers at the University of Nottingham, supported by the Medical Research Council (MRC), are conducting research on blood platelets and how treatment for thrombotic conditions such as heart attack or stroke can be best treated. Platelets are important blood cells that help control bleeding, but can also cause the formation of blood clots that can lead to a heart attack or stroke. The researchers at Nottingham aim to provide simple-to-use blood testing kits that can be used in any healthcare setting (hospital, doctor's surgery, in the patient's home) to analysis a patient's platelet function. In doing so doctors and nurses will be able to tailor therapies to individual patients' needs. Personalised therapy such as this has been talked about by futurologists for several years and it is now becoming a reality.

IMPROVING OUR EYESIGHT

In recent years laser eye surgery has dramatically changed the lives of many people who no longer need to wear glasses to see properly. However, there are still more issues UK researchers are looking into that will help improve our eyesight in future years.

Researchers at Durham University are looking into computerised home-based technology for patients with visual field defects following brain injury such as a stroke. Previous research has shown that when using similar technology patients become more independent and enjoy a higher quality of life. The computerised training teaches patients how to compensate for their visual deficits by making more efficient eye-movements during exploration and reading tasks. The new home-based version of the training is low-cost and user-friendly as it is administrated by the patients themselves in their own home. If the research reveals that the computerised home-based training is an effective form of rehabilitation for patients with visual field defects, then such an intervention could transform the lives of many patients with partial blindness at little cost to the NHS.

Research from the University of Oxford's Centre for Vision is helping provide corrected vision to the developing world with the aid of self-adjusted

glasses. We are very fortunate in the UK to have the NHS, but in developing countries, there simply aren't enough optometrists. Research suggests that, as long as you can build an affordable pair of glasses with adjustable lenses, patients young and old can set the prescription of their own glasses remarkably accurately. Josh Silver Director of Oxford's Centre for Vision, has developed Adspecs, the first available self-adjustable glasses that allow the user to tune their glasses to their eyes. The Centre now hopes to deliver glasses to the one billion people that need them so desperately by 2020.

Throughout the world, vision plays a crucial role in a person's quality of life. As we get older we can lose the ability to focus on objects, a condition called presbyopia and potentially also suffer from cataracts, a condition where the lens of the human eye degrades. Currently it is possible to treat cataracts with surgery, but there is no treatment, apart from glasses, for presbyopia. Researchers at Durham University are therefore trying to produce a replacement lens to allow people to focus their eyesight once again. The new replacement lenses would remove the need for 'reading glasses' beyond the age of around 50, significantly improving the quality of life for the ageing population.

THE WORLD'S FIRST ARTIFICIAL PANCREAS

Professor Joan Taylor of De Montfort University has dedicated almost 20 years to building the world's first artificial pancreas. This year, her research took a massive step forward with the construction of a life-sized and refillable model which has been used in pre-clinical trials, providing proof that the invention works. The artificial pancreas is designed to administer appropriate doses of insulin to diabetics as and when they need it – bringing to an end the daily chore of having injections up to four times a day.

It is made of a metal casing containing a reservoir of insulin which is kept in place by a special gel barrier invented and patented by Professor Taylor. When glucose levels in the body fluids rise, the gel barrier starts to liquefy and lets insulin out. This insulin feeds into the veins around the gut – the mesenteric vasculature – then into the portal vein to the liver, mimicking the normal pancreas to liver blood supply of insulin. As the insulin lowers glucose levels in the body, the gel reacts to this by hardening again and stopping the insulin from leaking out. It means the right amount of insulin is released

automatically every time the body needs it. The device is implanted in the body in the area between the lowest rib and the hip and is topped up using a fine tubing circuit under the skin.

Many diabetics worry about going 'low', a hypoglycaemic attack, which is an acute risk associated with overenthusiastic insulin treatment. The artificial pancreas is a simple and cheap solution to the problem and could be helping people in just five years time totally revolutionising the treatment of diabetes for millions of people around the world.

USING ULTRASOUND TO TREAT ILLNESS AS WELL AS DIAGNOSE IT

Ultrasound in medicine is normally associated with medical scanning for the diagnosis of health problems or the observation of foetal growth. It is also used routinely in physiotherapy to alleviate pain. However, over the last few years an exciting new application of ultrasound known as High-Intensity Focused Ultrasound (HIFU) has been receiving attention as a very promising treatment for cancer. This technology provides what is currently regarded as one of the best hopes for the non-invasive treatment of a number of cancers.

HIFU uses equipment which emits high frequency sound waves. Patients lie with part of their body touching a small bath of water containing two concentric ultrasound transducers. The water allows the ultrasound beam to transmit into the body. One transducer, positioned centrally, transmits a low-power diagnostic beam, of the type normally used in scanning. This allows the doctor to visualise the tumour and guide the treatment. The other is a concave dish transducer that produces a high-power focus from low power ultrasound beams which targets and kills the cancerous cells by heating them to temperatures of up to 90°C.

The first HIFU unit in Europe was introduced to the Churchill hospital in Oxford 10 years ago with the direct help of Coventry University's Sonochemistry Centre. Feedback from patients who have been successfully treated using the new technology has been extremely positive, with no reports of pain or side-effects. In some cases patients are able to return home the next day.

> 'The technology has been around for a long time, maybe 30 or 40 years, but only in the last 10 years or so has anything really serious been developed.'
>
> Professor Tim Mason

Follow-up MRI scans have shown that after treatment the tumours are dead or beginning to shrink.

The Coventry University team is being led by Professor Tim Mason who said: "I'm associated with the group who works on this technology and have been for many years. The technology has been around for a long time, maybe 30 or 40 years, but only in the last 10 years or so has anything really serious been developed. The technology uses low energy ultrasound, similar energies and frequencies to that used in diagnostic imaging, but using it in a focused sense. So instead of a beam going through the body, reflecting and giving you an image, you have a number of beams going through the body from a concave source which end up as a focus within the body. Each beam really doesn't do much damage at all, but with the focused beams, just like a magnifying glass in the sun, you have an intense area of heat. That's the basic idea of the technology and in principle it sounds absolutely wonderful and that's why people for so many years have been chasing after it. It is a sort of Holy Grail for cancer treatment!

The benefits to patients are that this is a totally non-invasive treatment. Patients can come into hospital one day, receive the treatment and then go home the next, and in some cases even on the same day. For example for breast cancer, it could mean a 'walk in, walk out' treatment which is remarkable!

This is a technology that when people hear about it they say 'I don't believe this, it can't possibly be that good', but it is, it seriously is! The technology is most effective in treating early stage cancers. What we need are more of the machines in the UK, so that more research into this technology can be carried out and this type of treatment for cancer becomes a reality on a large scale. Potentially we have a treatment for cancer which no longer requires big extensive nasty surgery, minimal chemotherapy and can be done on a patient coming in and going out the next or even the same day. What you then have is something so remarkable as to be, well almost a miracle."

HEALTHY FUTURE: DETECTION

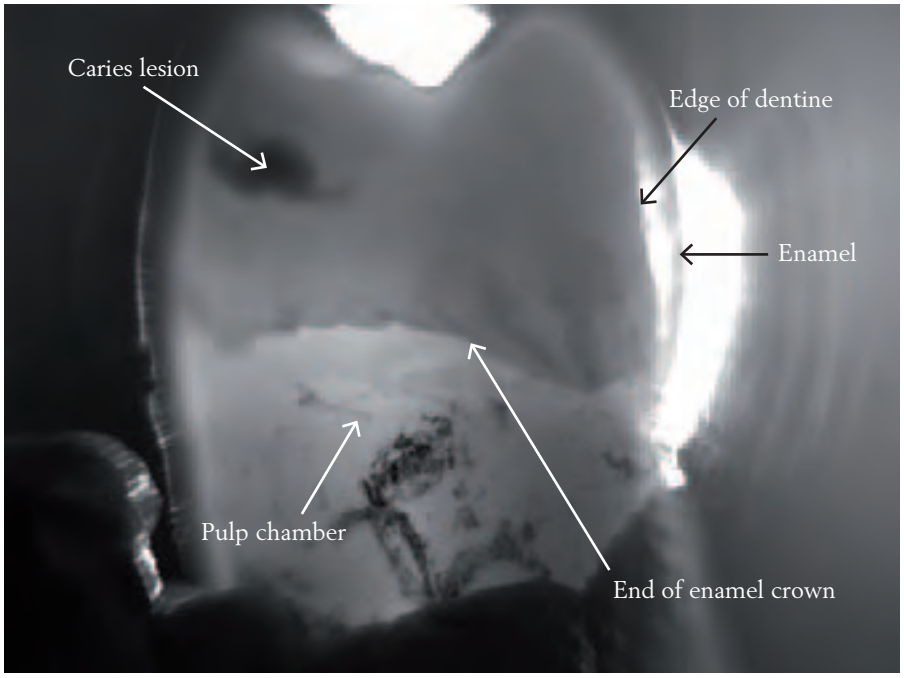
EARLY DETECTION IS MORE VITAL than ever in the fight against serious disease and UK researchers are constantly seeking new and more precise ways of doing just that.

In 1976 Peter Mansfield at the University of Nottingham published the first successful MRI scan of a human body part. In doing so, he changed forever the way in which we detect and subsequently treat illness.

Magnetic Resonance Imaging (MRI) has revolutionised modern healthcare, providing a fast and non-invasive method for diagnosing disease, guiding medical interventions, and monitoring brain function. Its value, however, is greatly limited by its low sensitivity – like looking for a needle in a haystack. Now, researchers at the University of York are developing new technology to make smaller and more cost effective MRI scanners that are more precise and faster. The researchers plan to use nuclear magnetic resonance (NMR) technology to achieve this. NMR technology is currently used in chemistry laboratories throughout the world to characterise materials for drug discovery. The researchers aim to harness this new technology and make in seconds measurements that were previously impossible. In the future this technology could mean the replacement of many hospital scanners with a cheaper instrument that could be located in a GP's surgery and allow much wider screening than we have today.

FEWER TRIPS TO THE DENTIST

Nobody enjoys a trip to the dentist and dental treatment in the UK costs the NHS in excess of £350 million for replacement fillings alone. However, researchers have now discovered that early dental caries can be helped to heal



themselves before a tooth cavity is fully developed. This requires minimal intervention by the dentist and the patient does not have to suffer the trauma of having their tooth 'drilled and filled'.

To deliver such treatment a dentist must be able to detect caries at an early stage and traditional X-rays are not suitable. Researchers at Durham University are developing a replacement for X-ray diagnosis that will change dental care in the UK and the world. The new instrument uses light from a lower power laser (identical to that used in CD players) to illuminate the tooth with a miniature camera (even a web cam is sufficient) mounted on the reversed side of the tooth. This wavelength of light passes through the tooth presenting an X-ray like image of the tooth, but one in which early lesions can be clearly seen.

The researchers are also using digital mirrors (like those found in data projectors) to work through the gum and jaw providing a direct and totally safe replacement of full dental X-rays. Both these technologies will mean that dentists can detect and react to problems earlier and so reduce the suffering for patients.

EARLY DIAGNOSIS OF ALZHEIMER'S DISEASE

Alzheimer's disease is the most common form of Dementia and affects around 465,000 people in the UK today (Alzheimer's Society). Researchers are continually learning more about this disease, what causes it and how we can possibly detect and prevent it. A team of researchers at the University of the West of England (UWE) are studying ways of detecting Alzheimer's disease and new therapies to slow down or prevent its progression. To do this

the researchers are working to understand the pathways involved in the development of the disease. If they can single out what might cause the disease, they can develop new therapies to slow down or prevent it progressing. The team also hope to identify the early biomarkers of the disease which will make early diagnosis possible and ensure people are treated more quickly. Ultimately this research could radically change the way in which Alzheimer's disease is treated and so improve the lives of those who suffer from it and their families and carers.

DETECTING CANCER

Breast cancer is the most common form of cancer diagnosed in the UK today followed by lung cancer (Cancer Research UK). Early detection of both these diseases can help save lives. Researchers at the University of York are developing a way of detecting early stage lung cancers without the need for a biopsy. This new method involves taking small quantities of blood rather than tissue and could be used to identify people who do not yet know they have cancer or used to test at-risk people. It could dramatically change how lung cancer is treated in the future.

A team of researchers at Coventry University is developing a way of improving attendance at the Breast Screening Programme (BSP). The more people who are tested the better chance of detecting the disease early and effectively treating it. The researchers have developed an Artificial Intelligence Attendance (AI-ATT) algorithm that can predict the likelihood of a person attending screening. By predicting a person's attitude towards testing GPs can intervene and help encourage more people to attend screening. If they are better informed, people will hopefully be more likely to attend the BSP.

Small quantities of blood rather than tissue could be used to identify people who do not yet know they have cancer.

TREATING MENTAL HEALTH

Mental health problems are very common. One in four British adults experience at least one diagnosable mental health problem in any one year, and one in six experiences this at any given time (The Office for National Statistics Psychiatric Morbidity). It is therefore important that we have a greater understanding of the causes and effects of mental health to ensure the most effective treatment is available.

Researchers at Durham University are conducting an investigation into the nature and role of emotions and feelings in those who suffer from depression. Depression is one of the most common forms of mental health problems, but it is not very well understood and very little research has looked at what it feels like to experience depression. The team at Durham are aiming to look at just that in the hope that by understanding more about what depression actually feels like, we can learn how to better prevent and treat it.

Another team of researchers at Anglia Ruskin University are looking into long-term mental illness and how best to ensure people regularly take their medication. Often people who are prescribed psychiatric medication do not take it systematically and do not share this information with their doctor. Furthermore, even those who do take medication sometimes complain of serious side effects that prevent them from leading an ordinary life and of difficulties in communicating their experience to their doctor. This highlights lack of trust between mental health service users and their clinicians, and difficulties in sharing knowledge, both scientific and experiential, in a way that is constructive for all. The team at Anglia Ruskin aim to ensure that both patients and doctors learn how to effectively go about reaching shared decisions about long-term psychiatric medicine and mental healthcare.

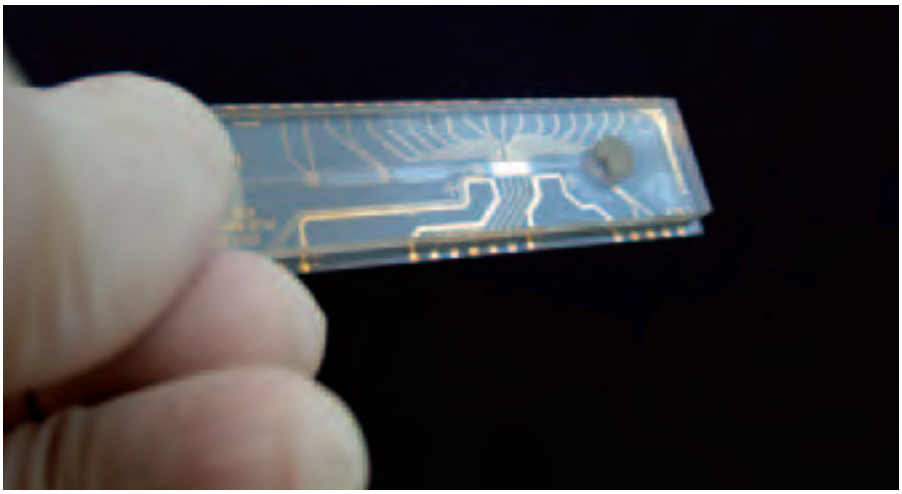
IMPROVING WELLBEING IN OLD AGE

Today we are living longer than ever before and this trend is set to continue. By 2020 it is anticipated that approximately one in five of the UK population will be aged 65 years or over. However, this increase in life expectancy has not been accompanied by a proportional increase in a healthy longer life. We may be living longer, but we might not be healthy enough to enjoy our latter years.

A team of researchers at the University of Birmingham are working on a multi-disciplinary programme of research to improve healthy ageing by looking at vaccination response, infection rates, and the ability of immune cells to fight off bacterial and viral infections. They are also examining the effects of bereavement, depression, and caregiving in older adults with and without hip fracture, on immunity and infection rates.

The knowledge gained from this research can lead to important, but simple to implement interventions such as altering when in the day older adults are vaccinated, or given nutritional supplements to older adults at risk of extremely poor immune function, such as caregivers and those who have suffered hip fracture, depression, or recent bereavement. It is hoped that by understanding the links between these factors and immunity it will lead to improved psychological and physical wellbeing in older age.

EARLY DIAGNOSIS OF DEEP VEIN THROMBOSIS



Deep vein thrombosis (DVT) is a severe condition where a clot forms in one of the body's deep veins, usually in the leg. DVT and pulmonary embolism, where the clot lodges in the lung, are the most common cause of unexpected death in hospitals. Now researchers led by Professor Zulfiqur Ali at Teesside University are developing a portable device that can diagnose DVT earlier and help save lives. Currently diagnosis of DVT is confirmed by an ultrasound, but this is expensive and patients can wait for several days before examination. This new device is fast and lower in cost and could reduce the number of referrals without compromising patient care.

The device will be easy to use by non-specialists and can be used in a wide range of locations such as a GP surgery, in an accident and emergency department or by a paramedic on call. It works by taking a small drop of blood which is put into a disposable cartridge. The cartridge is then placed into a reader device which measures the concentration of a d-dimer molecule which is present in blood and signals if a DVT condition is present.

With an ageing population the cost of healthcare is set to increase and there is therefore a need to reduce the costs of diagnosis and treatment. More generally, early diagnosis gives a better opportunity for more effective treatment. Better diagnostics will also allow more personalised medicines. Better, low cost diagnostics will mean doctors can prescribe specific drugs to individuals so that they are more effective.

SAFER PRENATAL TESTS

Advances in medical care mean that pregnant women can now undergo various tests to ensure the health of their baby before they are born. However, some of these necessary tests can occasionally cause harm to mother or baby. Some of the risks associated with current procedures include bleeding, leakage and infection of the amniotic fluid and miscarriage.

Researchers from Heriot-Watt University are developing the area of Non-Invasive Prenatal Diagnosis (NIPD), which will mean certain foetal conditions can be detected from a few drops of blood from the mother instead of more invasive procedures. Current technology can be slow, cumbersome and require expensive pieces of medical equipment which are difficult to transport. This new technology is simple and only requires a few millilitres of blood from the mother.

The team at Heriot-Watt led by Professor Marc Desmulliez are developing a series of Lab-On-a-Chip (LOaC) modules for the study of prenatal diagnosis of foetal sex and rhesus D status, and ultimately foetal chromosome abnormality. The availability of Lab-On-a-Chip NIPD technology has the potential to cut the numbers of women having to undergo an invasive prenatal diagnosis by approximately 50 per cent and significantly reduce risks of miscarriages or harm to the mother. It will also mean earlier diagnosis than current tests and give doctors the opportunity to treat any problems more quickly.

DETECTING HEART FAILURE

Heart failure affects over one million people in the UK and is increasingly common with older age, but can be difficult to correctly diagnose. It can cause severe breathlessness, tiredness and swelling of the ankles and feet, hinder normal daily activities, and reduce life expectancy. Currently the best way to diagnose it is by taking an echocardiogram (an ultrasound scan of the heart). Other tests include an electrocardiogram (ECG), chest X-ray, and special blood tests called biomarkers. Recommended treatment for heart failure includes two drugs (ACE-inhibitors and beta-blockers), which can help patients to live longer and suffer fewer consequences of the disease.

Heart failure is sometimes difficult to diagnose in older people, in whom other diseases, limited mobility and reduced access to health services are common. New research being carried out by a team at Durham University and led by Professor James Mason will tell us how common heart failure is in older people who live in nursing and residential care, and the best way of treating them. The team hope their findings will potentially reduce the number of premature deaths to heart failure and improve the quality of life for sufferers. Given the impact of heart failure, improved diagnosis and management, even in a small proportion of cases, would preserve life, reduce suffering, and be a cost-effective intervention for the NHS.

PREDICTING RECOVERY FROM STROKE

Every year an estimated 150,000 people in the UK have a stroke (The Stroke Association) and over 90 per cent of survivors experience cognitive impairments which can be undetected by doctors. These cognitive impairments usually mean patients need to stay longer in hospital, have poorer long term function, and are more likely to be readmitted to hospital. Current technologies to test for these conditions cannot be used in cases where individuals have post-stroke speech impairments or post-stroke visual spatial neglect.

To address this problem, behavioural brain sciences experts at the School of Psychology at the University of Birmingham have devised a unique assessment tool called the Birmingham Cognitive Screen, BCoS. This new tool enables efficient and comprehensive screening of cognitive function after a brain injury and can reliably predict functional outcome for patients after nine months. BCoS tests are designed so that individuals who would struggle to participate in conventional tests can be assessed. The research team, led by Professor Glyn Humphreys, Professor Jane Riddoch and Dr Wai-Ling Bickerton from the University of Birmingham, have also developed training for health professionals and an electronic data processing system to help ensure assessments are reliable, informative and time saving.

Early and detailed diagnoses of cognitive impairment will significantly improve the care of stroke survivors. BCoS will substantially improve the management of cognitive impairments after a stroke and potentially other brain injuries. These new tests will enhance the health service's ability to deliver the best possible care outcomes for the cognitively impaired following a stroke.

TESTING FOR THE CAUSE OF BLINDNESS

Glaucoma is the leading cause of irreversible blindness. The global estimate is 65 million sufferers, with at least 50 per cent undiagnosed in the developed world rising to 95 per cent undiagnosed in parts of the developing world. The UK estimate is 500,000 with 67 per cent undiagnosed (HTA 2007, 11:47). Glaucoma is a condition of optic neuropathy; the patient presents with a gradual loss of the field of vision. This is so gradual that the patient is often unaware of the problem until a late stage in the disease.

Current tests for glaucoma are expensive, bulky and can be influenced by cataract which results in people being unnecessarily referred to hospital. Researchers at Moorfields Eye Hospital, University College London and City University London have developed a flexible software programme called The Moorfields Motion Displacement Test (MMDT) which provides a test of the field of vision for the detection of glaucoma. The test is simple and quick to perform (90-120 seconds per eye). An independent pilot study found it outperformed conventional tests for glaucoma (St Kitts Eye Study IOVS 2008: 49: ARVO E-abstract 4080). The current test is presented on a 15 inch laptop. 32 white lines are constantly displayed on a grey background. All a patient has to do is look steadily at a central spot and click the computer mouse each time they see a line move. The simplicity of the test means it is easily understood by patients. It is designed to be performed without glasses and is resistant to cataract. These features make it an excellent future screening tool.

The Moorfields Motion Displacement Test by Mr Glen Sharp (The St Kitts Eye Study 2008)

The vision of the MMDT is to address the global challenge of undiagnosed glaucoma by providing an affordable, portable case-finding device with the mantra 'let's go and find our patients' rather than waiting for them to present at the hospital with irreversible blindness. The research is led by Professor David Garway-Heath.

THE SUPER MICROSCOPE!

The process for creating and viewing microscope glass slides has remained the same for more than 100 years. However, technological advances mean that it is now possible to completely digitise such slides so that they can be viewed on a computer screen. A group of researchers at the University of Leeds are setting out to develop a virtual reality (VR) microscope, which will transform the usage of digital slides in the delivery of patient care.

Traditionally, histopathologists have diagnosed cancer and other diseases by using a light microscope to examine glass slides containing thin sections of human tissue. This new VR microscope will allow diagnoses to be made quicker, but as accurately as, a conventional microscope by using fast interaction with ultra-high resolution displays that can show 30 times as much information as a desktop display. While currently glass slides wait in the histopathologist's pigeon hole to be collected, a digital system would alert the histopathologist when new cases are ready to be viewed. This will help to increase the speed at which diseases are diagnosed and remove the risk of patient slides getting mixed up.

This research project is being conducted by experts in pathology, human-computer interaction and computer graphics. The team members work in the Leeds Institute of Molecular Medicine and the School of Computing (both University of Leeds), and at St. James's University Hospital (Leeds Teaching Hospitals NHS Trust). The project is led by Dr Darren Treanor, a consultant histopathologist at St. James's, and includes regular input from other consultant histopathologists at the hospital, meaning that the technologies developed are focused on the needs of histopathologists in their day to day work. The research is funded by the National Institute for Health Research.

HEALTHY FUTURE: PREVENTION

WE CAN NOW ALL EXPECT to live for longer thanks to new treatments and advances in medicine. But it is also due, in part, to a better awareness of what is good for us and what is not. This awareness brings with it more questions such as 'are we doing the right things?', 'are we healthy enough?', and 'what more can we do?' Scientists are still researching ways in which we can prevent illness and what we as individuals can do to keep ourselves healthy.

PREVENTING INFECTION

The advances in medical treatments and a growing population mean our hospitals are busier than ever. Annually there are some 300,000 cases of hospital-acquired infections in the UK with 5,000 deaths and more than £3 billion loss to the National Health Service. It is therefore vital to keep hospitals clean and infection free so that patients can recover without risk from further infection.

Researchers at the University of Birmingham are working to create new anti-bacterial surfaces for stainless steel to help ensure our hospitals are free from infections in the future. The researchers do this by applying active screen plasma (ASP) to the surface of the stainless steel. Not only will the surfaces then kill any bacteria that lands on them, they will maintain their effectiveness for the lifetime of the components. This research has the potential to revolutionise hospitals

and could be applied to hospital instruments, furniture, medical tools and even body implants.

A well known infection that causes major concern for the hospitals of today is Methicillin-resistant Staphylococcus aureus (MRSA). In recent years the cases of MRSA have fallen as a result of more strenuous controls in our hospitals, but it is still a very worrying infection that needs to be tackled. The Richard Wells Centre, a nurse-led research group that is part of University of West London, has been evaluating current practice in fighting MRSA and the results of this work will hopefully lead to a further reduction in MRSA and similar infections in the future.

FIGHTING CANCER WITH VEGETABLES

Today we are advised that eating lots of fruit and vegetables helps keep our bodies healthy. Researchers at Sheffield Hallam University have taken this one step further and are looking at whether particular fruits and vegetables can help prevent cancer. The researchers are looking at the potential anti-cancer properties of rhubarb, carrots and pomegranates, among others, and have found that baking British garden rhubarb for 20 minutes dramatically increases its levels of anti-cancerous chemicals. These chemicals, called polyphenols, have been shown to selectively kill or prevent the growth of cancer cells in the laboratory and could be used to develop new, less toxic, treatments for the disease, possibly even in cases where cancers have proven resistant to other treatments.

Chemicals called polyphenols have been shown to selectively kill or prevent the growth of cancer cells in the laboratory.

Another group of scientists from the University of Nottingham are looking to nature to inspire the creation of anti-cancer therapies. Their work is looking at two areas. On the one hand they hope to encourage our bodies own immune system to reject tumours by blocking an enzyme called indoleamine 2,3-dioxygenase (IDO) which causes tumours to escape our immune system. The team aim to do this by producing anti-cancer medicines based on natural products isolated from marine sources. In collaboration with the University of Colorado in the United States, the researchers are also studying how to create new drugs based on mitomycin C, a compound isolated from bacteria half a century ago. If successful, this research could lead to a prevention of cancer and reduce the number of people who have to endure treatment for the disease.

WHY CAN'T YOU QUIT SMOKING?

Even though the dangers of smoking are clear for us all to see, there is still a proportion of the population who persist and these people are sometimes referred to as 'hardened smokers'. Research at Durham University is looking to address this problem by looking at what it means to become a smoker, and the pleasures people derive from being one. The researchers hope that their findings will help develop more imaginative and responsive interventions to encourage more people to quit smoking. If successful, this approach could also be applied to other health concerns such as obesity and alcohol abuse.

PREVENTING ILLNESS IN OLD AGE

As we get older we can expect to be subject to increased chances of becoming ill, but the research being conducted today can help us prevent, or at least reduce, the effects of old age. Researchers at Bangor University are seeking to identify ways of preventing, delaying, or reducing the severity of age-related disability. In doing so, they aim to promote the independence, well-being and quality of life of older people. Leading a healthy lifestyle is something we should all strive to do and the researchers believe we must maintain this behaviour throughout our lives. This study will give evidence of how people can integrate healthy behaviour into their daily lives, especially in older age and how this can be maintained. The results of the research will be used to advise decision makers and people working with the elderly about ways of maintaining and improving well-being in later life.

If the onset of dementia could be delayed by just five years, diagnosed cases could be reduced by 50 per cent.

Another illness faced by a large number of people in older age is Dementia. The National Dementia Strategy states that if the onset of dementia could be delayed by just five years, diagnosed cases could be reduced by 50 per cent. The popular perception is that Dementia is not preventable, but Vascular Dementia (about 30-40 per cent of all Dementias) may be preventable through better cardio-vascular care. A team of researchers from Staffordshire University are aiming to increase awareness of this fact in the hope that it will help reduce the cases of Vascular Dementia in the future. The campaign will be targeted at health professionals working in primary care with the message 'look after your heart and you look after your brain.'

HEALTHY FUTURE:
FUTURE OF THE NHS

THE NATIONAL HEALTH SERVICE (NHS) has undergone many changes in its 63 year history, but one thing has remained constant and that is the aim of the NHS to provide healthcare to all. Researchers around the UK are not only considering how to prevent, detect, treat and tackle illnesses, but how we can ensure these things are delivered in the best way by the NHS in the future.

SUSTAINABLE HOSPITALS OF THE FUTURE

A team of researchers at the University of Cambridge are devising cost-effective, low-energy refurbishment strategies for NHS Trust sites. Hospitals have been slow in addressing questions of sustainability. The NHS is legally obligated to reduce its carbon output and the costs saved through energy efficiency can be used as funds for patient care. Ambitious targets have been set, but they are not easily achieved.

Some 23 per cent of NHS buildings pre-date 1948, and another 31 per cent were built between 1948 and 1985 (University of Cambridge). Replacement would take decades and in the current economic climate is not an option, it may also be unnecessary and wasteful. The researchers at Cambridge have shown that pre-1948 buildings, in particular, perform well in current and future climates. A catalogue of refurbishment options for application by NHS Trusts is being developed and costed, from simple changes to controls, to major interventions which may fundamentally change the planning and image of the hospital. The work is supported by the Engineering and Physical Sciences Research Council (EPSRC).

ENSURING A QUALITY SERVICE

Demand for NHS services is unlimited, so there is a need to constantly improve quality and increase capacity within budgeting constraints. Researchers from Manchester Business School are helping NHS Bradford and Airedale to re-shape and re-design the local health and social care system, by engaging further with the local population for planning and designing modern healthcare infrastructures (premises).

The NHS is moving toward a more community based care provision. One that is closer to the local population and offers bespoke health and social services to meet a particular local demand. The research team believe that improved infrastructure development management will help reduce backlog maintenance costs, enhance the quality and effectiveness of the NHS, reduce

hospital admissions, as well as shaping and sustaining the environment through innovative designs. Ultimately, the research will improve the access to and quality of healthcare within an entire health community. Initially this research will help improve the NHS in one location, but it could also be used as a model across the NHS in the UK.

MAKING THE NHS MORE COST EFFECTIVE

Today the NHS has set itself clear goals and values: to maximise service quality, safety, equity and patient outcomes at lower cost. Researchers from The Cumberland Initiative are developing computer models and simulations of healthcare processes and systems so that health service staff can operate and deploy resources in the most effective ways. This modelling is based on the fundamental knowledge of healthcare of the researchers involved.

In 10 years' time, healthcare is likely to be delivered in a mixed economy involving significant levels of private money.

The initiative aims to deliver savings for the NHS by identifying the training, metric development, and research needed to offer credible tools and methods for operations, commissioning and policy. The underlying decision making processes will be based within a risk management framework offering sufficient flexibility to adapt to future changes. In 10 years' time, healthcare is likely to be delivered in a mixed economy, embracing what is currently health service budgets and social care budgets, but also involving significant levels of private money, through direct payments and insurance cover. NHS Commissioners will need the business and economic models to operate effectively in such an environment.

MAKĪNG BLOOD

In the UK, blood is normally provided by volunteer donors through a nationally funded scheme that ensures safety and quality. For patients with very rare blood groups, as well as some patients who have multiple red cell antibodies, finding compatible blood can be extremely difficult and, at times impossible. This can result in compromised compatibility of blood or delays in provision, which can contribute to morbidity or death. Therefore an alternative, practical and cost-effective solution to conventional donated blood is needed to stabilise and guarantee the donor supply.

Researchers at Imperial College London have designed and fabricated a 'blood factory' that mimics the architecture and function of the bone marrow in vivo and allows continuous harvesting of red blood cells. The team plan to optimise the design and fabrication of the blood factory to ensure the continuous production of 'clinically-relevant' quality red blood cells. Initially, this technology could complement the existing volunteer donor blood supply, in areas of shortfall or special needs. Ultimately, blood donation could be replaced and transfusion needs can be made by such 'red blood cell factories'.

This research is being co-ordinated by Professor Sakis Mantalaris who said: "Our design is bio-inspired which means we looked at what nature does and we tried to engineer a bioreactor that mimics that structure. The idea of making blood is not a new one, but the attempts so far and the theoretical calculations clearly indicate that it will take say £10,000 or more to produce a pint of blood, so we have tried to make sure that our design is cost effective.

The ultimate goal of this research is to do away with blood donations, so any transfusion that needs to take place would not require a donation. Instead of having to collect and store blood we would actually be making blood from core blood. However that scenario is a very long way away. So, we have looked at the current needs of the National Blood Service and there are particular cases where sourcing blood from donors is extremely difficult. For example where people have developed immune responses towards receiving blood donations. In cases such as these sourcing the blood is very difficult, so, once pre-clinical testing is complete, we plan to conduct a clinical trial using these very few, but extremely rare cases where blood is difficult to obtain.

The blood can be produced per type, such as O negative, or on a per patient basis. At the moment we are using core blood that is stored, so we are growing blood based on a type. Obviously O negative is the more useful blood to grow, but for cases where you need donations for specific patients, this would require many months or years to grow the blood and so would be done only on a case by case basis."

MEDICAL TRAINING IN A VIRTUAL WORLD

For centuries surgeons have studied the anatomy of the human body by looking at it and dissecting it first hand. Today, it is becoming more difficult to store the materials needed for this anatomical learning and there is now a need for accurate 3D anatomical visualisation to provide innovative and intuitive teaching tools for training and simulation. The Digital Design Studio at The Glasgow School of Art, in partnership with the University of Glasgow, NHS Highland and NHS Education for Scotland (NES), are leading an innovative programme of interdisciplinary research to create a digital 3D anatomical training product for the head and neck, based on cadaveric dissection. This will be used to teach complex anatomy to trainee healthcare professionals.

This training product will be the most accurate 3D anatomical dataset in the world. It is produced by detailed serial dissection of the head and neck of a dentate male cadaver, followed by ultra-high resolution 3D laser scanning and high resolution digital photography. The 3D model includes all structures of the skull and cervical vertebrae, including nerves, blood supply, lymphatic drainage, muscle and supporting tissues. Data are clinically verified at every stage to ensure they are accurate. Also, each significant anatomical structure will be 'tagged' with further information, for example text labels, and images can be included where required. Students will be able to manipulate the 3D model in real time, and investigate the different structures by a deconstruction process. Adoption of these technologies will improve clinical skills used in patient care, enhance knowledge, improve productivity and increase healthcare providers' capability to address defined clinical priorities.

TECHNOLOGY TO REDUCE HUMAN ERROR IN HEALTHCARE

Human error in healthcare kills more people per year than are killed in car accidents. Between 2005 and 2010 there were 1,085 reported incidents of which 21 per cent were attributed to user error. Part of the problem is the design of interactive medical devices: the processes to use them are hard and unnecessarily confusing. Fortunately, errors are often noticed and sorted out before they lead to actual harm. Even so, errors and work-arounds take time away from other activities, which nurses have little of, so poor design is also an unnecessary drain on the NHS as well as on the people and families affected by error.

A team of researchers at Swansea University led by Professor Harold Thimbleby are looking at how to make interactive medical devices safer. Their research, in collaboration with teams at University College London, Queen Mary University and City University, is showing that if the design of devices is improved it may halve fatalities from this cause. However, devices are part of a large and complex system, and the problem has to be tackled from many angles. For instance, how can hospitals tell which devices are better? Part of the problem is being able to analyse and evaluate design quality, not just find better ways of designing. It is very important that devices are designed to the highest standards of usability and dependability and the researchers at Swansea are generating ideas that will help.

MORE POWERFUL MICROSCOPES

As scientists look to discover more about the diseases that face the world today, they need to be able to look more closely at samples of cells and virus'. Standard optical microscopy has an ultimate lateral resolution of 200 nanometer (nm), but earlier this year a new white light optical imaging technique achieved a record lateral resolution of 50 nm. It was developed by the scientists at the University of Manchester, in collaboration with scientists in Singapore.

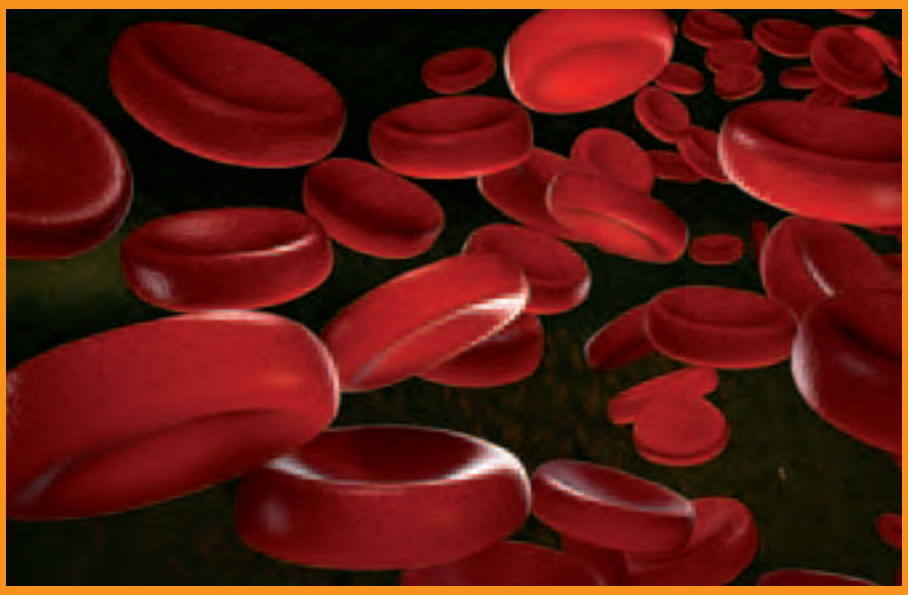
This development now provides a new opportunity to image live cells or virus' without staining or dehydrating the sample. Further research at the University of Manchester led by Professor Lin Li is aiming to achieve higher resolution (5 nm) and use the technology to study live cell/bacteria/virus structures and their interactions for medical applications. This direct optical nano-imaging will potentially allow researchers and medical doctors to examine interactions between live cells and bacteria/viruses and to understand the causes of diseases and the effect of drug treatments.

IMPROVING HEALTH AND SOCIAL CARE

Self help or mutual aid groups are run for and by peers who are facing a similar social or health related condition. There is considerable evidence that peer-led self help groups offer an effective means for improving health and social care outcomes for people. However despite this evidence, studies suggest that professionals can misunderstand the purpose of self help and intervene inappropriately.

Researchers at Anglia Ruskin University are producing evidence based guidelines on how community based practitioners can best support local self help groups. The project is called Effective Support for Self Help/Mutual aid groups (ESTEEM) and it will improve the quality of advice and support to UK self help groups by community practitioners through the provision of appropriate guidance and resources. It will also support the development of resilient and resourceful self help groups in the future.

NEW MECHANISMS TO CONTROL THROMBOSIS IN CARDIOVASCULAR DISEASE



Cardiovascular diseases kill more members of the UK population than the sum of all forms of cancer. Despite these worrying statistics, biomedical research in this area over the last 40 years has resulted in a 50 per cent reduction in the death rate in sufferers of cardiovascular diseases. These improvements are due to improved clinical practice, surgery, and pharmaceutical agents. The incident rates are, however, increasing at an alarming rate, largely due to obesity and consequent metabolic conditions, from which cardiovascular disease develops.

This Institute for Cardiovascular and Metabolic Research (ICMR) at the University of Reading are working to understand the regulation of platelet function and the impact of this in the development of thrombotic conditions which are the principal triggers for heart attacks and strokes. Platelets are blood cells that monitor our circulation, and on encountering injury, cause the blood to clot. Their research has led to the identification, and understanding at the molecular level, of mechanisms through which healthy blood vessels suppress platelet function.

Anti-platelet drugs are established and effective means to prevent heart attacks and strokes, but new and more sophisticated approaches are required to harness knowledge of the mechanisms that regulate platelet function and help identify new targets for drug development. The ICMR team led by Professor Jon Gibbins has discovered three new mechanisms to exploit existing drugs families and new drugs which are already in development. This will speed up the process of validating these discoveries and translating them into potential new therapies. Benefit from this research may therefore be realistic within the next five to 10 years.

CHAPTER 2

PEOPLE AND ENVIRONMENT: SUSTAINABILITY FOR THE NEXT CENTURY AND BEYOND

IAIN STEWART
PROFESSOR OF GEOSCIENCE COMMUNICATION

THE UMANAK REGION, IN NORTH WEST GREENLAND, might seem an odd place to begin a chapter on the challenges that climate change is presenting to the economic and social wellbeing of the United Kingdom. But bear with me because this community clinging to a rock in the Arctic Circle has something to tell us about the complexities of climate change.

The people of Umanak are acutely connected and attuned to their environment, an environment which has what we might term a split personality. In the winter, it is encased in sea ice, and that ice dictates how they live: it becomes their highways and byways, the very basis of their existence. In the summer, it retreats and they are released from their 'encapsulation', and once again the outside world can be admitted to their shores. I accompanied a BBC television crew to the region in May 2008, when usually we would not have been able to reach them until June. And while we were filming, I had an opportunity to speak to one of the men, and I asked him: "Have you noticed the changing of the seasons and global warming?" He replied, "Absolutely. The sea ice melts a month or so earlier and it is transforming the way we live." My natural reaction was to say "That must be terrible?!" to which he replied, "Terrible? No it's good! All through winter I have to cut holes in the ice and lay there waiting for a seal so that I can shoot it. Do you know how boring that is? In the summer I can go out on my boat hunting whales and dolphins and fish, and it is much, much easier."

Umanak is a community on the very edge, where the reality of global warming is truly starting to bite. And it is one of those places that transform your understanding of the world, because you can read all of the papers and articles you like on climate change or on science in general, but it is not until you experience the human stories that you fully appreciate it. For these people there is no talk of climate change as an 'issue' – it is just happening and changing their traditional way of living. Their summers are growing longer, and with that change comes a frenzy of activity and opportunity. They now have an extra month to repair their houses. An extra month to welcome tourists and the revenue they bring. They can operate the iron ore mine for the first time, and they've recently sold off-shore petroleum rights. If, as the climate scientists predict, we witness the end of sea ice during the summer months, then that will be a tremendous boon to the shipping industry.

Climate change is going to have winners and losers and just as the people of Umanak are positively adapting to change, so the droughts in the American South West are threatening the socio-economic livelihoods of millions. The expectation is that if this 'mega-drought' continues, by around 2020 Lake Mead will not be able to supply enough water to satisfy the Hoover Dam for electricity and Las Vegas for water. So at that point, one has to take priority over the other, and in all likelihood it will be Hoover that wins. So Las Vegas, one of the most extraordinary cities in the world, becomes unsustainable. And if you move the model on for another decade there would not be enough water

for Hoover either, and who then supplies the electricity for major conurbations such as Phoenix and Tucson? You might think this an extraordinary set of circumstances, but try telling that to the Anasazi people who braved a series of droughts in the region before their civilization went to the wall in the late 13th Century after one cataclysmic 20-year drought.

The question persists today as to whether this warming in the last century is natural changes in the system or an unprecedented aberration caused by man. That is a difficult question to address, even with temperature records for the past several hundred years in the UK. So we have to look for evidence that relates indirectly to temperature – and that is where geology comes in. As a geologist, my scale of reference is often measured in the millions of years, and there are plenty of very eminent scientists who argue that climate change has to be viewed and measured along that timescale. The theory goes that geologists see the bigger picture, where meteorologists and climate scientists get caught up in the detail. Some have even gone so far as to dismiss the concept of man-made climate change as 'twaddle'.

From the geological records we know that the planet is always changing; it is dynamic and has experienced great fluctuations during its lifetime, with peaks and troughs in temperature and carbon dioxide levels. Complex forces are constantly at work, such as the movement of the tectonic plates. 200 million years ago our planet was dominated by a big lump of continents which were all sitting together. Since then we have seen the opening up and dispersal of this great plate boundary and this has created gateways which have altered the way currents move around the planet. Our circulatory system is evolving and changing as the world undergoes geological development.

A geologist might point to 55 million years ago, as an example, when the planet was experiencing the so-called Paleocene-Eocene thermal maximum (PETM). This was manifest as a 'sudden' spike in temperature, an increase of some five degrees centigrade. To the geologist it looks like an instant, but in reality it was tens of thousands of years over which time a huge amount of carbon – probably in the form of methane – was injected naturally into the atmosphere. Far more carbon was released in fact than

The planet is always changing; it is dynamic and has experienced great fluctuations during its lifetime, with peaks and troughs in temperature and carbon dioxide levels.

if we burned all of the petroleum reserves on the planet today. From the geological record we know that it had a major effect upon life, with a biotic response across all ecosystems, characterised by an immediate flourishing and a subsequent crash.

Now on the one hand, this perspective of tens of millions of years is a comforting one. We see rising temperatures and high CO_2 levels at a time when man was not driving around in cars. But what you gain in time, you lose in resolution. There in the small print is the fact that humans today are putting carbon into the atmosphere at a faster rate than the planet's able to do itself. We now think that the planet is capable of moving in and out of ice ages within perhaps three years or so. In the duration that our students go through university, we can move in and out of ice age; that is how sensitive the climate system is. The pioneering climate scientist Wallace Broecker famously said, "Climate is like an angry beast and we are poking at it with a stick." Well we are poking at it, and the system is teetering.

Planet Earth has its natural rhythms and cycles, and for millions of years it has regulated these patterns. But on our watch, we've had a massive impact upon it, and that is being felt by millions of people, not just in Greenland and America, but across the planet.

PEOPLE AND ENVIRONMENT: BUILT ENVIRONMENT

AROUND 90 PER CENT OF THE UK'S POPULATION lives in an urban environment. As urban and suburban populations continue to grow across the world, improving the quality of life for city-dwellers is an important part of designing for the future. Cities, where many people live close together, offer unparalleled opportunities for sustainability planning, both in terms of reducing emissions by providing better infrastructure, and ensuring the health and wellbeing of inhabitants.

BUILDING DESIGN

If children are the future, then education is the foundation of a successful and sustainable future. At the University of the West of England, architecture students are receiving innovative teaching which asks them to integrate public health considerations into their designs. By understanding how building design can impact the health of occupants, the next generation of architects are taking an important step towards a healthier and happier society. At the University of the West of Scotland, a study examining the impact of new buildings on students and staff will evaluate perceptions about recently constructed secondary schools. As perceptions are related to key educational and psychological outcomes, such as academic performance, self-esteem and engagement with school, identifying what makes a good learning environment is vital to improving the quality of education. Stepping outside the classroom, researchers at Anglia Ruskin University are exploring the benefits of 'Forest School' for children aged three to five. Forest School is an innovative educational approach to outdoor play and learning, engaging children with their environment at a young age and establishing healthy habits of fresh air and exercise. The project outcomes will support the delivery of local policy to provide access to Forest School sessions for all children in the area.

URBAN DESIGN

Living in a city, it's sometimes hard to find peaceful places to sit and reflect. 'Ways of hearing', a national programme of research focused on listening, recognises the importance of architecture and urban design in contributing to a rich and varied soundscape in cities. By assessing the overall mix of city sounds, and their acoustic management, the project aims to improve the aural quality of life for city-dwellers. While the suburbs are often stereotyped as quiet backwaters, University College London's 'Adaptable Suburbs' project intends to demonstrate how, in tough economic times, growth and positive change will come from small-scale, incremental change specific to individual places. Like a phoenix rising from the ashes of large-scale, all-encompassing regeneration, the project will help make small suburban neighbourhoods visible to policy makers, providing new information and practical understanding on how places can be planned to work better and more sustainably.

As society evolves and adapts to the challenges of our changing environments, so must the infrastructure which underpins society. A project based at the University of York, supported by the Engineering and Physical Sciences Research Council (EPSRC) aims to ensure that demand doesn't outstrip supply, as proposed low-carbon infrastructures call for new, and potentially rare, materials. By analysing future construction needs, researchers plan to predict and mitigate infrastructure failures caused by shortages of materials. At the other end of the scale, interdisciplinary research is providing strategies for mini-regenerations via 'The Seed Catalogue: growing solutions to urban decline'. The project consists of adaptable strategies to make use of urban wasteland to help cities successfully transition into a post-industrial economy and create a more self-sufficient, affordable and higher quality built environment.

PEOPLE AND ENVIRONMENT: PREDICTION

PREDICTING THE LIKELY EFFECTS of climate change on our environment and ecosystems is becoming ever more important. A small rise in the average global temperature may lead to melting glaciers, a subsequent rise in sea level, and consequently large areas of land becoming uninhabitable. Without effective ways of predicting and modelling these kinds of changes to our environment, we face an even more uncertain future. Research is vital in helping us map out how our world might look in 20, 50, even 100 years time.

Sometimes we have to look back in history to see the future. At the University of Birmingham, researchers have made use of available commercial 3D seismic datasets to map out the unique historic coastal landscapes of the North Sea. Following the last Ice Age, rising sea levels resulted in vast swathes of inhabited prehistoric land becoming the North Sea. A team of archaeologists and geomorphologists has now mapped nearly 55,000km^2 of this lost world, allowing unprecedented access to landscapes which could provide vital clues to how climate change might affect us. This project is a timely reminder that modern humankind has endured catastrophic change in the past and that this resulted in the permanent loss of immense areas of habitable land.

Back in the present, researchers at the University of Reading are working with the Australian Government to improve predications of the impact of climate change in Queensland, an area which consistently experiences considerable fluctuations in its rainfall. Recent climate models have predicted that by 2050 Queensland could be from 30 per cent wetter to 30 per cent drier than today; this uncertainty makes it very difficult for governments and industries to take measures to adapt to climate change. By combining historical rainfall data with the latest, high-resolution models of the Earth's climate, far more accurate predication can be made, providing essential information for planning suitable climate mitigation.

Making good use of available data is central to improving environmental modelling techniques. Researchers at Imperial College London are developing a 'virtual observatory' which aims to integrate the huge range of software and data used in environmental simulation, scenario analysis and decision making. Much of this data is currently held in unconnected systems in incompatible formats, so the 'virtual observatory' will bring it together in one place, facilitating fast communication of data to create tailored, interactive simulations of the impact of environmental decision making.

PEOPLE AND ENVIRONMENT: ENERGY SUPPLY

FINDING RELIABLE ENERGY SOURCES for the future is seen by many as perhaps the most pressing challenge facing the world. Methods designed to maximise energy manufacture from current fuel sources, such as coal and gas, must be combined with new, innovative ways of generating energy. Cutting-edge research continues to seek new techniques of harnessing the Earth's natural resources in ways which don't produce harmful side effects.

Photovoltaic (PV) cells that convert sunlight into electricity will be one of the most important technologies this Century. Researchers at the University of Edinburgh, supported by the EPSRC, are developing luminescent solar concentrators to maximise efficiency of PV cells and make them more cost-effective. The technology uses luminescent dyes incorporated into plastic sheets, which not only increases the amount of light absorbed by PV cells, but could lead to a revolution in architectural design! The luminescent dye treatment can be applied in a range of pigments, so as PV cells replace plate-glass in office blocks, the UK's windows could soon be covered in a rainbow of colours.

At Birmingham City University, researchers are investigating the use of algae as a fuel source. Algae makes up a large part of the Earth's biomass, grows quickly and in poor conditions, has a high oil content and can process CO_2 at a higher rate than terrestrial plants. On an urban farm in the iconic former HP factory in Birmingham, the researchers have teamed up with industry partners to combine sustainable energy generation with localised food production and use of food waste.

In addition to renewable energy sources, back at the University of Edinburgh, researchers have also been taking part in an international project designed to improve the new generation of fusion reactors. While nuclear fission raises significant environmental and political worries, nuclear fusion promises a low pollution route to generate a large proportion of the world's energy needs sustainably. The Nu-FuSE project aims to facilitate the development of new fusion reactors by providing greater computational modelling capabilities which are needed to meet the considerable scientific and engineering challenges involved in designing commercial-scale power plants.

Nuclear fusion promises a low pollution route to generate a large proportion of the world's energy needs sustainably.

PEOPLE AND ENVIRONMENT: REDUCING EMISSIONS

REDUCING THE EMISSIONS WHICH CONTRIBUTE to environmental change is a major challenge for researchers and governments across the world. Research needs to find ways of reducing emissions and cutting energy consumption in all areas, from global industry to individual households, while ensuring that those who are most vulnerable are not disadvantaged by changes in policy and practice.

At a household level, researchers at Coventry University are using communications technology and artificial intelligence systems to improve domestic energy efficiency. By providing households with visible information on the energy consumption of each appliance in the home, together with targeted energy saving advice, they expect to reduce the energy consumption of participating households by eight per cent in three years. Those taking part will also be able to share their experiences and energy-saving tips via Twitter and Facebook, encouraging a community approach to reducing consumption.

At the University of Birmingham researchers are focusing on households which can't afford to waste energy: those in fuel poverty. Researchers will use their findings to help people address the social and political problems associated with inadequate access to affordable, comfortable and sustainable energy services in the home. In Salford, researchers have gone one step further and built their own house! The house stands in a testing chamber featuring a unique climate system which can generate a range of weather conditions, from snow to gale-force winds. This enables researchers to experiment, regardless of the weather outside, and gather data monitoring energy consumption. Results from this project will inform sustainable retrofitting of the UK's housing stock. As 91 per cent of all UK homes would benefit substantially from improvements in energy efficiency this is an important challenge.

Reducing greenhouses gases at an industrial level is another major challenge for research. The Carbon Capture and Storage (CCS) technique, where CO_2 is captured from sources such as fossil fuel power plants and stored so that it does not enter the atmosphere, is likely to be introduced in the UK on a large-scale in 2015-2020. Researchers at Imperial College London have been investigating ways to use the same material, calcium oxide, in both the capture

of CO_2 via CCS and the manufacture of cement. Power generation and cement manufacture account for over 60 per cent of emissions created by human activity, so a significant reduction in these industries would have a positive impact on global emissions.

At the University of East Anglia, researchers are focusing on agriculture. They aim to improve soil quality and increase crop yields by introducing biochar to the soil, a charcoal-like substance formed by burning biomass in a process which captures CO_2. This has the potential to mitigate some of the disastrous effects of poor soil quality in developing countries, where low crops yields cause starvation and suffering.

Meanwhile, researchers at the University of Cambridge are working to identify policies likely to reduce emissions, through their project 'New Economics of Decarbonising the Global Economy'. Links with organisations across the world, including the Intergovernmental Panel on Climate Change, bring their research to policy-makers world-wide, helping governments choose effective, efficient and equitable policies for mitigating climate change.

CARBON CAPTURE AND STORAGE (CCS)

CCS technology is being used in innovative ways by researchers at the University of Nottingham. Many chemicals are currently manufactured using potentially toxic solvents, but their method plans to make use of the 'captured' and compressed CO_2 as a substitute solvent. This is an excellent example of a clean and sustainable technology using a 'waste' product to manufacture valuable commodities. The researchers working on this project are Professor Martyn Poliakoff, Professor Mike George and Dr Trevor Drage, a collaboration which was inspired by UNICAS, a University-wide partnership in analytical science.

Speaking about CCS, Dr Drage said: "CCS is a process by which you avoid releasing carbon dioxide into the atmosphere from the burning of fossil fuels such as coal and gas. The gases released from burning coal, oil or gas are a mixture of carbon dioxide, nitrogen and water. To be able to transport and store the carbon dioxide you need to turn it into a pure form by separating it from the nitrogen and water. Once you have your carbon dioxide in a liquid form you can transport it to a storage site. The aim of CCS is to store the carbon dioxide somewhere it's not going to leak into the atmosphere for millions of years. In the UK we are considering storing it in geological formations, so the rocks under the North Sea. It's essentially replacing the natural gas we remove from these rocks with the carbon dioxide. There is naturally a lot of carbon dioxide compressed in the ground, so this new idea is in fact based on something that already occurs in nature."

Professor Martyn Poliakoff is keen to put the waste CO_2 from power stations to better use, as a solvent for chemical production. Talking about his research idea he said: "In order to conduct many chemical reactions for industrial purposes you need to use a solvent. At the moment the majority of solvents used in the chemical industry are made from petroleum. This creates an added cost because the cost of oil is going up and the chemical industry is using a product that will at some point run out.

So, if you can replace a proportion of the solvents with

CO_2 from a power station, you don't need to use oil and you don't generate additional CO_2. The ultimate idea is that you can possibly locate the chemical processing plant and the power station close to each other. This makes sense because all power stations have very good rail communications, they also have a high level of security so the chemicals would be produced in a safe area and, from the point of view of power station owners and operators, it would be an extra source of income. These chemical processing plants could also use the excess heat from the power stations which is currently evaporated through cooling towers. So, the power station could feed the needs of the chemical processing plant by supplying the CO_2, heat and energy.

The basic principles of using CO_2 for chemical reactions are reasonably well understood. Now is the right moment to be discussing the possibility of this technology because in terms of the overall plans for CCS, incorporating chemical processing into the plant will not be difficult. However, it will be difficult in the future to go back and try to incorporate chemical processing plants into CCS networks at a later date."

PEOPLE AND ENVIRONMENT: FUTURE OF FOOD

FOOD SECURITY IS AN INCREASING CONCERN in the 21st Century. Climate change means we have to think about new, more efficient and environmentally-friendly ways of feeding our growing global population. A review, 'Reaping the benefit', by the Royal Society in 2009 predicted that the global demand for food will double by 2050. Changing the way we eat, from farm to fork, is essential if we are to maintain and improve our food security.

A 'Virtual Root', developed by an interdisciplinary team of researchers at the University of Nottingham, and supported by the Biotechnology and Biological Sciences Research Council (BBSRC) has been built using a systems biology approach as a predictive model to simulate plant root growth accurately. The root is the critical part of the plant for seedling establishment and plant growth and development, through water and nutrient uptake and responses to heat, drought and salinity. Understanding plant root development will enable researchers to accelerate the production of crops with roots which will better exploit the soil's resources. Results from the modelling are already being translated into crops such as barley and full-scale crop breeding programmes could result in improved varieties available to farmers in 10 years time.

3D visualisation of Arabidopsis root apex

Looking at the genes of plants is also a key part of improving crop strains for the future. In many cereals and forage grasses, chromosomal properties mean that it is difficult for plant breeders to introduce new genetic traits rapidly, making it very hard to alter the plant's characteristics over a short period of time. These characteristics may include susceptibility to disease, or poor adaptability in varying climate conditions. At the University of Birmingham researchers, also supported by the BBSRC, have been identifying key genes that control meiotic recombination, the process which allows genetic modification to occur. Once identified, this information will be an important tool for plant breeders, enabling them to breed improved plant varieties in a shorter period of time.

A 'Virtual Root', has been built using a systems biology approach as a predictive model to simulate plant root growth accurately.

Variety is not only the spice of life, it can add a great deal to our food security. Of 7,000 plant species that have been used for food, fewer than 150 have been commercialised and just three – maize, wheat and rice – supply half the world's daily food. Promoting agricultural diversification as a crucial link between biodiversity and climate change, researchers at the University of Nottingham Malaysia Campus are busy looking at how under-utilised crops can be matched to specific environments and consumer needs to ensure maximum productivity and minimum waste.

Although many diets across the world are largely vegetarian, a significant proportion of the global population eat meat regularly. According to the 2006 United Nations initiative, 'Livestock's long shadow', the livestock industry is one of the largest contributors to environmental degradation worldwide, and modern practices of raising animals for food contributes on a massive scale to air and water pollution, land degradation, climate change, and loss of biodiversity. At Newcastle University, Jan Deckers' research focuses on the ethics of farmed animal products consumption, arguing the case for 'minimal moral veganism' as a change which would result in profoundly positive environmental and health benefits, and presenting a range of policy options which could have a significant impact within 20 years of implementation.

PEOPLE AND ENVIRONMENT: TO INFINITY... AND BACK TO EARTH

OVER THE PAST FEW CENTURIES, as technology has developed and economies expanded, people have been travelling more widely and commuting further than ever before. In the 21st Century, while improving access to public transport remains a vital aim and clear solution to many of the transport challenges faced across the world, individuals will continue to need access to cleaner, greener ways of getting about. Research will help us find the best answers to these problems by exploring both technological and behavioural methods of improving the way we travel.

While space travel on a significant scale for humans is still more in the realms of science fiction than science fact, use of the area of space directly outside the Earth's atmosphere has a huge impact on the way we live. Hundreds of satellites currently orbit the Earth for military, communications and research purposes. Thousands more defunct and fragmented satellites also orbit the Earth and the build-up of debris is in danger of rendering near-Earth space unusable, as old spacecraft can collide with operational ones, causing considerable damage. Researchers at the University of Glasgow have now developed a prototype aerobrake 'de-orbit' system which can be activated remotely at the end of missions. This braking system would increase a satellite's aerodynamic drag, making it easier for them to re-enter the atmosphere where they will burn up. The upward trend in space mission launches means that this project will be essential in keeping space clear in the future.

On this side of the atmosphere, the environmental impact of civil aviation is well known. Researchers at Nottingham, as part of the European project 'Clean Sky', are working on ways to reduce the use of fossil fuels as well as cutting down on noise and emissions. Their project will enable the use of more electrical systems on aircraft, removing the need for hydraulic, pneumatic and mechanical systems. This will reduce weight and increase system efficiency, making future aircraft much more environmentally and financially friendly, as they will use far less fuel.

Researchers at the University of Glasgow have developed a prototype aerobrake 'de-orbit' system which can be activated remotely at the end of missions.

Back on the ground the Foot-LITE project, a revolutionary driver information system designed to educate and encourage safer and greener driving, is underway at Brunel University. By capturing, processing and displaying information about journeys and driving style through smart-phone applications, the project seeks to address both road safety and environmental impact by supporting long-term behavioural change. Drivers will be able to access information and advice about their driving and share data with an online community, encouraging them to realise the benefits gained by better driving.

INTEGRATED SOLUTIONS FOR TSUNAMI, STORM-SURGE AND URBAN FLOOD MANAGEMENT

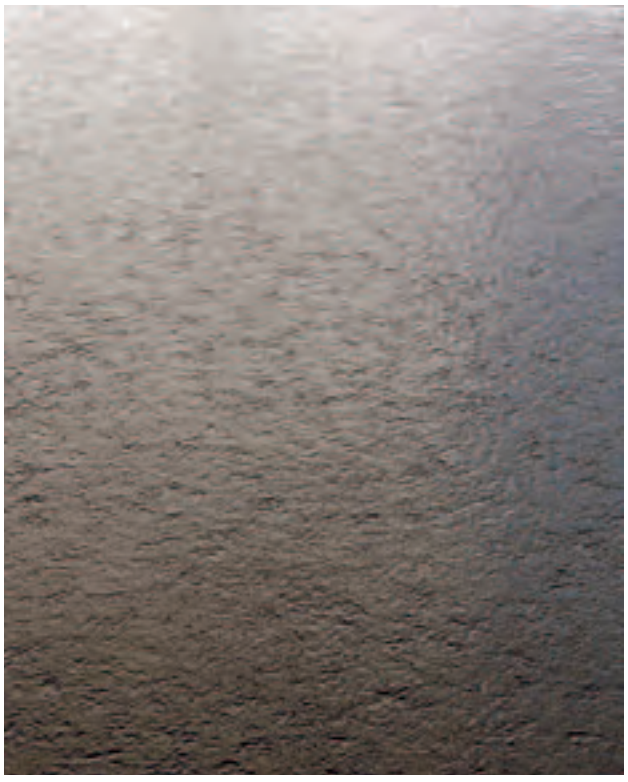
Tsunamis and flooding can wreak havoc on coastal and urban areas, destroying buildings and infrastructure and often taking the lives of hundreds of people. Researchers at Imperial College London have been working for some time on separate aspects of large scale natural disasters, such as tsunami-induced coastal flood, storm surges, rainfall and river flooding and are now looking to integrate these into a complete disaster management tool.

There is currently a gap in knowledge where two or more natural hazards occur simultaneously or are causally linked and happen unexpectedly over a short time scale. To plug this knowledge gap, the team has developed modelling technologies to provide a single model of ocean basin and coastal zones which can be used for 3-D tsunami and flooding scenarios. By enhancing the modelling and predictive capabilities of individual components of natural disasters, emergency planning will vastly improve. This will enable natural hazards to be managed better, minimising potentially devastating consequences.

THE GROUND BENEATH YOUR FEET

Building on its reputation as a leader in the field, Coventry University's Sustainable Urban Drainage Systems Applied Research Group (SUDS ARG), led by Dr Sue Charlesworth, has carried out research to assess the efficiency of porous paving systems. The SUDS ARG research shows clearly that, in spite of contaminant additions to the surface of TarmacDry™, the resulting effluent water is of drinking quality which conforms to World Health Organisation's drinking water guidelines.

Porous paving systems are an important aspect of sustainable urban drainage systems which altogether helps mitigate flooding and improve water quality as well as greening and cooling urban areas, resulting in a positive impact on human health and wellbeing. In the UK, floods during the summers of 2007-2009 illustrated that the ageing storm sewer system can no longer cope with intense, long duration storms. As more porous paving systems are installed across the UK, the risks associated with flooding will gradually decrease.



SUSTAINING BEES

Many crop and wildflower plant species are strongly dependent on bumblebees for cross-pollinations. Bumblebees have however, rapidly declined in abundance over the past 40 years and research is essential to ensure their survival and the continuation of the ecological service they provide. Working on over 20 farms in Devon and Cornwall, researchers at the University of Plymouth have found that bumblebees visits to native plants are shaped by what types of crops farmers grow in their fields. This information has major implications for pollinator conservation and may help shape future agricultural policy.

The team recorded bumblebee activity along hedgerows situated next to field bean and wheat crops and found that native plants, like foxglove and red campion, received over twice as many bee visits when next to bean fields. Encouraging pollinator visits to native hedgerow plants ensures a better natural habitat for a variety of insect species and the animals and plants that depend on them for survival. By helping understand how modern farming practice affects pollinator numbers, ecologists can better predict how climate change or fluctuations in world food prices will influence pollinator numbers by virtue of dictating which types of crops farmers grow. Subsidies for different crops can then be determined not simply on the basis of their value in food terms, but also with regard to their potential role as sustaining pollinator communities and the essential ecosystem service these insects provide.

OCEAN ACIDIFICATION

The acidification of our oceans and the unsustainable degradation of coastal resources is one of the results of rising CO_2 levels. Many people across the world either live in coastal areas or depend on the ocean for their livelihood and it is vital that marine ecosystems are more able to withstand the effects of climate change.

Dr Jason Hall-Spencer, at the University of Plymouth, has assembled an international team of diving scientists who are examining giant underwater volcanoes to better understand the effects of CO_2 on the ocean. The volcanoes emit huge amounts of CO_2 into the seawater which allows the researchers to work out what dies and what can survive as coastal areas become more and more acidified. Data from these natural laboratories are being used by the Intergovernmental Panel on Climate Change to inform international policy on carbon emissions. Resilient marine ecosystems will result in greater food security and protection from erosion, as well as preserving the huge variety of indigenous marine life which are currently at risk from human activity.

WASTE NOT, WANT NOT

What's your parents' attitude to recycling compared to yours? Did your grandparents ever use phrases like "Waste not, want not", and was that reflected in their consumption profile? There is limited research into waste management practices in the UK which goes beyond a 'snap-shot' survey approach of contemporary attitudes and behaviour and, as landfill sites begin to be in short supply, this is becoming a more and more pressing issue.

Researchers across the UK are exploring the links between lifestyles and life histories, taking people's cultural and ethnic backgrounds into account, to try and understand what influences their attitudes to waste disposal over the long term. The results from this research will inform the development of evidence-based policies that are targeted to encourage behaviour change across a range of increasingly multicultural British communities. In addition, providing a greater understanding of resource consumption patterns means that the UK will be better placed to meet the EU's upcoming waste reduction targets in 2015 and 2020.

WE ALWAYS HURT THE ONES WE LOVE (BUT WE DON'T HAVE TO!)

Since the birth of homo sapiens, human activity, whether immediately lethal or merely precipitating a change in natural environment, has affected all other species with whom we share the Earth. Recent legislation make it illegal to cause 'significant' disturbance to European Protected Species, but this concept is poorly understood, leaving plenty of room for misinterpretation.

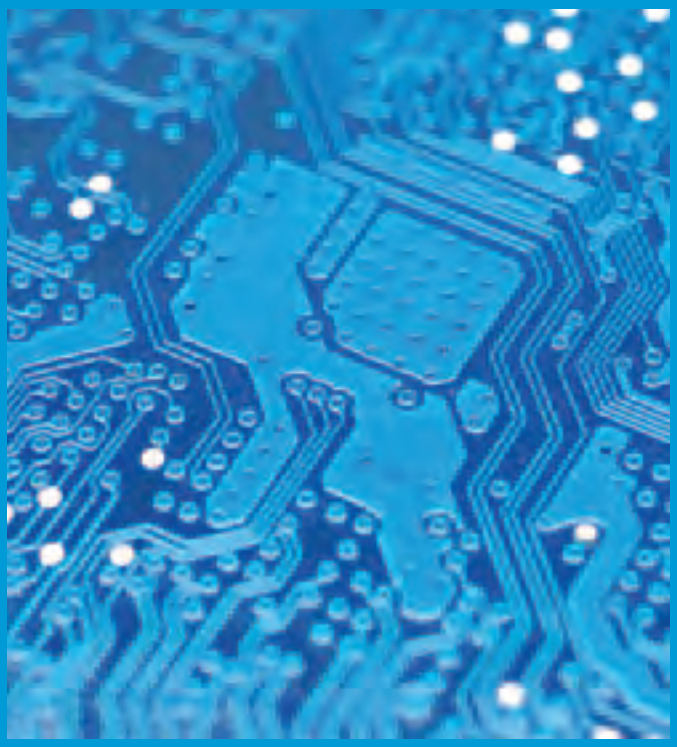
Until now, forecasting techniques in conservation biology have been limited by their descriptive approach, but recent advances in statistical methodology make it possible to predict the effect of human activity on wildlife populations far more accurately. Researchers in Scotland are developing frameworks to monitor the effect of human activity on wildlife populations, both looking at acoustic activity such as sonar, and wildlife tourism. In the next few years this research will provide advice to regulators, developers and the Ministry of Defence (MoD) for the management of sound emission in the vicinity of marine mammals. This will be particularly relevant for the development of marine renewable energy resources. In addition, beginning with a focus on the sustainable management of whalewatching tourism, the project is working with the U.N. World Tourism Organisation to manage wildlife tourism more generally.

REDUCE, REUSE, RECYCLE

The vast majority of products are designed and manufactured with no thought to their eventual demise and subsequent reuse, recycling or refuse potential. Current industrial production methods rely upon an assumption that there will always be natural resources ready and available, along with somewhere to throw away products at the end of their lives. As both of these assumptions are called into question, a research project at the University of Cambridge may just have the answer.

The project aims to reduce the environmental impact of society by creating a fully recycling global economy that matches industrial production and consumption to environmental processes, through use of specific materials, technologies and energy sources. Achieving this largely recycling and regenerative economy is technologically feasible, but economically and institutionally problematic, requiring the total redesign of current products and production processes to ensure that waste is recycled into materials with their original properties so they don't degrade over time. However, if coordinated appropriately full implementation would be possible within 50 years.

ULTRASONIC TECHNOLOGY



In the electronics industry, particularly for the manufacture of Printed Circuit Boards (PCBs), current technology employs harsh chemicals to provide surface treatment of the board, an essential first step in laying down the conducting pathways for the circuit. As awareness of the negative effects which chemicals often have on the environment continues to grow, a green solution for this process may be at hand.

Dr Andrew Cobley and his team at Coventry University's Sonochemistry Centre have come up with a method to treat the surface of the material used to make the PCB board using just water and ultrasound. This environmentally-friendly technique can also be used to reduce the temperatures employed in the subsequent electroless and immersion plating processes involved in PCB manufacture, a discovery which will give UK industry the edge as it will allow substantial reductions in the energy used. The excellent progress to date suggests that ultrasonic technology could be in place in the electronics industry within three to five years.

BETTER WASTE MANAGEMENT

Safe disposal of Waste Electrical and Electronic Equipment (WEEE) is a growing problem, particularly in parts of the developing world where industries have evolved WEEE from richer nations, which is shipped out in bulk for cheap disposal. In Nigeria, for example, WEEE management is characterised by open burning and dumping, which has significant health and environmental effects.

It is important to encourage environmentally sound management of WEEE for economic, social and environmental sustainable development. A project at the University of Northampton has developed and delivered education and training materials to show those in Nigeria, who make their living from WEEE management, how to continue without damaging their health or the environment. This research has already had a positive impact on behaviour change at a worker level and it is expected that, following talks with waste management partners, a recycling facility will be established by the end of 2012.

COASTAL FLOODING

Protecting the UK's coastline against the forces of nature is a hugely complex problem. According to the Environment Agency, one in six homes are at risk from flooding and 2.4 million properties are vulnerable to coastal/river floods, which can also wreak havoc on infrastructure.

Following a significant breakthrough in understanding the behaviour of mixed sand and shingle beaches in response to waves, researchers at the University of Plymouth are developing a blueprint for coastal authorities to help them manage beaches more effectively over the next 100 years. Professor Dominic Reeve led the team in constructing a novel temporary groyne that used only the native beach material, then carefully measuring waves, tide levels and beach positions over two and a half years. The results led to modification of the formulae currently used to estimate longshore drift and have enabled the team to produce much more accurate computational models, helping to protect coastal communities better from flood risks.

INTERSTELLAR CHEMISTRY

The region between the stars, the interstellar medium, is not empty, but is instead populated with a rich array of atoms, molecules and dust. The next decade will see a revolution in our ability to explore these regions with a range of new, cutting-edge telescopes. LASSIE (Laboratory Astrochemical Surface Science in Europe) is a major pan-European initiative into astrochemistry, the study of chemistry in the interstellar medium.

Interstellar chemistry forms a broad range of simple molecules and more complex species, which are now believed to be the precursors to life on Earth. LASSIE-UK research aims to understand the fundamental questions of how stars form and how prebiotic species can be generated, by understanding the unusual chemistry of the interstellar medium. It has already made a number of major contributions to our understanding of the role of surface chemistry in driving the interstellar medium towards chemical complexity. As the project continues, it will advance understanding of the origins of life and the likelihood of life having developed elsewhere in the universe.

BIODIVERSITY

The Earth's biodiversity is one of our greatest assets yet not enough is understood about how to protect and preserve it effectively. The Conflicted Planet Project, set up by researchers at Kings College London, aims to understand the interplay of conflict and protection of all life on Earth

The research will contribute to a greater understanding of threats emanating from the destruction of biodiversity and help to create greater resilience and sustainability in global society. Focusing on the Himalayas and the effect of melting glaciers on the major Asian river basins, via the Third Pole Project, the team plan to use its findings to apply to future projects, developing adaptable and effective biodiversity protection strategies for a wider use.

CHAPTER 3

RECREATION AND LEISURE

TONY WHEELER
FOUNDER OF LONELY PLANET TRAVEL GUIDES

GOOD IDEAS DON'T HAPPEN IN ISOLATION, social and cultural changes and trends usually mean that people will have similar solutions to contemporary problems at around the same time. Look at social media in the last few years: Facebook to Twitter to YouTube, the time was ripe and they all happened. A generation earlier Apple, Microsoft and other pioneers of the personal computer business were born in garages and university dorms around the same time.

In the fast moving world of leisure and recreation, ideas build on each other and grow, ever evolving under the influence of social needs and desires, new technologies, and new inspiration.

The late '60s and early '70s saw the creation of a list of new travel information providers, guidebook publishers as we were back in those days. Insight Guides popped up in Singapore after Hans Hoefer made a lengthy stay on the island of Bali. A few years later my travels across Asia led to the creation of Lonely Planet in Australia, a similar trip led to the birth of Guide du Routard in Paris in the same year while it was an Indonesian adventure which inspired Moon Publications, also in Australia although later relocated to the USA. Bradt Publications popped up soon afterwards and Rough Guides a couple of years later.

None of these new publishers came from the existing publishing world, they were all created by people who had travelled and seen an information gap. Why did it happen when it did? Well we were all post war baby boomers stretching our travel wings. The horizons were wider than they were for previous generations, you didn't just travel in Europe you took the jump from Spain to North Africa, or continued on from Greece into Turkey and on across Asia. Americans were heading further south than Mexico, Australians were discovering that South-East Asia was only a stone's throw to their north

and far more than just a war zone centred on Vietnam. Plus the ability to go further, faster and cheaper was happening. The first Boeing 747 had entered service in 1970 and new airlines were appearing to take us to places our parents had barely heard of.

Those social and technological changes would expand and accelerate in the following decades. Our horizons would get wider and wider. Regions that were undreamed of as tourist destinations – like Antarctica – would open up. Great swathes of the world which had been totally closed off would be unlocked – it's hard to imagine that China, with a large chunk of the world's population, was a closed shop in the 1970s. Then computers would make information more readily available and more easily processed. The internet would make that information instantly accessible and mobile phones would revolutionise communications. Airline deregulation led to a flood of 'low cost carriers' which pushed fares down to unbelievably low levels and opened up countless new destinations.

Innovation can be a long and challenging process. As we become busier at work as well as in our leisure time, the need to try new things and explore continues to grow.

So where is it all going to lead? Who knows. Like everything else these days there's no single trend to follow. These days everything splinters into a myriad of possibilities, split up into a host of subdivisions.

As this section of the report shows – innovation can be a long and challenging process. As we become busier at work as well as in our leisure time, the need to try new things and explore continues to grow, and this, in part, was what the growth of Lonely Planet has been based on. But in other areas too we see developments in how people want to spend their leisure time and this is the real driver of the research that leads to the pastimes of tomorrow. Innovation and ideas can blow our mind, while it's the consumers that vote with their wallets and their time.

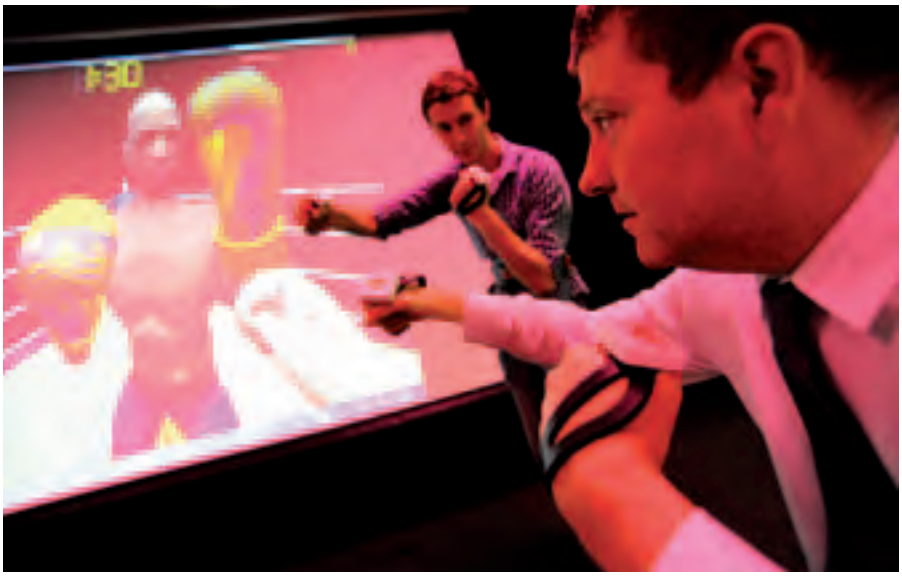
RECREATION AND LEISURE: HEALTHY LIFESTYLE

IT'S NOT ALWAYS EASY to maintain a healthy lifestyle, but the benefits can be worth the effort. With the knowledge that exercise and a healthy diet should help us live longer and more active lives, researchers are working to find new ways to help people lead a healthy life.

FIGHTING FIT

Leading a healthy lifestyle is not always easy and gym membership is not for everyone. New research is looking to see if a new computer gaming system developed at Teesside University can be used to make middle–aged men healthier.

The research team have created an alternative to existing virtual fitness games and in the new Teesside game, which is called the 'exergaming' system; participants compete against a virtual boxer who reacts to their punches. The games are highly immersive and those taking part get a thorough workout.



A group of 50 men who currently don't get much exercise are being recruited from Teesside workingmen's clubs to take part in a 12 week high-intensity, low-volume exercise trial. The researchers will measure health indicators of participants before and after the trial period to see whether this fun approach to health promotion can have real benefits.

The research is led by Dr Iain Spears, Reader in Sports and Exercise at Teesside University. Co-researcher Dr Alan Batterham, Professor of Exercise Science, said: "There is a growing body of evidence that brief, relatively high-intensity exercise of this type is beneficial for health."

SEAWEED INSTEAD OF SALT

Salt may add flavour to our food, but excessive amounts of it are not good for our health with a high salt diet leading to raised blood pressure and heart problems. Researchers at the Centre for Food Innovation at Sheffield Hallam University are researching alternatives to salt that can be added to food to make it more healthy without ruining the taste.

There are salt substitutes available, many based on potassium chloride, but they are not suitable for use in all foods and can sometimes leave a bitter taste in the mouth. The research team at Sheffield Hallam has been exploring the potential of Seagreens®, a wild wrack seaweed that can be used in food. The great thing about this product is that it has a salty taste, but only 3.5 per cent sodium and a good balance of other minerals. It appears to be allergy free and is 100 per cent vegetable in origin so suitable for vegetarians and vegans.

TECHNOLOGY THAT MAKES US HEALTHY

More than ever we are relying on technology to help us in our day to day lives from shopping to socialising and entertaining. The rapid development of technology means that in the future it could help us lead healthier lifestyles too. Two universities are using mobile phone applications (apps) to help people stay healthy. One app is helping with mental health and the other with physical health.

Researchers at the University of the West of England (UWE) have designed a new app to support students with social anxiety. Social anxiety is a persistent fear of social or performance situations, estimated to affect 10 per cent of higher education students. It is personally distressing, has an adverse affect on engagement with learning and affects adult quality of life including career development. This new app will monitor anxiety levels and help users reduce their social anxiety, including anxiety about learning situations such as presentations, seminars and other group work.

Researchers at the University of Leeds have developed an app to support weight loss called 'My Meal Mate'. The app allows users to set a weight loss goal and monitor their daily calorie intake towards achieving a set goal. Users select the food and drink they have consumed from a comprehensive branded food database and log items in

The new app will monitor anxiety levels and help users reduce their social anxiety.

an electronic food diary. Users can also select and record physical activity in the diary and receive instant feedback on their energy intake and how much they have used. The app gives instant progress tracking as well as further support by sending weekly text messages. 'My Meal Mate' also has a function to take a photograph of the food eaten to serve as a memory prompt if food is added to the diary at a later time. The application also has a website where users can upload the data stored in their phone to help monitor their diet.

EDUCATING THE NEXT GENERATION ABOUT HEALTHY EATING

With high levels of obesity and rising levels of chronic disease, how can we prevent teenagers becoming the patients of tomorrow? Eating more healthily and exercising more have been on the government's health agenda for a while and have been the subject of public health campaigns. Young people may know what a healthy lifestyle is, but this knowledge isn't resulting in lifestyle changes and new and personalised ways of getting the message across are needed.

Researchers at the University of Leicester have developed Health Education Reaching Out (HERO). A health education programme that aims to improve long-term health through education and evaluate the best practical approaches to deliver lifestyle outreach messages. This is done through fun and interactive workshops and public events which provide people with the insight to prevent and reduce their risk of developing chronic diseases, such as cancer, heart disease and diabetes. HERO is committed to providing adults, children and families with a basis to appreciate the long-term benefits of a healthy diet, regular exercise and a stress-free lifestyle.

There is growing concern that bad eating habits that are established at a young age are hard to break in adulthood. In Europe about 20 per cent of children are overweight, and a third of these are obese. Obesity is already responsible for two to eight per cent of health costs and 10 to 13 per cent of deaths in different parts of Europe (WHO, 2007). Researchers at the University of Leeds are leading work into establishing healthy eating habits in very young children by running two research programmes. The first called 'V is for Vegetable: Applying learning theory to increase liking and intake of vegetables' (VIVA) and the other is called 'Determining factors and critical periods in food

Habit formation and breaking in Early childhood: a multidisciplinary approach' (HabEat). The overall aim of both these research programmes is to establish healthy eating habits in very young children by specifically enhancing the liking and acceptance of vegetables during critical periods of early development.

The overall aim of these research programmes is to establish healthy eating in very young children.

Perhaps this indicates that if earlier generations had been educated better on the need to live a healthy lifestyle there would be fewer cases of obesity diabetes, cancer and other diseases. A team of researchers at the University of Birmingham believe that is the case and we should therefore make sure we do more to educate people to reduce obesity in future generations. The researchers aim to identify local customs that can affect our physical, social or mental wellbeing. They intend to look at how often and why individuals act in certain ways that can be of detriment to their health. The idea of the research is to help people cultivate their personal wellbeing by understanding and considering the impact of social customs on their everyday life.

FOOD SAFETY

Food quality and safety has a major impact on human health. The better quality a food is, the better it is for us. However, exactly what it is that makes food good quality is not yet well understood. A team of researchers at the University of the West of England (UWE) are trying to discover the DNA and protein biomarkers for a range of food quality traits including the fatty acid composition. They then intend to develop new technology that can detect these traits in food. An important aspect of this project is not only to deliver new knowledge, but also to establish an effective international training and research network which will sustain food quality research and new technology development in the future.

OPTIMISING EXERCISE FOR BUSY PEOPLE

Despite knowing the health benefits of regular exercise, the majority of the population remain inactive. Current exercise guidelines recommend 30 to 60 minutes of exercise, on most days of the week. However, the most commonly reported barrier to participation in physical activity is a lack of time and these guidelines are perceived to be unrealistic for many. Therefore there is a need for a more time effective and efficient mode of exercise that can be incorporated into peoples' busy lives.

Researchers at the University of Birmingham, supported by the Biotechnology and Biological Sciences Research Council (BBSRC), are investigating the effectiveness of High Intensity Interval training (HIT). HIT involves repeated 30 second bouts of exercise with longer periods of rest. When performed on three days of the week, a total exercise time of nine minutes per week, or a total time commitment of 90 minutes is required. The research has shown that HIT is just as effective at enhancing metabolic and cardiovascular health as traditional training methods, but requires only one-third of the time commitment.

ENVIRONMENT AND HEALTH

There is evidence that contact with nature is beneficial to human health and well-being. A team at Staffordshire University are considering research to explore the relationship between the natural environment and health. They propose to collaborate with nine partners from countries across the EU to understand the mechanisms behind, and potential for, the preventive and therapeutic health benefits of natural environments. As the UK partner, the team at Staffordshire University will lead experimental work into psychological and physiological responses to people when exposed to different types of urban and natural environment, whilst contributing significantly to other parts of the project.

It is hoped that this new research will provide stronger evidence about why having exposure to nature and the outdoors has a positive impact on our health. A key outcome of the group's work will be the development of practical guidelines for better integration of human health needs into land use planning and green space management, to optimise the health potential of our natural environment.

RECREATION AND LEISURE: ARTS AND PERFORMANCE

IN THE FUTURE the way we listen to music, watch films, plays and other theatre performances could be very different to what we are used to now. In recent years 3D cinema has become a norm and 3D television is not far away. The aim of new technology and research is to optimise our enjoyment of the arts and find new ways to make them more inclusive for everyone.

EVERYONE DESERVES MUSIC

Research at the University of Liverpool aims to increase our understanding of interaction between musicians with and without hearing impairments. Musicians with normal hearing use a variety of cues to play together, not least listening to each others' performance. They also use visual cues from other musicians. In orchestral and large ensemble works these are provided by a conductor, but such cues are also provided by co-performers in small groups. However, auditory cues are not available to musicians with hearing impairments, and visual cues will not always provide sufficient information for interactive rehearsal and performance to be enjoyable and effective.

Collaborative research between the University of Liverpool and the Royal Northern College of Music aims to increase our understanding of interaction between musicians with and without hearing impairments, and to investigate how vibrotactile technology might be used to help them perform together. The outcomes will benefit current and future generations of people with hearing impairments, helping them to perform, enjoy and compose music, particularly with other musicians. One of the ways

the researchers seek to do this is by investigating the use of vibrating performance decks on which musicians could stand or sit, as well as using vibration pads attached to the body.

The idea was inspired by Dame Evelyn Glennie, a highly renowned solo percussionist who began to lose her hearing when she was eight years old. Many percussion instruments that she plays cause the floor to vibrate, and this vibration can be transmitted from the floor through her bare feet into her body. However, any feedback from the vibrating floor is highly dependent upon the type of floor construction, and this approach is better suited to solo performance. For musicians with a hearing impairment, group rehearsal, performance and musical improvisation would benefit from a more versatile solution that can transmit the music as an individually tailored vibration signal. The research is funded by the Arts and Humanities Research Council (AHRC) and combines the psychology of musical performance, the physics of structure-borne sound and acoustics, and the physiology of touch.

The Principal Investigator is Dr Carl Hopkins, Head of the Acoustics Research Unit at Liverpool who had this to say about the research: "By focusing on the interaction between musicians and vibrotactile perception of music we are aiming to provide a toolbox of ideas for how, if you were a deaf person who wanted to play a musical instrument, you might go about it. We expect there to be a variety of solutions, but by understanding the perception of music as vibration that is applied to the skin we want to identify what is feasible for people with different types of hearing impairment. It's important not to forget that there are already groups of deaf musicians who have developed their own strategies to perform together. To complement their experience we would like to provide an informed scientific basis on which others, particularly deaf children, could consider learning to play an instrument and experience the pleasure of performing music with other musicians.

Dame Evelyn Glennie is the inspiration for the research. Many years ago I was driving home from work listening to the radio and she was giving an interview about how she used the vibration of the floor as feedback whilst playing. At the time I was carrying out research on floor vibration in terms of sound transmission in buildings rather than musical performance. It occurred to me that every time she performed in a different concert hall, the floor would be different so she might never have the same feeling twice, or that she would find some floors unresponsive. So, for a solo musician I had the thought of designing a customised performance deck for specific instruments. In later years it became clearer to me that this was only part of the solution and that for interactive musical performance we would need to electronically process the sound from individual instruments before transmitting it as vibration to each musician with a hearing impairment. The project came about after we teamed up with Dr Jane Ginsborg, a music psychologist at RNCM, and the charity 'Music and the Deaf' that promote musicianship for the deaf. Everyone deserves music, and the project team are all excited to be working on research that has the potential to benefit musicians playing anything from Afrobeat, Bhangra, or Classical to Zouk!"

HARNESSING THE POWER OF SOUND

We usually associate sound with music and performance. However, a group of researchers from the University of Nottingham, led by Professor Tony Kent, are investigating new sources of sound energy for the future. Since the invention of the maser and laser just over 50 years ago, scientists have been working to demonstrate the equivalent for sound. The aim of this research is to study the fundamental physics and applications of terahertz (1000 billion Hertz) sasers. Saser, or Sound Amplification by the Stimulated Emission of Radiation, is the sound equivalent of the laser. If the researchers can harness power from sound it will give us another source of energy in the future that could be used in medical imaging and scanning, and security screening.

Professor Kent's team are working on miniscule devices, or nanostructures, made up of multiple layers of semiconducting materials known as superlattices. Using a combination of new optical and electrical measurements the researchers are studying the nature of the sound waves emitted by sasers, in particular the coherence and directionality of the sound. Using appropriate electronic devices it is possible to use terahertz sound in the generation, manipulation and detection of terahertz electromagnetic waves. This technology could provide a new and viable power source in the future when our energy needs can no longer be met by traditional sources.

MUSIC AND ETHICS

Throughout history, music has been used as a powerful religious, political and therapeutic tool. Music continues to influence many aspects of our lives, how we dress, what friends we have and how we relax. For some people music can become a way of life. In the future will music go one step further and influence the decisions we make and how we treat other people? Led by Dr Nanette Neilsen, a team of researchers from the University of Nottingham is now exploring the relationship between music and ethics.

By sharing information about how music and ethics have interacted historically, the researchers aim to enhance understanding about how this interaction has an effect in the present. The team hopes it will encourage people today to actively shape their current and future music-ethical experiences by ensuring today's music listeners realise that music has an ethical dimension, which goes beyond mysticism, therapy, psychology, or purely aesthetic appreciation. Through understanding music historically and critically, as a lived, created aspect of human endeavour, we can allow its ethical powers to take hold of our consciousness and imagination.

By explaining, clarifying and letting people listen to music, this research offers insights into the ways in which musical ethics can be understood and put into practice. When we can fully appreciate music's interaction with history, politics and the various narratives of our lives, we can better understand its inherent power to shape and inspire or lives in the past, the present and also in the future.

PERFORMANCE ON STAGE

Theatre performance has a long and rich history and even with the advent of film and other digital media, it is still popular today. Researchers at Oxford Brookes University are re-enacting the plays of the past to make their history more interactive today.

The UK has an extremely rich heritage. However it is understood and appreciated differently by those of us who live here, those who study it and tourists who visit the UK. These different interpretations are not surprising and can even be expected when we think about the different and sometimes conflicting angles we all view history and heritage. The researchers at Oxford Brookes believe that creating what might be the recreation of tomorrow will help bring entertainment, research and interpretation together, so they support one another. The research team plans to examine the courts of Henry VIII and the ceremonial significance of them. The courts of Henry VIII were famously spectacular and had a huge impact on the politics of the day. By highlighting our heritage through this showmanship the research will bring the past to life in an historically accurate and entertaining way.

The research team plans to examine the courts of Henry VIII and the ceremonial significance of them.

Researchers from the University of Northampton are considering the relationship between performance and trauma and how performance can help us understand trauma more clearly. The work explores how performance might provide a means of coming to experience and therefore understand individual, world-historical and social traumata. This work will add greatly to our understanding of trauma as well as the relationship between trauma and the arts more widely.

RECREATION AND LEISURE: SPORT

THE OLYMPIC AND PARALYMPIC GAMES are due to be held in London in 2012 and as sporting competition becomes more intense, athletes are turning to new research and technology to help them optimise their performance. Humans can already run and swim faster than ever before, but to achieve ultimate sporting prowess researchers are continuing to look at how we can do even more.

CRYOTHERAPY FOR TOP ATHLETES

Top sportsmen and women need to ensure they wind down and manage their bodies properly between rigorous competitive action and training. Researchers from the University of Plymouth have started looking at the best techniques to cool the body to prevent and manage injuries. This will ensure quick recovery and a return to peak physical condition after undertaking strenuous sports activity.

In particular the researchers are looking at the use of cryotherapy techniques where low temperatures are used as a form of medical therapy to remove heat from the body to ease pain, spasms or inflammation. 'Cool down' techniques are beneficial as they help remove waste products produced in the muscle during exercise, aiding recovery and reducing pain. By cooling the muscle any heat damage and inflammation can be reduced, enhancing subsequent performance.

Initially the research is looking at competitions where swimmers may have to swim more than once in a day and therefore need to recover quickly and efficiently between races. However, the technique could apply to any high intensity sprinting sport where multiple bouts are required, so the results are likely to be useful in athletics too. The research team is being led by Matt Barlow, an Exercise Physiologist at the University of Plymouth who said: "It is important to cool the body after exercising because it allows athletes to recover more quickly, so in competitions this allows them to perform to a high standard again on the same day. Whereas if you haven't recovered properly, your subsequent performance is going to get worse. When the body is exercising the muscles create a lot of heat and this heat can actually damage the muscle, so it's important to recover from that and remove the heat which is what the ice bath does.

Rather than just having a bath with ice water tipped into it, the ice baths we are using have refrigerated systems, so you can set the temperature you want the water to be and it will control the temperature and keep it constant while the athlete is in there. This is a vast improvement on traditional ice baths because the water stays cold. With traditional ice baths an athlete is giving off so much heat, they warm the water and therefore the treatment is less effective.

We're testing the baths with international swimmers to see how it affects high performance swimmers. In competition swimmers often need to be at their peak all through the day. For example, you might have a swimmer who has a heat in the morning and then has to recover very, very quickly to allow them to perform again during the afternoon, and that's where we think the ice bath is going to have the best impact.

Ice baths are used in a wide variety of sports from rugby to athletics and football. They are starting to be used in swimming, but the issue is that people are not really sure which are the best protocols to use yet. For example are ice baths more advantageous than the normal cool down swim, which is where you swim at a low intensity after your race? Our research will hopefully answer that question."

REMOTE MONITORING OF THE BODY

Researchers at the University of Sussex, led by Professor Robert Prance have developed an Electric Potential Sensor (EPS) that can monitor signals from a person's heart without having to be connected to the body. Almost everyone is familiar with Earth's magnetic field and instruments such as a compass or magnetometer that use and detect it. However, few of us will be aware of the existence of the Earth's electric field. EPS technology is able to make use of disruptions in the Earth's electric field, caused by human movement, to track position and motion. These attributes mean EPS technology can be used by unskilled operators and so is ideally suited for use in performance sports.

The research team has tested the technology and successfully tracked the movement of a person in a room. It can also easily recognise hand movements which could make it incredibly useful for monitoring a person during sports training or motion during computer gaming.

MONITORING SPORT PERFORMANCE

Researchers at Queen Mary, University of London are developing on-body wireless sensor networks that can monitor the health of the person wearing it. These sensors are intended to provide data for use in healthcare and sport performance enhancement. This technology will enable constant monitoring of health data and access to the athlete or patient regardless of their location or activity and at a fraction of the cost of the regular face-to-face examination.

Current wireless sensor networks have issues with power efficiency and operational reliability. This new research work aims to deliver an efficient and reliable wireless sensor network capable of collecting various types of medical and physiological data, location-based information (such as 3D limb movement to millimetre accuracy) and user-centric parameters within different environments. The system will use concepts from radio sensing and intelligent machine learning algorithms to ensure that the system can adapt to the environmental requirements in which it is operating. The research is being supported by the Engineering and Physical Sciences Research Council (EPSRC).

ENCOURAGING DISABLED PEOPLE TO PARTICIPATE IN SPORT

Across the EU, countries have in place different policies to make sport more inclusive for those with disabilities. Research at Staffordshire University has sought to determine the extent to which countries across Europe have policies in place and are committed to the development of equal opportunities for disabled people in sport. The findings of this research so far show varying levels of commitment to sport for disabled people, but a shared belief that mainstream sport federations should play more of a leading role. This research is helping policy makers by establishing a set of clear directions for developing a European wide policy to give disabled people opportunities to take part in and benefit from sport.

RECREATION AND LEISURE: RECREATION

THE WAYS IN WHICH WE RELAX and take time out from our busy lives is changing. New digital technologies mean we can socialise online and connect with people who live in a different place. In the future recreation activities could have changed even more as we discover new ways of entertaining ourselves.

CONNECTING WITH FRIENDS

The rapid adoption and use of the Internet has led to the creation of various social media that enable people from across the world and various walks of life to come together and share materials and experiences. These social media have now become very much the norm in society. Social networking sites such as Facebook, MySpace and Twitter are thriving online communities. Children also actively participate in social interactions using such media and are often more familiar and comfortable with it than adults. There are risks associated with children socialising online. How can they tell who to trust? The anonymous nature of the Internet means that paedophiles have direct and easy access to potential victims for grooming and sexual exploitation purposes, potentially 24 hours a day.

The Engineering and Physical Sciences Research Council (EPSRC) and the Economic and Social Research Council (ESRC) are jointly funding researchers at Lancaster University to develop new language analysis technologies to identify active paedophiles across online communities. Paedophiles often masquerade as children in order to establish contact with potential victims and gain their trust. Distinguishing the 'innocent' interaction amongst children or amongst children and adults from such predatory advances is a non-trivial task, yet effective, early and accurate identification of paedophiles is vital for the protection of children. At the same time paedophiles may use multiple online identities and known paedophiles may move to other online social networks upon detection in one network. It is, therefore, vital that once a paedophile is detected in one network, they can be successfully detected in other networks which they may attempt to employ for grooming children.

Researchers at Lancaster University are developing new language analysis technologies to identify active paedophiles across online communities.

The software technologies being developed by the researchers can not only detect such potential paedophile activity during pro-active undercover investigations online, but also enable efficient analysis of large amounts of data from online interactions extracted from computers, mobile phones, etc. seized as part of an investigation. The inability to process such interactions efficiently currently leads to huge backlogs in law enforcement agencies dealing with such cases, often as long as nine to twelve months. This new research could change the way such cases are handled and provide more online security for children in the future.

USING COMPUTERS TO HELP US MAKE DECISIONS

Digital Behaviour Change Interventions (DBCIs) are interactive, automated packages that can give advice to users. They can provide support for behaviour change by giving personalised advice based on the user's needs, situation and preferences. They can provide support for goal-setting, planning and progress monitoring and they can give automated reminders and progress-relevant feedback and encouragement.

New research at the University of Southampton investigates the power and challenges of using mobile phones and social networking for DBCIs. The team aims to look at how to change human behaviour through mobile phone and social network technology. Previously, DBCIs have mainly been delivered by PCs and provide advice based on users' answers to questions about their past or future activities and feelings. The research team wants to develop DBCIs that work without users having to answer questions. Mobile phones can sense the users' activities, mood, location, and who they are with or talking to, while online social networks can provide information about users' attitudes and social contacts. This information can then be used to deliver exactly the right kind of messages to users at the right time, depending on what the user is doing and feeling. In the future our mobile phones could be making decisions about our day to day lives for us.

MAKING SWIMMING IN THE SEA SAFER

Surfing and swimming in the sea are popular pastimes for many people, even in the UK. However, there are more risks associated with sports in the sea than you would find in a controlled environment such as your local swimming pool. Rip currents are strong seaward-flowing currents that frequently occur on beaches and present a major hazard. Currently there is little understanding of how rip current behaviour changes at different tide times which poses a real danger to both those taking part in sport and the rescue services. New research being carried out at University of Plymouth is investigating this phenomenon to try and better predict when they might occur.

The Plymouth team are being supported by the Natural Environment Research Council (NERC) and is working alongside Royal National Lifeboat Institution (RNLI) lifeguards and crew at the popular Perranporth beach in North Cornwall. Detailed modelling work of the beach will establish a pattern which will enable the RNLI to see where and at what stage in the tide time the most dangerous rips will occur. This research will then be turned into guidance to ensure the beach is appropriately manned when the currents are at their strongest. The model for predicting these rips has been designed so that it could easily be 'ported' to other beaches.

CONNECTING CITIES

Large urban television screens are becoming part of our urban experience, forming an important shift in rethinking cities, public spaces and their social importance allowing new possibilities for social interactions and emergent shared encounters to arise.

New research at University College London is looking at the potential of connected urban television screens for communities and culture. It is investigating how the urban experience derived through connected large displays can be designed to allow real world interactions, support communities, and promote and develop culture to maximise the quality of the public experience within the urban realm.

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The research will act as an exchange platform between people in various cities and will support new forms of social interactions that are relevant to the existing local and online social communities. The project will generate greater understanding of how the urban experience (mediated through connected urban screens) can be designed to augment real world interactions through embedding multidisciplinary research directly within the community. Local authorities can benefit from learning about how the screens perform through different seasons, how they work in conjunction with surrounding users within and near to a space, and how they may be used in respect to major events either of national or local significance, such as sporting fixtures or mass participation cultural events.

THE JOY OF READING BOOKS FROM THE PAST

For many people reading a good book is a relaxing and enjoyable pastime. The UK can boast some of the most notable figures in the history of literature including William Shakespeare, Charles Dickens and Jane Austen. To ensure we can enjoy the works of these authors for years to come, researchers at the University of Oxford have digitised the handwritten manuscripts of Jane Austen's work. Thanks to new digital technology, anyone with an interest in Austen can read her original hand.

Totalling more than 1,100 pages, the manuscripts were written throughout Jane Austen's life, from childhood through to the year of her death. They were held in a single collection until 1845, when, at her sister Cassandra's death, they were dispersed. The manuscripts remain scattered in museums and private collections around the world. In collaboration with King's College London, and with the help of the photographer who shot pictures of some of the Dead Sea Scrolls, the highest quality images were taken of every page. The images were then transcribed and XML encoded to make them fully searchable – even the punctuation and the order in which Austen wrote can be analysed.

Dr Declan Kiely, Curator of the Morgan Library & Museum, New York said about the work: "This immensely rich resource breaks new ground in the online presentation of any author's manuscript materials by providing painstakingly faithful transcriptions alongside digital facsimiles. It enormously enhances remote access and amplifies the potential for new research into Austen's imagination at work."

LINKING TOURISM AND HEALTH INITIATIVES

There is a clear need to promote a sustainable healthy lifestyle and achievable exercise habits within the population of the UK. Researchers at Bournemouth University believe that one way to do this is by linking future tourism strategies with public health strategies. The key to this is creating a community culture where the tourism destination is seen to enhance and promote the physical and mental health for both local inhabitants and tourists. The introduction of bike hire schemes in major cities across the world has prompted a new social

norm and visual hint, encouraging more people to want to cycle. Running 'grids' have been developed using a GPS smart phone app which allows runners to track their run. All these initiatives help encourage people to be more active and could also act as a unique selling point for a tourist destination. This research is particularly looking at the positioning of seaside towns in Southern England, but the results of the research could then be used by other seaside towns around the UK.

RECREATION AND LEISURE: CONSERVATION

LOOKING INTO OUR PAST gives us a wonderful insight into what has shaped our lives as we know them today. Advances in technology means we are able to better preserve our lives today to be studied by the generations of tomorrow. A vital part of the future is the conservation of what will one day be the past. The following examples highlight some of the measures being taken by researchers to ensure our lives today are recording and saved for our children and grandchildren.

NEW PRESERVATION TECHNIQUES

One of the most important issues facing museums, galleries, artists and collectors across the world today is how do we best preserve and understand important artworks and objects so that we can ensure the enjoyment and education of future generations? Collections and artefacts in museums and art galleries are very valuable and if something happens to them, they can't usually be replaced.

Conservation teaching work at the University of Glasgow's Centre for Textile Conservation and Technical Art History is training students how to understand, interpret, display and preserve a diverse array of objects and artwork. Current research into preserving materials has focused on traditional materials like silk, wool and cotton but the Centre hopes to expand study to modern art and 20th Century synthetic fibres, including videotape, photographs and plastics, to ensure these materials can be preserved and treated for the future as well. The National Trust for Scotland is particularly interested in this research as they have hundred of tapestries and each one can cost hundreds of thousands of pounds to conserve. Methods from the new research will allow them to evaluate how much risk a particular tapestry is under, enabling treatment to be prioritised.

RECORDING OUR HISTORY

Researchers at the University of Aberdeen are investigating how online cultural communities are transforming the ways in which local history is 'written' and remembered. Today we live in a digital age and communities themselves have therefore become more complex and virtual. Bringing together engineers, computer scientists, geographers, sociologists, folklorists and historians, this research aims to look at how communities can be empowered to construct their own histories.

Supported by the Research Councils UK (RCUK) Digital Economy programme, this research also raises questions about how digital archives can inform identity and discussions of belonging and identity in return. The social histories of remote communities in the UK are marked by emigration and prolonged outmigration.

Research is showing that being determined to write and record information is just as important as a talent for doing so.

The development of digital technology enables local heritage archives to become a meaningful identity resource for an international community, who previously had no access to them. As tourists seek to become informed about their destinations, this kind of community activity is becoming increasingly important as a leisure and tourist attraction and could therefore feed into local business activity to help create sustainable tourism.

With people living longer, but recording information about their lives less, many people have no photographic record of their recent lives due to a move to digital mechanisms. Society today is busy. Attention spans are short, social mobility is accompanied by geographical separation and in the process much potentially valuable material remains unshared. Exploring family history is a very popular hobby, but how this information is recorded and made available is less established.

Research at Kingston University is showing that being determined to write and record information is just as important as a talent for doing so. Some of us may not be able to write as articulately as some of our great authors, but recording information about our day-to-day lives, even in a straightforward and simple way, will leave a rich source of history for future generations. The researchers at Kingston hope to encourage more people to record their history by writing more, even if the outcome of our efforts is only read and enjoyed by a small number of people. It might not make front page news, but our children and grandchildren will find our history fascinating!

REGENERATION

How can an abandoned, derelict and contaminated industrial heritage site of world significance be used to create a dialogue between the past, present and future? Researchers at Swansea University are using digital technologies and animations to explain to public audiences how the Swansea copper industry became the world's first globally integrated heavy industry.

Through a series of community-inspired practical interventions this project will bring visitors onto a key historic site, and give them a better understanding of the key role that the Swansea copper industry played in the development of the world economy. The team plan to restore 14 historic buildings or structures given over to sustainable educational, cultural, social, and commercial use. This work will have a very considerable effect upon the leisure activities of visitors and local residents, as well as upon the sense of 'place', identity and civic consciousness of those who live and work in Swansea. Regenerating historical sites is one way we can conserve our history for the next generation. The example set by the research in Swansea could be used across the UK.

Researchers at Swansea University are using digital technologies and animations to explain to public audiences how the Swansea copper industry became the world's first globally integrated heavy industry.

ROBOTS AS FRIENDS

In the future as well as our human friends, we might have robots as friends too.

Studies have shown that children are more receptive to information and recover faster when they have the opportunity to interact with animals. There are clear hygiene issues with animals in hospitals, so a new research project is looking to replace them with robots, which prove similarly fascinating for youngsters. Dr Tony Belpaeme from the University of Plymouth is leading researched to design a new breed of robot, one able to form memories and engage in social interaction.

In technical terms, the project will look at how it is possible to overcome the traditional limitations of artificial intelligence in robots. It will do this by using cloud-computing to give the robot access to more data and computer power. Cloud-computing gives computers access to much more data without having it saved on its own hardrive. By using such techniques the robot will be able to draw on a lot more computational power and build up a degree of social cognition – essentially enabling it to create memories and engage in an ongoing 'relationship' with a person. The robots will act as a companion and communication

channel, facilitating a more open and imaginative dialogue between patient, parent and hospital staff. This is why it is so important to develop a robot that can participate in social interaction to a more realistic degree and remember not just faces, but emotional states. This will enable a more engaging relationship to be established.

ONLINE COMMUNITIES

Researchers from Kings College London are building a new community online. Strandlines is about past, present and creative lives on the Strand in London.

Creating a digital community through developing a website comprises a different kind of 'virtual' community where individuals and groups can learn and understand more about each other in ways that would otherwise not be possible. Participants include local residents; elderly and homeless people in the area; academics; a group of artists; staff and student members of King's College London; representatives of cultural institutions around the Strand; as well as interested parties world-wide.

Strandlines aims to create and enhance community in a part of London that is both central and local. The Strand is a street with a rich history, yet one which is undersung in the present day. The project illuminates the contemporary nature of urban life, especially for people such as the homeless whose voices are not usually heard. Through audio diaries, interviews, and personal stories from these often marginalised groups, it explores relations between the past and present in the texture of urban life and promotes a creative community shared by a world-class university and those who live, work and play in its locality.

The project has so far created a wide range of exciting ways to find out more about the community from audio diaries to drawings by local people; stories about the past as well as the present; walking tours and imaginative recreations of place. Each set of contributions deepens local understanding of and attachment to place which, in turn, helps extend knowledge of local communities within the area.

RECLAIMING BROWNFIELD LAND FOR COMMUNITIES

Brownfield is land that has previously been developed, sometimes for industrial purposes, as opposed to greenfield, which has not been developed. Low value brownfield is of less interest to developers and is often situated in the heart of a community. A new research project led by Dr Karen Johnson from Durham University is hoping to bridge the gap between engineering, public health and social science by considering the health and social impacts of the small, low-value brownfield sites they aim to regenerate.

The project will engage with local communities and use sustainable technologies to reclaim low value brownfield that is currently marginally polluted. Supported by the Engineering and Physical Sciences Research Council (EPSRC), clean recycled minerals will be dug into the soil, helping to make the low level pollutants less harmful and to enable the land to be used productively in the future. Once it has been shown that the process of regeneration works and is not harmful, communities will be able to be involved in the digging in of the minerals. This much improved environment may then provide opportunities for further community activities, for example green exercise. Removing pollution from brownfield land may also help people gain a positive perception of their community and come to appreciate it more. In the future it may be possible to use waste materials to provide a cheaper, safe means to remediate low-level contamination of brownfield, benefitting communities across the UK and beyond.

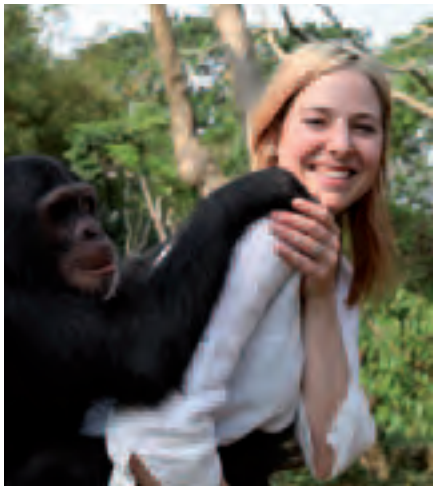
ENHANCING THE CULTURAL HISTORY OF TOMORROW

In the 1920s Kegan Paul launched an ambitious book series called 'To-Day and To-Morrow'. Over 100 contributors were charged with describing the current state of their fields – which ranged from cosmology to cookery, juvenile delinquency to opera, politics to humour, sexuality to automation, genetics to flying machines and then to predict how those fields would develop over the next 50 years or more.

A new research project at Kings College London builds on that original series, to assemble a network of experts and commentators to repeat the experiment for the 21st Century, to produce a collective and co-ordinated act of social and intellectual futurology. The researchers, led by Professor Max Saunders, hope this will enhance our understanding of how predictions are made and in the long-term contribute to better futurology in future. To consider such past futurology alongside contemporary projections about, for example, genetic modification has the potential to help us understand not only why we envision the futures that we do, but also why we don't envision those we don't (but which may still happen).

CHAPTER 4

THE FUTURE OF HUMANITY AND SOCIETY



DR ALICE ROBERTS
ANATOMIST, AUTHOR AND BROADCASTER

HUMANS ARE INGENIOUS CREATURES. Our species has benefited enormously from our natural predisposition to copy each other and share ideas. Our culture is cumulative, with each generation building on what went before. Anthropologists have argued that we are the most social species on the planet, and that our success depends on that sociability, and on our inherent tendency towards copying and co-operation. We don't just share physical things with each other, we share our minds.

Recent research into population genetics and archaeology has revealed that population density and migration have been crucial to the propagation of ideas in the past, helping to produce a 'cultural ratchet' effect, where cultural (including technological) advances accumulate over time, helping to support a growing population. Increasing population density, in turn, makes it more likely that new, good ideas will take root and flourish. This demographic approach may help to explain why, when and where we find archaeological traces of the emergence of so-called 'modern human behaviour' – such as art and body decoration, advanced stone tools, and bone and ivory artefacts. The digital revolution takes the meeting of minds to a new extreme: in the age of the Internet, ideas can quickly go global. Cultural evolution no longer depends on physical population expansion or migration if ideas can be transmitted virtually.

Our species has been so successful, thanks to culture and technology, that we are now rightly worried about the degree of our success. Now that there are nearly 7 billion of us (and still growing) on the planet, the natural resources that we have exploited so readily in the past start to look decidedly limited. This crisis has provoked some very pessimistic predictions about the future of humanity. Whilst we need to take concerns about environmental destruction, climate change, and finite resources very seriously indeed, I agree with Matt Ridley that there are grounds for rational optimism. In developed countries – even in the current economic climate – our lives are much longer and healthier than our ancestors'. We are also able to support people whose work is not immediately relevant to us. These people are not keeping us healthy right now, nor putting the food on our plates, clothes on our bodies, or building houses for us. But we support them because we believe, as a society, that they are working to secure our futures, and those of our children.

This is why some of our taxes – perhaps not enough – is used to support publicly-funded science. Stopping science and technology right now would be to deny the improvement in length and quality of life that cultural evolution has provided in the past. Conversely, investing in science gives us the greatest chances of improving the human condition still further, and turning this into a global phenomenon. Science also offers us the hope and expectation that we may overcome the obstacles that threaten, not just humanity, but also many other forms of life that we share our planet with.

It could be argued quite coherently that all publicly-funded research in the UK will have an impact beyond the laboratories, universities or institutes where it is carried out. But this chapter introduces a range of projects which have been specifically designed to tackle questions about the current and future state of our society. Some of these projects are embedded in the physical sciences, aimed at exploring new technologies, or new applications of existing technologies. But the success of exploiting new technology requires that we understand our societies well, and appreciate the complexity of human culture, so some projects fall within the domains of the social sciences, arts and humanities.

Our ageing population presents us with major social and economic challenges. Across the world, pension age is increasing, and this is often seen in a very negative light. But it seems that many older people would like to continue working – as long as that work is fulfilling and flexible. Older people represent a considerable resource in any society: a valuable fund of experience and skills. Businesses could benefit enormously from a much more positive attitude towards their older employees. Aside from paid employment – and arguably even more important – research is emphasising the important role of grandparents. The effect appears to go way beyond childcare, including helping children to cope with difficult family situations. Grandchildren with involved, proactive grandparents are less likely to have emotional and behavioural problems than others.

Maintaining physical and mental health into old age, and supporting those with needs, is an enormous challenge for our society. Some of the projects included in this chapter are aimed at collecting information: looking at the relationship between ageing, diet and nutrition, and mental health, for instance; gathering an unprecedented body of evidence about the wellbeing of people in nursing homes across Europe; investigating how couples living with dementia might be supported in such a way that their autonomy is respected and protected. Some research involves innovative use of technology. One project, looking at people living with chronic pain, includes the collection of detailed data using a vest containing embedded sensors, and a tiny camera which records a visual diary. Another project explores how telecommunications technology could revolutionise healthcare for the elderly.

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'Telecare' could form an alternative, more accessible, means of consulting a clinician – from your own home. Other research is looking at the potential for active computer games, to help us to stay fit and healthy into old age.

The second major theme in this chapter is crime and justice. Some projects deal with the experience of those in custody, including their mental wellbeing, and the risk of re-offending. Other projects explore broader social issues: looking at the complex relationships between mental health, crime and justice, for instance; exploring how punishment, deterrence and rehabilitation could be balanced in criminal policy, and even how sentencing might be made more objective.

At the other end of the spectrum in this general area, scientists are looking for applications for new technologies. Whilst physicists are working on making science fiction into reality – using metamaterials to weave an actual 'Invisibility Cloak', chemists are close to developing a simple test for drugs in saliva samples, which could help police to identify drug-drivers.

Research in the field of education explores the importance of new technology to the next generation of learners. New techniques may challenge old paradigms and traditional views, forcing us to look again at how teaching and learning could happen in our society. One project brings together older people and children in a virtual meeting place, using digital technology to facilitate access to knowledge. This goes back to the roots of humanity, but has the potential – with modern technology, to become a global phenomenon.

Some research tackles the potential for novel lifestyles and habitats in the future, investigating possibilities in ways that take ideas beyond mere thought-experiments. Could living on a floating island or in an underwater dome be a realistic possibility? Such environments would carry great technological, physiological and psychological challenges, but relocating humans underwater or on floating islands could free up land for agriculture and for the regeneration of biodiversity. How about urban biospheres: self-contained, sustainable human habitats – with forest-gardens and worm-farms – in our cities?

An important theme within this chapter turns the focus on us, looking at attitudes within our society. We need to understand ourselves very well if we are to implement policies, adopt technologies, and embrace lifestyles that will benefit us in the future.

Some projects look at global issues, investigating environmental, political and cultural challenges facing us. A project in Kenya investigates the feasibility of a scheme to alleviate poverty and protect an important ecosystem, mangrove forest. Another project – which aims to challenge stereotypes – is looking at welfare and social equality in the Middle East, investigating how policy and practice has been shaped by Islam. Closer to home, other projects are focussing on causes of deprivation in refugee, asylum and migrant communities; asking whether charity campaigns could be guilty of instilling in children not just a sense of compassion, but of superiority – which could later turn into prejudice and racism; and the evolving nature of UK democracy. One project that seems relevant to our immediate future considers preschool children and their families. It seems that we need to catch up with the way our families have changed, and that the role of the father in child development is more important than current attitudes and policy acknowledges.

I hope that, as you read the descriptions of these projects, you too will be inspired by a sense of rational optimism. Ultimately, all of this research has been funded because it is believed to contain the potential to increase our collective wellbeing. Some projects will provide evidence to help us make sensible decisions about our current society, and where it is headed, whilst others will ultimately provide us with new tools and new technology, to improve lives now and in the future.

HUMANITY AND SOCIETY:
THE FUTURE OF LIVING

THE WORLD'S POPULATION is predicted to double in the next 50 years and that will mean more people to house and feed. It will also mean we need to ensure there will be resources such as energy, water and food to help future populations survive. Today we live in houses, supplied with power and water, which when compared to how our ancestors lived is quite remarkable. But what if rising sea levels mean there is less land available to house people or to graze cattle and grow food? How will we survive if the earth becomes less hospitable than it is today?

As futuristic as this scenario might sound, it is something researchers today are considering very seriously. If we don't address these potential issues now, there might come a day when it is too late to do so.

LIVING ON OR UNDERWATER INSTEAD OF ON LAND

Researchers at De Montfort University are considering whether it is possible for humans to live not on land, but on or under the sea. The Intergovernmental Panel on Climate Change (IPCC) predicts that human displacement through environmental factors is inevitable and will create many additional challenges for our planet. The research was initiated by PhD student Pamela Boardman, under Professor Peter Ford. She is working to develop underwater or floating human settlements that would free-up land for agricultural use and help reduce land-based population. This would reduce the strain placed on natural resources, such as fuel and water, and help natural ecosystems recover from human intervention. The predicted window of opportunity for solutions to World overcrowding and food shortage is unknown in absolute terms. However, expert opinion strongly suggests that there is an urgent need to research and plan for the future.

Research will explore the use of sustainable integrated systems, to deliver all human needs within an 'alien' environment.

The researchers at De Montfort plan to investigate whether it is feasible to build self-sustainable underwater or floating human settlements. They have already established the design performance specifications to meet basic human physiological and psychological needs within such an environment. Further research will explore the use of sustainable integrated systems, to deliver all human needs within an 'alien' environment and how to provide sustainable energy and life support sources with maximum efficiency and self-sufficiency.

BIOSPHERIC URBAN DWELLINGS

With the same future scenario in mind, researchers from Manchester Metropolitan University are considering whether the cities and towns of tomorrow can be more biological. The research team are looking at designing human settlements and agricultural systems that mimic the relationships found in natural ecologies. Called biomimicry it is the examination of nature, its models, systems, processes, and elements that can be copied or used as inspiration to solve human problems.

In the future, cities will become more biological. Urban systems such as food and waste will mimic natural processes. If successful the research could mean that, from around 2020 both biological and non-biological technology will emerge to change the world as we know it by creating biospheric urban dwellings. The aim is to create stable, productive food, waste and dwelling systems that provide for human needs, harmoniously integrating the land with its inhabitants.

The research team will test their theories by creating a small forest garden on a plot of land in Manchester where they will analyse the process of creating compost using earthworms, which is known as vermiculture. This research will give a new perspective on how we can implement urban permanent and sustainable eco-systems in the 21st Century and beyond.

ENSURING THERE IS ENOUGH DRINKING WATER FOR EVERYONE

The United Nations estimates that by 2050, four billion people in 48 countries will lack sufficient water. As 97 per cent of the water on the planet is saltwater, large-scale technologies to make seawater or other contaminated water drinkable are therefore needed urgently. New research at the University of Warwick is looking at how to extract drinking water from the sea to prepare for a world parched by climate change.

The research team aims to deliver a new technique for simulating fluid flows at the micro and nano scale, which will be used to distil and purify sea water, to make it suitable for human consumption. Early indications show that membranes of carbon nanotubes have remarkable properties in filtering salt ions and other contaminants from water. However, to enable the development of these technologies, it is essential that the fluids engineering is accurate and reliable. At the moment, very few tools exist to help engineers and scientists to understand and simulate such 'non-equilibrium flows'. This new research will help to bridge that gap, so that it will become possible to engineer the new technologies needed to solve problems such as future drinking water supply.

The research team includes Dr Duncan Lockerby from the University of Warwick who is working with Professor Jason Reese from the University of Strathclyde and Professor David Emerson from Daresbury Laboratory in Warrington. The research is being supported by the Engineering and Physical Sciences Research Council (EPSRC), as well as key industrial partners.

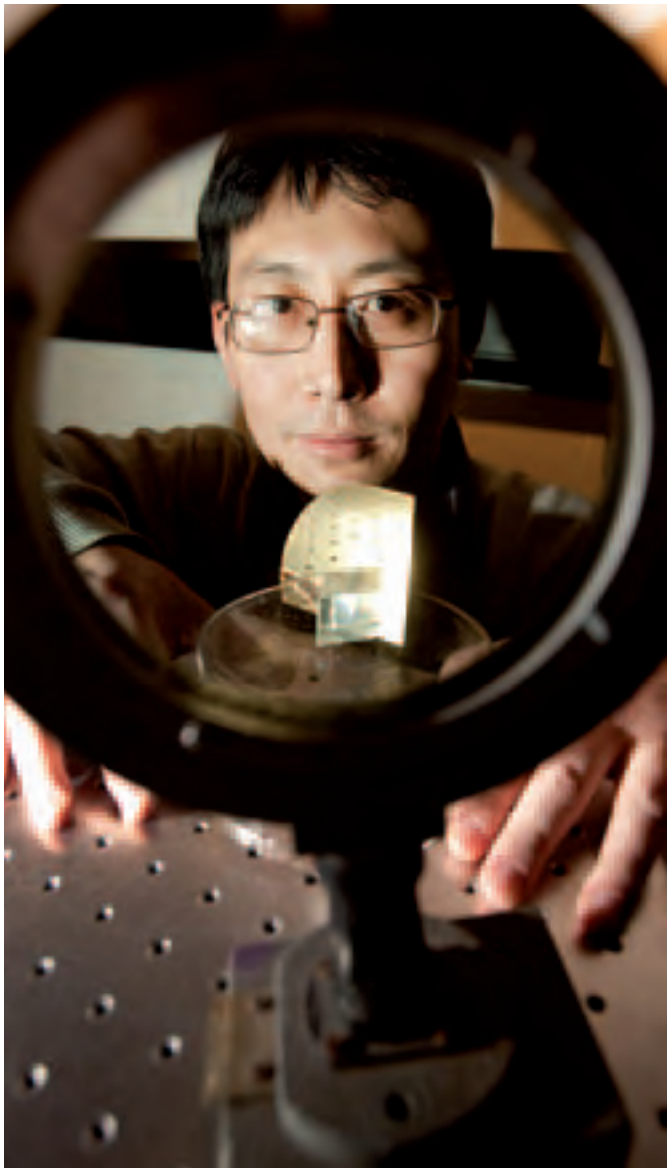
HUMANITY AND SOCIETY:
CRIME AND JUSTICE

AS TECHNOLOGY BECOMES MORE ADVANCED, criminals become more sophisticated in their methods. Law enforcement needs to keep up pace to ensure criminals are caught and brought to justice. We are also using more hi-tech methods to protect ourselves from threats such as international terrorism.

THE INVISIBILITY CLOAK

It might sound incredible, but the technology to produce invisibility cloaks is not just a work of fiction. Researchers at the University of Birmingham, led by Dr Shuang Zhang, are working to make this a reality. The technology they are exploring is metamaterials which are artificial materials made up of cells much smaller than the operating wavelength, in other words, so small they can't be seen by the human eye. Optical metamaterials are still far from reaching their full potential mainly because the fabrication techniques needed to make them are limited, and the materials from which they are made suffer from optical loss which means they do not work in the right way.

This new research will make real many important applications in the future. In the next few years, highly nonlinear and low loss optical metamaterials will be used to achieve ultra high speed information processing and optical communication. In the next 10 years, superlens made of metamaterials may enable biologists to see viruses of sizes much smaller than what can be resolved using conventional microscopes, therefore bringing significant changes to the medical sciences. The metamaterial invisibility cloaks, which are expected to be scaled up to hide large objects in free spaces in the next few decades, will bring revolutionary applications for security and defence.



CATCHING DRUG DRIVERS

It's difficult to say how widespread the problem of drug-driving is because, until now, there has been no reliable method of testing for the presence of drugs in a person's system at the roadside. Now chemists at the University of Oxford have developed a simple test that could help. Led by Richard Compton, the research group has created a device which uses electrochemical processes to detect the presence of drugs. All that's needed is a saliva sample which is then placed in the device. The drug present in the sample reacts with the coating on the sensor, providing a measurable electrical current (presented as a sound or a signal) that indicates how much of a drug is present in the sample.

The detector is quick, easy to use and incredibly reliable. So far, the team have developed sensors capable of detecting cannabis from just a three millimetre diameter dot of saliva, but they have plans to extend the technology, and a sensor capable of detecting amphetamines is already in the pipeline.

USING THE ARTS TO STOP PEOPLE RE-OFFENDING

It is no secret that many criminals re-offend on leaving prison. Prisons aim to reduce individuals' risk of reoffending through education and other programmes, but often these kinds of formalised courses can seem like a replica of what put them off education in the first place. Poor educational achievement is statistically associated with risk of re-offending. In contrast to this, there is much anecdotal evidence that suggests arts-based programmes might help re-engage some of these offenders and help lead them into formalised education courses and towards non-offending futures.

Laura Caulfield at Birmingham City University is researching a number of arts-based projects with offenders in prison. In particular she is looking at how offenders may be assisted in working towards non-offending futures by improving their engagement with education, social-skills, and anger management. The research is focused on a range of arts projects, including music, art, and drama. The evaluations are on-going, and have been used by the Arts Alliance as evidence in their campaign to highlight the impact of such work with offenders.

CRIMINAL JUSTICE AND PUNISHMENT

The ways in which crime is punished has changed dramatically through the course of history. Today, punishments are more humane and consider in more detail the most effective way to punish an individual that gives justice to the victim.

Research at Newcastle University is considering criminal justice policy and what the best approach to this is. Different approaches to criminal justice have conflicting aims. For example, retribution might demand we punish only the guilty to the degree of the wrongness of their act, but this could clash with deterrence because a better deterrent effect might arise from punishing more or less severely.

However the researchers at Newcastle are considering a unified theory of punishment. This would be a logical theory of punishment that accounts for the potential future dangerousness, deterrence methods, and criminal rehabilitation of offenders. These problems cut to the heart of our criminal justice public policy decision-making and should be taken into account when we decide how justice should be served. The difference in the future may be very significant not least in offering an entirely new approach to thinking about punishment, as well as a model for use in sentencing by judges and magistrates.

WELLBEING OF PRISONERS

Research into the impact of prison visiting on offenders' health outcomes is limited. Although only five per cent of the prison population are female, women in custody are five times more likely to have a mental health problem than women in the general population (Prison Reform Trust 2010). Social relationships and family ties are protective factors against mental distress, yet few researchers have focused specifically on the relationship between visiting schemes and the impact visits have on women's mental wellbeing. The social and emotional needs of older women in custody are rarely taken into consideration; with little known about the impact of custodial care and the importance of visits for older women's mental health.

Now researchers at Nottingham Trent University are exploring the extent to which visits to women offenders in custody can improve mental health and wellbeing. They hope this will identify the training needs of visitors in respect of mental health awareness. This research will increase understanding of the potential impact of prison visiting on women's mental health and develop training materials to help prison visitors be more aware of emotional health issues and how to respond to these appropriately.

In addition, the Institute of Mental Health is working with researchers from the University of Nottingham to consider the provision needed for mentally ill offenders in prison. A clear link has been found between childhood disturbance and mental illness in adulthood. There is also evidence that a small proportion of offenders are responsible for a disproportionate number of offences. These factors are not only associated with a loss to the individuals directly concerned, but have a wider impact on society. However, there is evidence that these cycles can be broken with strategies to improve educational and employment opportunities for mentally ill offenders.

To bring together research and agencies to address this problem the Institute of Mental Health are developing a Centre for Health and Criminal Justice. The new Centre will mark a major national development in the understanding of and provision for mentally ill offenders. These offenders are often the most marginalised from current service provision and cost the most in terms of societal impact. Mentally ill offenders require a multi-professional and across agency approach. The Centre will be unique in uniting agencies, government policies, academics and practitioners. This highly innovative Centre will be housed within Nottingham's Institute of Mental Health, and will carry out clinically focused and practically designed research to provide the evidence on which a new generation of services will be built.

HUMANITY AND SOCIETY: AGEING SOCIETY

AS LIFE EXPECTANCY INCREASES UK universities are investigating how we can make sure that, in living longer, we have a fulfilling old age. To support and sustain the older population researchers are looking into all manner of things including care for the elderly, the value of the older population to our society and how we can ensure we remain empowered to live our lives into our twilight years.

WORKING IN OLD AGE

As the retirement age edges upwards, more people than ever before will need to continue working into their 70s and sometimes even 80s. Older workers could prove to be a new and unique resource for businesses. For many companies this will be the first time they have ever had employees who have working lives stretching back 50 years or more. If handled properly, their experience and knowledge could be invaluable.

Professor Richard Ennals from Kingston University thinks that businesses should regard their older workers as a valuable resource, rather than assuming that age necessarily implies medical problems. He also suggests that automation of business functions, down-sizing and early retirement often lead to loss of workers whose knowledge is vital to the smooth-running of an organisation. "Unfortunately, this is often not realised until after they've gone, but if handled properly, these older workers amount to a new and unique resource," he explains. "Today, though, many older workers feel the world changing around them, without being able to participate in decision making." Professor Ennals' research is considering how best to address the pressures felt by older workers. This includes considering the effect of moving older workers away from the most stressful front-line roles or offering workers paid leave of absence to care for elderly sick parents. If we are to be productive in our old age, we must be supported by the businesses who employ us.

> 'Today, many older workers feel the world changing around them, without being able to participate in decision making.'
>
> Professor Richard Ennals

A recent survey conducted by the Centre for Research into the Older Workforce found that 80 per cent of workers aged 50 to 69 would like to delay their retirements if work was made more fulfilling and made to fit their lifestyles better. Quality work can therefore be an integral part of active ageing. A team of researchers at Middlesex University are being supported by the Economic and Social Research Council (ESRC) to consider workplace age and retirement policies in a variety of organisations. The research aims to produce a career development system with which employers can assess their human resource management policies with a focus on improving the quality of working lives for older workers and making delayed retirement more attractive. The research team hope the resultant system will have direct relevance in shaping meaningful HR policies and practices for other countries also facing ageing populations. Such a system will be culturally and institutionally sensitive and will enable managers to create and implement relevant policies and practices which take account of individuals' abilities and work expectations rather than generalised 'one-size-fits-all' assumptions predicated on age or generations.

As well as being assets in the workplace, the older generation are assets in the community. Researchers at the University of Lincoln are examining the social factors that support the promotion of older people as 'assets' within their community. There is growing concern that future services will not meet the increasing future needs of older people and that there is a need to improve services and opportunities. This research will develop a framework to support an understanding of an asset approach including how they can be built and strengthened. Asset building promotes wellbeing by building social capital, which has strong similarities with positive social and health outcomes, wellbeing and resilience. It is intended to promote face-to-face community networks, encourage civic participation and citizen power.

HAVING A HAPPY OLD AGE

It's reassuring to think that we can all expect to be well looked after in our old age. Researchers are working hard to maximise the impact of care in later life to ensure everyone has the opportunity to have a fulfilling and happy older age.

LOOKING AFTER OUR BODIES

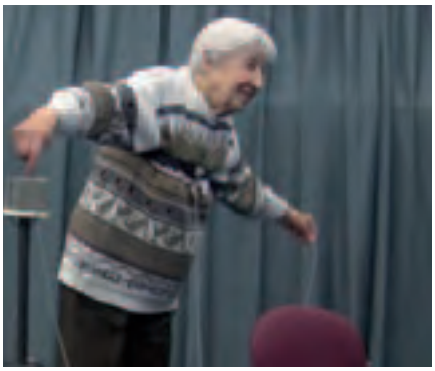
It is well known that exercise is helpful throughout life to help preserve key functions such as strength and balance that help to support high quality, independent living. Older people are often prevented from accessing exercise activities for reasons of health, cost and transport or because the activities may not be age or culturally appropriate. As well as losing exercise benefits, they are also deprived of the associated cognitive and social stimuli. Researchers from Sheffield Hallam University have designed a computer interface that allows older people to exercise and receive physiotherapy in a virtual way. The interface detects the users' actual movements and uses them to trigger appropriate movements of an avatar (the user's representative in the virtual world). For example, to walk the user marches on the spot, to fly they flap their arms and lean in the appropriate direction. The ease-of-use, age-appropriate virtual activities and social nature of the world encourage older people to participate.

Whilst not being designed as a replacement for real-life interaction, the system developed by the researchers allows older people, unable to access conventional provision, to benefit from exercise therapy and social interaction. In addition to the use of this system for recreation and therapy, it can also provide an intuitive way to access a variety of essential online services including social and health care, shopping and life-long learning.

Keeping fit and healthy is one way of looking after ourselves in old age. Another common problem for older people is chronic pain. The Medical Research Council (MRC) is supporting researchers at Northumbria University who are trying to understand the consequences of ageing with chronic pain. Through this research they hope to develop new ways in which older people can possess the knowledge, skills and confidence to live independently at home in the presence of self-managed pain.

Self-management is an important approach to enabling older people to live well with pain, but there is still uncertainty around the most effective form of self-management, or how to give people the right information about this. The researchers at Northumbria have developed two pieces of technology to help solve this problem. 'Life-shirt' is a 'vest' worn by the user and gathers physiological information, including, electrocardiograph (ECG) and blood pressure readings. This technology will be used to monitor body positions and movement of people, as well as physiological reactions to their functioning. 'Sense-cam' is a camera which is worn around the neck. Once turned on the camera automatically takes pictures from the viewpoint of the wearer. The device acts as a visual diary and will be used each day to gather an overview of a person's environment and social interactions. The data gathered by this technology will be used to gather valid and reliable information about how older people function with chronic pain.

Researchers have designed a computer interface that allows older people to exercise and receive physiotherapy in a virtual way.



CARING FOR THE ELDERLY

As we get older some of us may have to rely more on our family, friends and possibly healthcare staff to care for us.

Bucks New University is leading the research and development element of a new telecare centre of excellence in Aylesbury, Buckinghamshire. Telecare is the use of information, communication and sensor technologies to deliver health and social support to people in order to help them live as independently as possible in their old age. The new centre of excellence will help businesses and academics identify and develop the next generation of telecare products and services, with design input from service users and user groups. The Aylesbury centre is focused on support for 'fragile individuals in the home', including the elderly, disabled, and those with chronic conditions. It allows patients to be cared for in their own home, uses monitoring techniques which can help detect diseases earlier and is low cost to patients because it reduces the need for time off work. If successful, the model for the Centre could be used in other locations across the UK to provide care and support for people who need it most.

Sometimes our age or medical conditions mean we can no longer be cared for in our own homes. Measuring the quality of long-term care is important to establish standards of care quality. Several countries collect these measures using standardised and mandatory patient assessment systems, but Europe has only limited experience in measuring quality and setting performance standards. Researchers at the University of Kent are conducting a study to measure all aspects of an older person's wellbeing, from their psychosocial status to cognition and mood, disease and health status, medications, treatments, their leisure activities and social supports. The study will also measure all aspects of the nursing home, from the number of beds and residents, to payment regimes, presence of special care units, facilities for leisure and shared time, staffing hours, numbers and turnover, education and skills. The researchers hope the study will result in an evidence-based set of quality indicators for the health and wellbeing of nursing home residents. It will provide information for measuring quality and setting performance standards.

Measuring the quality of long-term care is important to establish standards of care quality.

SUPPORT FOR FAMILIES AFFECTED BY DEMENTIA

Dementia occurs when the brain is affected by specific diseases that cause memory loss, confusion and loss of speech. There are various different types of dementia, but the effects of the condition and its impact are the same. Today there are about 750,000 people in the UK with dementia (Alzheimer's Society). Research at the University of Bradford is looking at the social process of everyday decision-making by people with dementia and their spouses and the effects of social factors on their decision-making. The research aims to develop a better understanding of how couples living with dementia make decisions on a daily basis. It is hoped the study will inform debate on decision-making by couples living with dementia, the decision-making abilities of people with dementia themselves, and the particular forms of support which can be offered to them. The research should help us gain a better understanding of the actual decision-making abilities of people with dementia and how to actively involve them in decision-making processes.

THINKING ABOUT DEATH

From the 1890s Britain began to lead the world in the popularisation of modern cremation. From the 1990s something similar may have also been born in terms of what is variously called 'woodland, green, or ecological burial'. Research at the University of Durham is looking at why people choose to bury their dead at a particular site or chose a particular site for their own future funeral. Various assumptions have been made about why this is including whether British interest in nature and gardens is the reason, or the obligation felt by families of the deceased, or perhaps simply because tradition dictates this course of action.

The research team at Durham have interviewed bereaved relatives, managers, and funeral professionals associated with a site burial to determine the decision making processes and discussions that take place over aspects of contemporary death and funerals. The overall aim of the research is to create more in-depth discussions about this significant and important issue in life. How we make decisions about burial and the end of our lives could change in future and questioning our reasoning behind it now could have an impact on the way we bury the deceased in the future.

Planning for the end of our lives may seem a morbid thing to do, but at some point it will affect us all. Researchers from the University of Nottingham have developed a training programme to prepare volunteers to undertake community based education for advance care planning and end-of-life care issues. One of the greatest changes of modern times has been the occurrence of death at older ages and in connection with long term chronic illness. However, the rise in chronic long-term conditions means that it is often difficult to determine when a person is 'dying'. As a result there may be a lack of discussion about end-of-life care decisions and a delayed move to palliative care.

Lack of openness in society about death and dying compounds this problem and has negative consequences for the quality of care that people facing life limiting illness receive. Palliative care focuses on quality of life and helps people plan their move to end of life care. It can be provided alongside treatments focused on extending life and containing disease.

The rise in chronic long-term conditions means that it is often difficult to determine when a person is 'dying'.

'Advance care planning' allows people to express and record their views about treatment choices to ensure they receive the future palliative and end of life care and treatment they want. Given the host of complex cultural issues associated with death and its anticipation, the researchers want to encourage communities to share knowledge and discuss more the wider range of issues surrounding end-of-life care. Planning for our death does not mean we will enjoy our lives any less, but it will mean that we can be reassured that our last days will be as comfortable and happy as possible.

THE FIRST STEPS TO UNDERSTANDING SOCIETY

In 2009, the year when Britain officially entered recession for the first time since 1991 and the Copenhagen climate summit ended in more questions than answers, the world's largest study of households, *Understanding Society*, was begun and its first findings were published in early 2011. The study is funded by the Economic and Social Research Council (ESRC) and run by the Institute for Social and Economic Research (ISER). It offers an unprecedented insight into 40,000 UK households as they respond to regional, national and international change. As a longitudinal study it follows individuals over time, regularly collecting data about each participant and his or her household to provide a unique and enduring window on British society in the 21st Century.

From the first findings we learn how bullying often begins at home and how certain social groups are excluded from some types of social participation; who gets the best night's sleep and how where you live can affect your life chances. Looking forward the study will continue

to contribute to our understanding of how households and families are changing. Analysis of the stability and shifts within a family's home will be supplemented with information on kin and friends outside the household to examine social support opportunities and the balance of formal and informal provision of social care.

In the first wave of results, 60 per cent of young people said they are 'completely satisfied' with their family situation, but in families where the child's mother is unhappy in her partnership, only 55 per cent of young people said they are 'completely happy' with their family situation – compared with 73 per cent of young people whose mothers are 'perfectly happy' in their relationships.

Perhaps unsurprisingly, the study found that people's employment status during the recession had a major impact on how they coped financially. 40 per cent of the unemployed reported finding it quite or very difficult financially, compared to 25 per cent of the economically inactive and less than 15 per cent of those in work. Employment status also affects people's life satisfaction. Those in some form of employment reported a life satisfaction average of 5.3, on a seven point scale, while the unemployed and the economically inactive have the lowest average life satisfaction of 4.7 and 4.8 respectively.

Commenting on the findings, Dr Mark Taylor at ISER said: "This first look at employment and unemployment during the recession, and their impacts on financial and mental wellbeing has revealed a strong relationship between labour market status and age, education, family status and ethnicity. The high levels of optimism among the unemployed in relation to their financial situation improving are surprising and it will be interesting to see how this evolves over time."

Due to the changing labour market, questions about wage determination and job matching, job qualities and how these relate to global processes such as migration, will be useful for understanding the balance of paid and voluntary work, as well as the dynamics of the work-life balance.

Understanding Society will make major contributions to the study of changing patterns of economic opportunities, including the prevalence of persistent poverty and social exclusion. This will continue the work of previous longitudinal studies such as the British Household Panel Study (BHPS) that examined how individuals' and families' income and pay changes from year to year. The Research Centre on Micro-Social Change used data from the BHPS which has led to a far better understanding of how poverty and low pay persist, and the factors influencing social mobility. The findings have informed policies for combating child poverty, the reform of the UK tax system, and the Department for Work and Pensions' Opportunity for All programme.

> 'The high levels of optimism among the unemployed in relation to their financial situation improving are surprising.'
>
> Dr Mark Taylor

Part of *Understanding Society's* plan of research is motivated by understanding the effects of state policies. For example, it is important to trace the impact of government responses to economic stress in the form of deregulation and reduction in the protection offered by the welfare state.

As *Understanding Society* grows and develops over time it will also support research on a wide range of questions relating to environmental change, and how individuals and households organise to support their environmental preferences and values. According to the first findings people with degrees are 25 per cent more likely, on average, than people with no educational qualifications to adopt pro-environmental behaviours, at least in terms of paying more for environmentally-friendly products. Yet, they are less likely to turn the TV off overnight, to switch off lights in unused rooms and to use public transport rather than travel by car.

Commenting on the findings Professor Peter Lynn at

ISER added: "These initial findings suggest that people's behaviour is motivated by considerations other than environmental concern such as income and personal resources. These motivations need to be better understood if policy makers and civil society organisations looking to change people's behaviours are to make any genuine headway. There clearly remains across all sections of society a considerable reluctance to take part in environmentally-friendly behaviour that has a personal cost, even though the importance of doing so is recognised by the majority of people."

The study can also address issues concerning diversity which are of increasing salience for public policy and the understanding of UK society. Diversity is defined in terms of a range of cultures, practices and identities: class, ethnicity, gender, sexual orientation, citizenship, national identity, age group, disability status, consumption and lifestyle groups. It is important to understanding the impacts of inequalities associated with this diversity for life chances and for social cohesion.

Interdisciplinarity is also another area in which this research is breaking new ground. The study will capture biomedical data on 20,000 participants and place this alongside rich social histories, helping us weigh the extent to which people's environment influences their health. Through the collection of appropriate biomarkers and objective health indicators, *Understanding Society* will provide the basis for understanding the interactions between biology and environment in the formation of health and other outcomes and behaviours.

Further waves of results will be used to examine the formation of well-being over the life cycle. This includes the effects of health and also economic factors of income, savings, asset accumulation, and pensions on the economic and social well-being of older persons. The study gives opportunities to examine different definitions of well-being, ranging from traditional economic measures based on income or consumption and more subjective measures of happiness and satisfaction. These findings are just some

Part of *Understanding Society's* plan of research is motivated by understanding the effects of state politics.

of the potential research areas that *Understanding Society* could produce results in, but its realisation depends on large numbers of researchers taking up the opportunities the study offers. It will be up to these researchers, along with the users of research to shape the actual agenda.

Understanding Society builds on the achievement of the highly successful British Household Panel Survey (BHPS) which is heavily used by government departments and by researchers within and outside the UK.

The ambitions of *Understanding Society* go well beyond what has been achieved with the BHPS to support a much wider range of research. The BHPS has been accessed by more than 2,000 users, including researchers within and outside the UK, and generates more than 150 publications per year. It is an important addition to the UK's rich portfolio of longitudinal studies and continues the UK's contribution to an international network of household panel studies.

HUMANITY AND SOCIETY: SOCIETAL ATTITUDES

OUR MULTICULTURAL SOCIETY MEANS that we enjoy a mixture of cultures and traditions. As the population becomes more diverse, our attitudes and opinions will become more informed by society around us. The way we perceive other countries, politics and situations around the world will evolve.

Research at the University of Kent is exploring the problems of poverty and human deprivation and what positive social action is being undertaken to advance social justice and social equality in the Middle East. Supported by the Economic and Social Research Council (ESRC) the research is considering the idea that issues of social justice, poverty, equality and freedom are rarely discussed in academic and media circles in the West from the point of view of the people in the Middle East. The recent uprisings in the region underpin this view and emphasise how very little is known about what social welfare provisions countries of the region provide for their citizens. The researchers hope their work will expanded the horizons of social policy in the UK. Working closely with policy makers in government ministries as well as heads of poverty programmes in the major international institutions such as the World Bank and UN, the researchers are hoping that their findings will be of use in policy making. Overall, the research aims to offer a fuller, more human view of Middle Eastern societies and help counter uninformed, negative public stereotypes of the region.

Another team of researchers is looking at the attitudes we have towards African nations. The work being carried out by the Leeds University Centre for African Studies seeks to determine whether young people exhibit infrahumanisation, a belief that a person is less than human compared with ourselves, with respect to people from Africa. It is thought that this can occur by the time a child is 10 years old. Previous research (Borowski, R & Plastow, J, 2009) indicates that the media and fundraising campaigns are the main influences on young people's perceptions of Africa. These media campaigns lead children to believe that nearly all Africans are poor, helpless and in need of Western charity. In addition, the research findings indicate that young people with the most negative perceptions of Africa are likely to come from the most deprived areas. Whilst this stereotypical perception engenders compassion for Africans, it also develops a sense of superiority amongst young people which has the potential to manifest itself as prejudice, discrimination and racism in later life.

The stereotypical perceptions of Africa, as expressed by young people, are deeply rooted in British society.

The stereotypical perceptions of Africa, as expressed by young people, are deeply rooted in British society. This research will provide evidence for all those involved in the education of young people including policy makers within government, local education authority advisors and school heads and senior managers, to make informed decisions about how best to educate children about Africa. Changes within education can take many years to have an impact on young people, so it is important we start to consider this now so that the future generations are accurately informed.

Asylum seekers, refugees and migrants are among the most vulnerable people in our society. A new research partnership at the University of Glasgow called GRAMNet is aiming to tackle the problem of racially based inequalities in the city. The City of Glasgow hosts the largest population of refugees and asylum seekers under the dispersal policy and has a proud history of hosting large communities of migrants. Glasgow also has a large number of organisations working with migrants, refugees and asylum seekers in a variety of ways. GRAMNet brings these communities together in a research to promote and strengthen interdisciplinary research on refugees, asylum and migration. Through careful needs-driven research GRAMNet wants to identify and propose solutions that address root causes of deprivation in multicultural areas. Over the next 10 years, the researchers want to change the perception of migrants and asylum seekers in Scotland.

UNDERSTANDING SOCIAL DEVELOPMENT IN BABIES

It is remarkable how skilled babies are at understanding social norms and producing socially relevant responses when interacting with people. A research project at the University of Durham, supported by the Economic and Social Research Council (ESRC), has collected data investigating how an infant sees the world and how this is related to their own experiences. The link between action perception and action production has been puzzling researchers for generations. How can a newborn infant imitate someone's mouth movements unless they have some knowledge of their own body schematics and biomechanical composition?

Work on investigating social cognitive processing in early development is the most likely way we might be able to identify autism at an early age. Should this occur, then it will be possible to develop early screening systems, which would allow early intervention to take place, with associated health benefits for the individual and their family. Current work on intervention with young people has had mixed results, however, with improved screening, the possibility of early detection will have a positive impact on people with autism. This research is being led by Vincent Reid, Lecturer of Psychology at Durham University who had this to say:

"Part of my research is looking at improving methodology and this involves resolving issues associated with attrition rate. When you do a standard study with infants you typically have anywhere from 30 to 50 per cent of your sample not contributing data. How to resolve this is one of the key elements that we must address. To do that we need to consider the different measures that we use and assess which ones are most appropriate. Exploring these alternatives will help us determine how best to look at brain activity in this young group of the population.

Most probably the best way to screen for autism in early development will be to look at how the infant brain

processes information about other people. For example, we would look at how an infant processes someone's eye gaze direction and we would then compare that between different groups of babies. I think that sufficient data for an early version screening tool is probably between three and four years away. There are some technical problems to overcome before that can happen including resolving unacceptably high attrition rates, which explains why my work over the last few years has sought to overcome that. Now that we have more or less resolved how to get meaningful data from every infant, we plan to apply machine learning systems that are being developing at Kings College London which will examine infant data for signs of autism. The work in this area is being conducted by a collective group of researchers coming together to resolve these issues before large scale screening can begin.

If the screening is able to detect autism earlier, it means early intervention and treatment for the condition is possible."

A HAPPY FUTURE

What makes us happy and how we can stay happy are questions we would all like answers to. New research at the University of Reading being led by Dr Marina Della Giusta is hoping to understand the answers to these questions and help make society happier. The research is looking at the link between happiness and gender. Research to date has not considered the reasons why men and women experience differences in life satisfaction. Dr Della Giusta's research shows that both men's and women's life satisfaction is increased when in employment. Life satisfaction also increases with the number of paid hours worked. The research is also looking at the relationship between values (the principles that guide our behaviour), choices and their final outcomes in terms of life satisfaction. This involves attempting to assess whether our individual values of what is important in life are broadly connected to what we experience as important in our lives, our life satisfaction. The outputs from this research will help us all to understand what makes us happy and so make better decisions for a better quality of life.

TACKLING WORKLESSNESS

There is a popular and powerful view that in some disadvantaged areas of the UK 'intergenerational cultures of worklessness' (IGCW) have developed. It is thought that in these areas lack of aspirations have locked people into cycles of worklessness. This in turn has caused people to embrace anti-work attitudes. Researchers, led by Professor Tracy Shildrick from Teesside University, aim to challenge the concept of IGCW by drawing together key evidence and giving a critical analysis of aspirations, work commitment and experiences across and within families with experiences of long-term unemployment.

This research, funded by the Joseph Rowntree Foundation will provide robust and detailed evidence and engage directly with the currently popular political rhetoric around IGCW. Policies to assist the long term unemployed will benefit greatly from a deeper understanding of the exact nature of IGCW and how, if at all, these processes operate across and within families and within deprived communities. The research findings could have lasting significance for welfare policy development in the future. As young people are likely to feel the worst impacts of the current recession, this research will provide timely and new evidence about the ways in which young people think about and respond to worklessness within their families.

THE FUTURE OF DEMOCRACY

At a time when our democratic institutions and processes are questioned as never before, we need to gain an understanding of the long-term path of reform, so that we can better understand what the future will hold and how we can respond to it. A research project at the University of Reading, led by Dr Alan Renwick, is looking at how democracy in the UK is evolving. Many ideas for democratic reform have been discussed over the last few years. But where are they heading, and do they form part of any coherent pattern? This research seeks to answer these questions by looking back at and analysing debates about democratic reform in the UK since 1945.

The project is finding a gradual shift from a collectivist to an individualist concept of democracy. This is demonstrated by a greater concentration upon individual rights, greater use of referendums, and growing pressure for recall and primaries. Drawing on international evidence, the research considers where this trend is likely to lead and what its implications are likely to be. This research aims to promote better public dialogue about the nature

of our democracy. As the debate surrounding the recent referendum on electoral reform indicated, that dialogue is currently severely lacking. There is little understanding of the nature of our democracy or the issues that are raised by proposals to change it. This research aims to change that, so we are able to make informed decisions about the future of our democracy.

IDENTITY MANAGEMENT

People today are cautious and a little anxious about the possibility of biometric identification, the introduction of stronger border security and the risks of identity theft and abuse. In contrast however, there is a growing appetite for identity sharing through social networks, customer profiling and various loyalty schemes. Research, led by Professor Liesbet van Zoonen at Loughborough University, is aiming to get a better understanding of such anxieties and appetites, by examining the taboos and desires around identity management, and what causes them. The researchers want to understand how people will respond to new identity management technologies and how these technologies can be promoted in a more trustworthy way. Identity management is a real concern for society and people need to be confident that their concerns will be incorporated into new systems and practices. This research could change the way identity management technologies in future will be discussed, developed and designed.

USING TECHNOLOGY TO ENABLE SOCIAL INCLUSION

Poor health, disability, family breakdown, poverty and unemployment are just some of the reasons why people of all ages may become excluded from society. A new research project at the University of Newcastle 'Social Inclusion through the Digital Economy' (SiDE), is researching how advanced technologies can be used to improve the lives of those from vulnerable groups including older people, disabled people, and marginalised youth. The researchers believe that digital technologies have the potential to transform the lives of those who find themselves in this situation, but research is needed to realise the opportunity and that is the goal of SiDE.

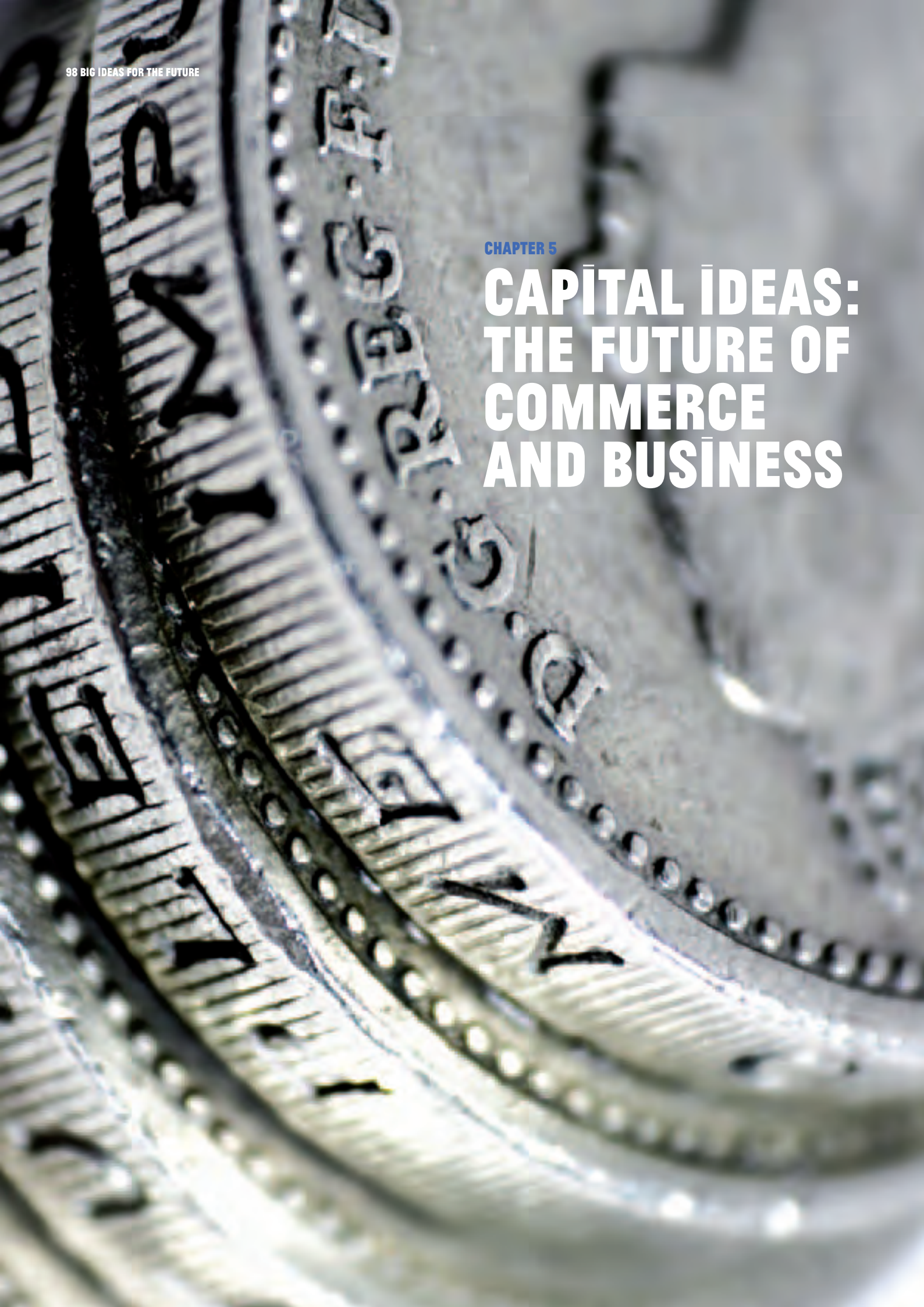
The research spans a range of activities including accessibility, the connected home, inclusive transport and the creative arts. SiDE is being led by Professor Paul Watson and is supported by the Research Councils UK (RCUK) Digital Economy programme. One of the projects being carried out by SiDE is an 'ambient kitchen' that can help users with dementia continue to live in their own homes by sensing their activity and prompting them when they need assistance to make progress. The research team are also using an instrumented car to understand the problems faced by older drivers which will result in new technology to assist them to remain mobile. This research will show that in future society can include everyone.

THE IMPORTANCE OF GRANDPARENTS TO WELLBEING

Research at the University of Oxford has shown how grandparents play a vital role in children's well-being and the results have been informing UK family policy. With changing family patterns, increased life expectancy, growing numbers of dual-worker households and higher rates of family breakdown, grandparents are now playing an increasing role in their grandchildren's lives.

The research by Professor Ann Buchanan from the Department of Social Policy and Social Work shows that a high level of grandparental involvement increases the well-being of children. A study of more than 1,500 children found that those with a high level of grandparental involvement had fewer emotional and behavioural problems.

The role of grandparents is currently unaccounted for in UK family policy, and grandparents have no legal rights to see their grandchildren. However, Professor Buchanan's study has demonstrated that their involvement is strongly associated with reduced adjustment difficulties in all family types, but particularly so amongst adolescences from divorced or separated families. The results of her research suggest that the role of grandparents in UK family policy should be re-evaluated so that future generations can benefit more from the care of their grandparents.



CHAPTER 5

CAPITAL IDEAS: THE FUTURE OF COMMERCE AND BUSINESS

SUSAN ANDERSON
DIRECTOR, EDUCATION AND SKILLS, CONFEDERATION OF BRITISH INDUSTRY

AS WE EMERGE FROM THE RECENT FINANCIAL CRISIS, we are all focusing on how to drive sustainable economic growth for the future. The ground-breaking research taking place in our universities is absolutely crucial to helping us meet and resolve the huge challenges facing our society today. It is not just this research that will help us to return to a position of prosperity, but the researchers that are working within our universities that will enable us to get there.

UK researchers are world-leading and increasing numbers of national and international companies are seeking opportunities to work with them. In fact UK researchers work with some of the biggest global names in business including Samsung, Siemens, GlaxoSmithKline, Boeing, the BBC and Rolls Royce. Their specialist knowledge, skills and experience in working creatively and independently, makes researchers highly employable across a wide range of occupations.

This world-leading reputation for research has been achieved by the continued development of the people within it. It is not only the discoveries and outputs of research, but the impact of those highly skilled individuals that have helped the UK reach this inspiring global position. In this chapter you will learn about some of the research taking place in our universities that is helping businesses compete on a global scale. This research leads to technological advances, boosts UK businesses and contributes to the prosperity of our economy.

We must continue to support the brightest minds in their endeavours within science and research. A well trained workforce is key to meeting the needs of businesses in the future. With record numbers of students entering university there is an opportunity to ensure that our workforce continues to be highly trained and well educated. These people are the future of our economy and it is vital we support them. More and more universities and their researchers are now working in partnership with businesses. This is an

Our creative industries produce some of the best business minds in the world and this is often as a result of collaboration between designers, artists and technology experts and engineers.

excellent way of encouraging researchers to think outside their academic box and consider how their work could be turned into viable business opportunities. These partnerships encourage and enable the movement of researchers between the research base, businesses and industry, at every career stage and level, and in every direction.

The knowledge and ideas generated by UK research are key drivers of business productivity and economic growth. Some of the research highlighted in this chapter will help industry become more efficient in future, by developing new ways of recycling materials and using by-products to create new electronics for example. The metals industry alone is worth £17 billion a year to the UK economy and researchers are developing new ways the sector can reuse, remanufacture and recycle in order to save more natural resources.

It is not just about strengthening existing industries. We need to be able to nurture emerging ones too. Our creative industries produce some of the best business minds in the world and this is often as a result of collaboration between designers, artists and technology experts and engineers. UK manufacturing is known for its high quality and innovative approach to design which allows us to stand out in the global economy. As global competition becomes more intense our creative minds will be pushed to new heights of design and manufacture to ensure we can compete for business. Universities must continue to encourage the best creative minds to work with their manufacturing and engineering colleagues to keep Britain at the cutting edge of world industry.

This chapter is a rich and exciting snapshot of just some of the vast array of research being developed here. The people responsible for this research are already changing the way industries will operate and what our jobs will be like in years to come. The support we give our researchers now is crucial to economic growth and prosperity for future generations.

COMMERCE AND BUSINESS: BUSINESS

HOW SOCIAL SCIENCE LEADS THE WAY IN BUSINESS

The UK economy boasts some of the best and most innovative companies in the western world. Tesco, a successful UK business is a good example, operating in 12 countries with sales of over £67 billion and 472,000 staff worldwide. Unsurprisingly, big brands are constantly the cause of customer comment, media debate and academic research. Social science research can play a key role in developing our understanding of business practices, tactics and the wider social and economics effects.

The collaboration between Future Foundation and the ESRC Centre for Business, Relationships, Accountability, Sustainability and Society (BRASS) demonstrates how social science supports some of Britain's biggest brands. Royal Mail and the travel company Thomson worked with researchers to better understand how changing consumer attitudes to climate change may impact on their businesses in the future. Royal Mail gained insights into how much customers would be willing to pay to recycle items such as batteries through the post. Thomson discovered that travellers would be positive to initiatives to help lower their carbon footprint. High quality social science has provided insight on new business areas as well as supporting decisions on corporate social responsibility.

Social science can also help to evaluate new ventures. Research from the Advanced Institute of Management (AIM) explores British innovation on the emerging plastic electronics industry. The Coalition Government has recently shown their support for this exciting new sector.

"Hollywood has depicted products that use flexible electronics – from animated, electronic newspapers like Harry Potter's Daily Prophet to smart pill packaging that beeps your doctor when you forget to take your medication. But now, plastic electronics has evolved from science fiction to science fact," comments Dr Zella King, AIM Innovation Fellow

"Thanks to developments, we could be seeing printed electronics appearing in our everyday lives, from large-area, ultra-efficient lighting and low-cost solar cells in new buildings, through to intelligent labels that authenticate high-value branded goods."

The government has identified plastic electronics as a key area for development. The launch of the UK Plastic Electronics Strategy in 2009 was coupled with an £8 million investment administered through the Technology

Strategy Board. The aim is to promote the growth and development of the industry through collaborative projects. The plastic electronics industry is predicted to be worth $300 billion by 2030 and Britain is leading the way on global innovations.

Besides advising business on new business ventures, social science can enhance business performance by providing a deeper understanding of the leadership and training needs of a business. The Centre for Skills, Knowledge and Organisational Performance (SKOPE) have researched leadership skills in UK supermarkets.

Besides advising business on new business ventures, social science can enhance business performance by providing a deeper understanding of the leadership and training needs of a business.

Research by Professor Irena Grugalis, Odul Bozkurt and Jeremy Clegg shows managers encouraged employees to work harder rather than employing other more bureaucratic leadership techniques. By observing two of Britain's largest supermarket chains the researchers found that leadership skills used by managers were changing from bureaucratic control to using charisma, creating a vision aimed at inspiring enthusiasm and in turn contributing to overall corporate drive.

"While leadership skills and qualities were presented as core to the work of everyone and as particularly central for progression into managerial roles, in stores almost every aspect of work for every kind of employee, from shopfloor workers… to the general store manager, was set out, standardised and occasionally scripted by the experts at head office," commented Professor Grugalis.

Store managers are required to meet a range of demanding targets directed from a central office. This leaves managers with little time to control other than day to day people management: motivating, beginning with 'getting the day started' meetings, they concentrate on meeting targets by, as one manager put it, 'ensuring they (staff) are motivated, trained, they're quick to do the job and hyped up, and they're going to go out there and deliver'.

Due to the high levels of central control, in-store managers need to ensure that they have the skills to motivate staff to meet targets. This research supports business decisions on relevant industrial training to provide efficient and effective management skills to drive sales.

Examining current industrial training can provide practical insights, as research by Professor Paula Jarzabkoeski, from Aston Business School and Insurance Intellectual Capital Initiative (IICI) hope to prove. The study of reinsurance underwriting and brokering practices in the London and Bermuda reinsurance markets analysed the strengths and weaknesses of face-to-face and electronic trading approaches and their implications for the evolution of the industry.

This research has lead to a report which has allowed organisations within the industry to understand the training and development implications of the different methods of doing business, helping policy makers see how the markets will develop over time, and share best practices in both markets for the benefit of the customers. The report outlines six key learning points which can affect a firm's performance.

These are:

1. Distinguishing the purpose of client meetings.
2. Developing focused retail and wholesale broker intermediation.
3. Establishing face-to-face contact on a 'need-to-know' basis.
4. Identifying those situations under which face-to-face interaction adds value.
5. Avoiding duplication of paper and electronic information.
6. Identifying and minimising ritualistic use of face-to-face interaction, such as 'signing the slip'. (the process of getting underwriters to put their signature to the percentage of the risk that they will cover on any particular programme).

These points are now being applied in practice. In giving businesses the tools to professionalise their trading processes, the study will enhance the firms' capacity to make the most of the opportunities afforded by current changes in the industry. This groundbreaking study, with its theoretical insights and its practical recommendations, allows reinsurance firms and brokering houses for the first time to evaluate and strengthen their practices systematically, identifying when best to use face-to-face and electronic trading.

Social science research permeates industry through generating ideas for new business areas, supporting decisions and key strategic questions, and improving business performance by developing greater awareness of the leadership and training needs of different industries. Engagement and collaboration with business also benefits social scientists, who gain an improved understanding of business requirements, can identify new research themes and widen networks with business.

COMMERCIALISING ARTS AND HUMANITIES RESEARCH

The Centre for Fine Print Research at the University of the West of England, led by Professor Stephen Hoskins, has filed three successful patents in the past 10 years: the first produces a commercial return; the second – for a printing substrate registration process – has attracted little interest until recently, but is being looked at carefully by one of the Centre's industrial partners; and the third, for a ceramic material arising from Centre's work on 3D rapid prototyping, is expected to be the source of substantial future revenues as it lies at the base of a large amount of planned industrial work.

Dan Pinchbeck, a Reader in Computer Games at the University of Portsmouth, has been negotiating for some months with commercial media studios about a partnership to commercialise a niche market product that emerged from his interest in creating an innovative form of narrative computer game. Any licensing deal that comes out of their talks will include marketing promotion via the company's online distribution platform. The credibility he has gained having reached this stage is immense: "There has always been a difficulty with academics trying to talk to industry. Industry doesn't really respect academia because they haven't really done anything […] that deserves respect. I know that if I'm talking to people I can say 'I have done this with producers, we've sent it to market' and they immediately go 'then you understand what it's like, you're operating in our world and you understand our world.'"

ORGANISATIONS OF THE FUTURE

Organisations today face complex and regularly changing operating environments, so the need to harness 'innovation' at organisational level has rapidly increased. Also, the type of skills that are needed in a knowledge economy is changing and most organisations are looking for creativity, flexibility, adaptive capacity and the ability to work in complex teams across disciplines. Researchers from Glasgow School of Art, led by Professor Irene McAra-McWilliam, are looking at the modernisation of organisations. This involves considering how our future workplaces might be structured and how employers can sustain innovation, both from an individuals and organisational perspective.

The project is developing in-depth case studies, which explore design thinking as a way of creating effective and valuable uses of employee core capabilities. The research is also looking at how design thinking might sustain innovation within organisations. In the future this research could help improve employee engagement and help organisations understand how to increase capacity and capability for enabling innovative working-practice.

UNDERSTANDING CHINA

China has the largest population in the world and with its rapidly growing economy and political power, greater understanding of the country is essential. Professor Rana Mitter from the University of Oxford is using his expert knowledge of Chinese history to help the government, businesses and the public understand and engage with contemporary Chinese politics.

China is more historically conscious than the West and Chinese policy is often based on an understanding of the country's history. Bringing a fresh understanding of China to the UK public is also important. Professor Mitter's academic work on China's role in World War II and its post-war recovery has become highly relevant to understanding contemporary Chinese politics. He has also briefed UK government ministers prior to diplomatic visits to China. Businesses use his knowledge to help them understand investment opportunities in China. In future, UK companies are likely to be conducting more and more business with their Chinese counterparts, so it is important that we learn as much about this vast economy as possible.

MULTI-UTILITY SERVICE COMPANIES

The service industry today is dictated by difficult supply streams that are expensive, inefficient and unsustainable. The demand for more personalised services is increasing. Researchers from the University of York supported by the Engineering and Physical Sciences Research Council (EPSRC) are promoting Multi-Utility Service Companies or MUSCos as the future of the service industry. They customise service delivery taking into account factors such as illumination, ambient comfort, cleanliness, food preservation, mobility, and communication rather than traditional measures of electricity, heat, water, or transportation. A MUSCos model allows the end-user to give explicit service requirements and focus on performance. For service suppliers, it means their profit is based on the reduced cost of the service delivery.

The aim of the research project is to bring the age of the MUSCos forward by understanding the current barriers to development. The research will bring together engaged stakeholders from the user and supplier communities to test MUSCos ideas in a present day context. The team hope to provide a robust, viable roadmap towards a more resource efficient, profitable business model for infrastructure service delivery by 2014.

THE FUTURE OF FARMING – SMALL IS SUCCESSFUL

Smallholdings of 10 acres or less can provide viable and highly sustainable livelihoods. They can support the transition to a more sustainable society by increasing local food production and boosting rural economies both in the UK and other countries. 'Small is Successful: Creating sustainable livelihoods on 10 acres or less' reports on research led by Dr Larch Maxey at the University of Plymouth in collaboration with The Ecological Land Cooperative. The research opens the door to new entrants to farming at a time when there is urgent need for them and calls for policies that allow highly sustainable, low acreage livelihoods to flourish. In contrast to the commonly held view that only large farms can survive, the research shows that smallholdings can succeed on tiny pockets of marginal land. Adding value is key to their success, with growers now able to process and take food to market. Businesses are increasingly spreading their risk too, so if one crop or market fails, others are available.

GRADUATE CAREERS

Today the job market is tight and graduates sometimes find competition for jobs is very high. The number of university graduates is expected to continue to rise in the future, so this competition for jobs is likely to increase. A talented graduate might not necessarily want to enter the world of work as an employee of an organisation; they might want to develop their own business.

The majority of UK universities are involved with local business and these ties can help graduates develop enterprises of their own. The University of Northampton, under the leadership of the Vice Chancellor, Professor Nick Petford, has implemented a new strategy to develop an institution wide approach to social enterprise. The strategy offers all students an enhanced experience by integrating the opportunity to work in a social enterprise as part of their degree; either in one that already exists or one the University helps them set up.

To support the strategy, the University has also launched 'The Leadership Academy Research Initiative' (LARI) which will encourage researchers into the field of social enterprise; informing national and local policy makers, social enterprise practitioners, businesses, and HEIs about the ways in which they can work together to significantly enhance the effectiveness and impact of the social enterprise sector.

COMMERCE AND BUSINESS: TECHNOLOGY

THE EVER CHANGING WORLD OF COMMUNICATIONS

Before mobile phones we had to carry loose change in our pocket in case we needed to use a public telephone to make a call. Before the Internet and email we relied on letters and faxes to communicate with people. And before the World Wide Web we had to rely on books for research and reading. It's amazing to think how quickly these technologies had an impact on all our lives, but not so amazing to consider that they are still developing and are likely to change even more in future.

The World Wide Web has had a massive impact on all our lives, giving us instant access to a vast amount of information, allowing us to communicate globally in an instant, and making it possible to conduct business online. A team of researchers from Sheffield Hallam University are developing technology that will capture information that is currently hidden within the World Wide Web. Currently, not all data posted on the Internet can be read intelligently by computers. This means that users have to visit several websites before they find the information they want. This project will focus on creating new visual tools to help businesses make sense of the vast amounts of data that are out there. This type of technology is known as 'semantic technology' and according to father of the Internet, Sir Tim Berners-Lee, this next generation of the Internet will allow users to access and search data more intelligently. This will result in more relevant results and will save users time.

Currently, the Internet is insecure and fragile, meaning that it is susceptible to significant disruption when attacked or challenged by natural disasters. Individuals, businesses, governments, and society are increasingly dependent on the Internet and are adversely affected when its service is disrupted by attacks and large-scale disasters. Researchers at Lancaster University are developing ResiliNets, a new

This type of technology is known as 'semantic technology' and according to father of the Internet, Sir Tim Berners-Lee, this next generation of the Internet will allow users to access and search data more intelligently.

set of algorithms, mechanisms, and protocols that will help the Internet defend itself. It will allow the Internet to detect when defences have been penetrated, correct any faults and continue to deliver services to users, and recover back to normal operation. The research team want to understand the weaknesses and vulnerabilities of the current Internet so that they can develop new ways of hardening the Future Internet. Without such advances, intrusions and disruptions from attackers and criminals will become increasingly common, and threaten the well-being of society.

The Internet and World Wide Web aren't the only means by which we communicate, but they are becoming more important to society. Semiconductors are vital to all our modern communication technology as they process and transmit information. Electronic signals are manipulated with semiconductor devices and transmitted over large distances via optical fibres, using semiconductor lasers and detectors. However, new ways of processing and transmitting information are vital if we are to keep pace with the increasing volume of information we share and continued miniaturisation of devices including mobile phone and computers. Now, researchers at Heriot-Watt University are working on new 'hardware' to address this issue. Over a five to 10 year timeframe, the research will develop practical devices that can encode information mechanically to allow ultra-secure communication.

RECYCLING RARE EARTH MAGNETS

Over 20 per cent of all rare earth metals are used in permanent magnets including neodymium, samarium and dysprosium. Neodymium Iron Boron (NdFeB) magnets are used in many high tech applications and clean technologies including consumer electronics, motors in electric/hybrid vehicles and generators in offshore wind turbines.

By replacing induction generators in wind turbines with permanent magnet devices it is possible to improve efficiency and manufacture the machine as a direct drive device (no gearbox required). To replace a gearbox in an offshore wind turbine can cost up to £500,000. Therefore all of the large wind turbine manufacturers are investing heavily in this technology. However, each wind turbine requires 0.25 to 0.5 tonnes of NdFeB per MegaWatt (MW) and given that the UK alone is investing in 33 GigaWatt (GW) of offshore wind turbine generation by 2020 this is going to put huge pressure on resources.

China currently provides more than 95 per cent of the world's rare earth elements, but in 2006 it began to impose export quotas and last year this was cut by 40 per cent. This produced a shortfall in rare earth material for permanent magnets and resulted in NdFeB prices rising from $30 per kg to $270 per kg in the last 18 months. There are three possible solutions to this material shortage. Open new rare earth mines, use alternative devices which do not contain rare earth elements or recycle the existing stock of material contained within scrap devices. Dr Allan Walton from the University of Birmingham is aiming to achieve the third solution, recycling magnets.

Dr Walton is working closely with the Magnetic Materials group run by Dr Andy Williams, investigating the use of hydrogen to separate rare earth magnets from electrical devices, for example hard drives and electric motors. When hydrogen is introduced to an NdFeB magnet it is absorbed into the crystal lattice with an associated five per cent volume expansion. The differential expansion between the surface (hydrided) and the bulk (non-hydrided) causes the surface grains to peel away which results in the magnet breaking up into a course powder (known as Hydrogen Decrepitation – HD). As the hydrided powder is not permanently magnetic it no longer sticks to the other ferromagnetic materials in the hard drive and can easily be removed from the other components. The extracted NdFeB powder can then be re-processed using hydrogen to form new magnets. Dr Walton's work in being funded through the Science City Initiative.

ADDITIVE MANUFACTURING

Mass production has made desirable objects affordable. Problems arise however, from the fact that the more we can have, the more we want and the more we regard objects as disposable. Generations ago most people made a pair of shoes last until they fell apart, today we think nothing of owning tens, or in some cases, hundreds of pairs of shoes. This disposable production and distribution of products can cause damage to our environment. Research at De Montfort University led by Dr Lionel Theodore Dean is looking at additive manufacturing. This process involves building up material in layers only where required rather than using traditional machinery to make things. Additive manufacturing will mean that products can be individual, empower customers and be locally produced to meet local needs. Specifically the researchers want to combine computer scripting with Computer Aided Design (CAD) to create 'living' consumer product designs. The technology has the potential to revolutionise the future of product manufacturing away from mass, disposable techniques.

ARTS AND HUMANITIES MOVING BETWEEN QUADRANTS

Professor Stephen Hoskins heads a visual arts research centre at the University of the West of England that explores the relationship in arts and crafts between technology, ideas and making. The Centre for Fine Print Research investigates the development of quality fine print from the Nineteenth Century through to the digital age primarily from a fine art perspective, but its focus on novel materials and processes to push forward innovation in 2D and 3D printing also attracts industrial partners. Around one third of the Centre's revenue comes from industrial projects, but Professor Hoskins is clear that, despite their success in working with industry, the industrial share should remain below half because they want to stay within the University's arts faculty.

A recent piece of research encapsulates the interest of Professor Hoskins' work for both artists and industrial partners. Building on prior research at the Centre into bas-reliefs his team investigated rapid prototyping for the creative arts. This would allow, for example, the possibility for artists to print ceramic objects directly in three dimensions, allowing them to produce unique works without incurring modelling and tooling costs. A major exhibition of art works produced in 2D and 3D was staged at the end of the research period of the project, which "was very well received". As the project progressed, industrial firms became increasingly interested, both from the production angle and in terms of developing the equipment required to produce bespoke items. "The industrial work often starts from pure research – and the pure research here was developing this ceramic material – and then moves through to a slightly more applied stage and that often leads to industry. So we often set the pure research agenda and then that leads out. And once we are going along a line, when industry comes they become industry focused projects because that's where the money comes from." Six companies are 'knocking at the door' because of the ceramic material developed during this project. Professor Hoskins has identified other exciting potential outcomes of the research, for example investigating printing ceramic bone replacements for surgical use.

CLOUD COMPUTING FOR AFRICA

Cloud computing allows people to get access to their applications and files from any computer, smartphone or other device from any location. It is effectively a place where you can keep your data safe and secure without clogging up the memory of one computer or device. Cloud computing is rapidly growing in popularity and also allows people to share data with others. A new project at Birmingham City University, led by Dr Peter Rayson, is seeking to use cloud computing to give remote areas of Africa access to computer software. By using a simple USB stick a virtual world of software has been made available to African villages, without the need for expensive and bulky hardware which may quickly become obsolete. The basis of the technology is a platform that has a light footprint, or energy use and allows people to download and stream large applications with virtually no download time, on basic laptops. It could help connect remote areas of the world in the future.

COMMERCE AND BUSINESS:
INDUSTRY

FINDING SUBSTITUTES FOR PRECIOUS METALS

Precious metals have a number of industrial uses especially as catalysts that increase the rate, and control the selectivity, of chemical reactions. The importance of catalysts to chemical science, the chemical industries, and consequently to society in general, can be appreciated when you look back at the number of Nobel prizes awarded to pioneers of this chemistry.

The majority of the most successful catalysts contain metals such as palladium, platinum, and rhodium, amongst others. These metals, whilst allowing chemistry to proceed beyond the boundaries of current understanding, are nevertheless a limited natural resource. These metals are rare, and consequently expensive. These resources will run out one day and there are currently no alternative catalyst systems that can compete with the performance of these metals. The consequence to future generations will be bleak, unless some other method can be found to catalyse organic chemical reactions.

Researchers at Cardiff University, led by Dr Ben Ward are working to develop the use of alternative metals which can catalyse some of the reactions currently carried out by precious metals. The team are specifically looking at the Alkaline Earth metals such as magnesium, and especially calcium. Realistically the researchers think real applications are many years, perhaps decades away, but their research is a starting point. Alkaline Earth metals do not obey the 'normal' rules of coordination chemistry, so through this research it will be possible to learn more about how to tame these metals towards new applications.

ARTS AND HUMANITIES ACADEMICS ENGAGED IN WIDESPREAD KNOWLEDGE EXCHANGE

Overall there is a high level of varied interactions between academics in the arts and humanities with other organisations, ranging from participating in networks (61 per cent), to providing informal advice (55 per cent) and consultancy services (37 per cent). Overall, the broad pattern of interactions is similar to that of all academics, although academics from the arts and humanities are proportionately more likely to be involved in community-based activities compared to other disciplines, and somewhat less likely to be involved in problem-solving interactions.

An industrial partner suggested to Coilin O'Dubhghaill, a silversmith and researcher at Sheffield Hallam that he should develop an educational package aimed at the amateur crafts or small business jewellery market. It would comprise a parcel of precious metal alloy samples with instructions on how to work them into jewellery. The hobby market for these particular alloys exists already in the US, but has not been developed in Europe. The industrial firm is interested in increasing the stock turnover of these precious metals. He is currently conducting tests to try out the alloys and patination techniques with novice users.

Dr Kristina Niedderer, who is based in the School of Art & Design at the University of Wolverhampton, is also a creative arts practitioner. She regrets the sensitivities that can emerge when commercial organisations engage with the academic world:

"It's one of those things I think that keeps academics and commercial research apart. We in design would like to see much more integration between design companies and academic design research." Both she and a specialised machinery manufacturer have hopes of commercial potential arising from her research on a particular metalworking technique for her silversmithing work, but further funding must be raised if she is to experiment further.

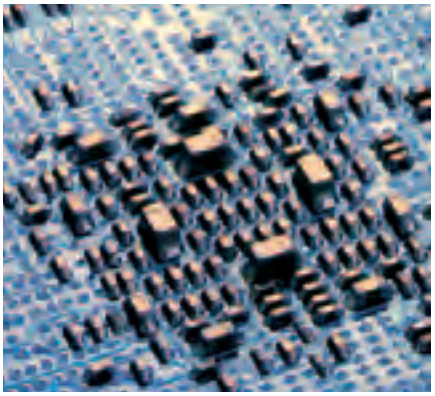
RECYCLING WASTE MATERIALS

We know we should recycle materials to reduce carbon emissions and help save energy and for a lot of us this is now a common part of our weekly rubbish chores. However, not many of us probably take the time to think about what happens to industrial rubbish that has to be recycled on a much larger scale. Researchers from the University of Warwick, led by Dr Kerry Kirwan, are developing new materials and products from everyday green waste by utilising natural mechanisms in a truly innovative and low energy way. The research team's bio-refinery uses bacteria and fungi to target high value aromatic compounds from ligno-cellulosic (i.e. plant) materials and extract chemicals that could be used for pharmaceuticals, plastics, lubricants and other higher value products that would normally be derived from crude oil. The leftover residue is then subjected to traditional fermentation processes to extract usable energy in the form of bio-ethanol and methane.

Emerging legislation and increasing demand for more ethical and sustainable products as well as greater consideration of the entire life-cycle of materials led the team to look at making alterations to the methods used to produce everyday items.

Conventional biorefineries use traditional fermentation methods to convert the cellulose element of biological materials such as bioethanol. Whilst bioethanol potentially has both social and economic benefits, there is an untapped resource for sustainable materials that is being wasted, lignin. The chemical structure of lignin has been shown to potentially yield many interesting breakdown products that could be used on an industrial scale. This combined approach of manufacturing, chemistry, economics and life science has allowed the researchers to unlock the potential of this material in a technically effective, environmentally friendly and cost effective manner, with huge potential benefit to the UK economy and the wider world.

ELECTRONICS INDUSTRY



To keep pace with new mobile communications and other technology the semiconductors that allow these devices to work have to rapidly change and improve. The competition to scale down the size of devices is predicted to run out of steam through a combination of technological and economic constraints. Already companies are starting to look for different routes that will allow them to retain unique product characteristics and marketability. A new research initiative called Smart Microsystems is looking at future directions for the semiconductor and consumer electronics industry, both in the UK and internationally.

The term 'Smart Microsystem' refers to micro and nano-scale devices that combine electronic integrated circuits with additional, non-electronic components on a single substrate which means they provide more functionality. The Smart Microsystems consortium is focused on creating innovative electronic based systems combining the use of microelectronics with new materials and manufacturing technologies. This involves combining electronic integrated circuits (ICs) with additional components, materials and new processing techniques. These microsystems will address a range of application areas including chemical, biological, optical, mechanical, electromagnetic and fluidic technologies. The research is being undertaken by the Institute of Integrated Systems (IIS), which combines the expertise, experience and facilities of the Scottish Microelectronics Centre at the University of Edinburgh and the Microsystems Engineering Centre at Heriot-Watt University.

COATINGS FOR MANUFACTURE

Products such as jet engines require strong coatings to protect them at high temperatures and harsh environments. A team of researchers from Sheffield Hallam University has established a High Power Impulse Magnetron Sputtering (HIPIMS) research centre to lead the global development of a new coating process based on physical vapour deposition (PVD). This process is revolutionising high tech industry by improving the performance of components in a wide range of applications from jet engines, through microelectronics to biomedical implants. The HIPIMS process can help in the manufacture of a range of products from jet engine turbines to knee joints by pumping out an eight mega watt of electrical impulses that create an unique plasma to improve coatings. Professor Arutiun Ehiasarian, director of the HIPIMS Research Centre at Sheffield Hallam, said: "By establishing a common philosophy and working processes, we can explore the full potential of HIPIMS in developing coatings applications for the aerospace and automotive industries, as well as functional coatings and microelectronics research."

International companies are queuing up to work with the new research centre, which will be based at Sheffield Hallam, to develop better performing coatings for jet turbines, microelectronics, space satellites, photovoltaics, titanium-framed spectacles and even tea cups. German power giants Fraunhofer are the joint partners in the new HIPIMS venture.

UK METALS INDUSTRY

The metals industry is worth £17 billion a year to the UK economy. The UK's manufacturing industry faces huge challenges. It must deliver on its clients' demands for more durable and lightweight components and structures, while also minimising its energy consumption, carbon footprint and overall environmental impact. The demand for metallic materials can be met by an efficient circulation of existing metallic materials with limited additions of primary metal to sustain the circulation loop. After so many years of intensive mining and chemical extraction, billions of tons of metals have been produced and primary metals production is still rising. The earth's resources have been extremely exploited; this trend has to be reversed.

Research being carried out at the Engineering and Physical Sciences Research Council (EPSRC) Centre for Innovative Manufacturing in Liquid Metal Engineering (LiME) led by Brunel University is focused on the science and engineering of metallic materials. The Centre's vision is full metal recirculation through advanced technologies for reuse, remanufacture and recycling of secondary metals. This will lead to a substantial conservation of natural resources, a reduction of energy consumption and CO_2 emissions while meeting the demand for metallic materials for economic growth and wealth creation. In the future (say 20 to 30 years), all metallic materials will be effectively circulated (e.g. in a 20 year cycle) through innovative technologies for reuse, remanufacture, direct recycling and chemical conversion. Only a limited amount of primary metals will need to be produced each year to sustain the circulation and to allow for growth and circulation losses. This will transform the current primary metal based metallurgical industry into one that thrives on secondary metals, and will lead to significant conservation of natural resources and energy.

MANUFACTURING FOR THE FUTURE

Manufacturing is one of the UK's biggest growth sectors. Manufacturing research has always underpinned science, simulated design, production, fabrication, systems and services. The research and investments in manufacturing are helping drive innovation in high-value manufacturing necessary for competitive aerospace, pharmaceutical, healthcare and other vital engineering sectors. To ensure this sector continues to grow in future, the Engineering and Physical Sciences Research Council (EPSRC) have created a number of EPSRC Centres for Innovative Manufacturing. These centres will undertake cutting-edge research to address major long-term manufacturing challenges as well as emergent market opportunities. The Centres are supported by leading industrial partners and a range of high-tech small and medium-sized enterprises across a wide range of sectors. The Centres have a diverse portfolio, with a mix across sectors and disciplines, and a balance between product, technology and systems focus.

To date, the Centres have created world-leading manufacturing technologies and ground-breaking solutions to a host of challenges, including deep sea subsea welding, novel software development and eco-friendly food packaging. UK-based businesses are the major beneficiaries of these breakthroughs, which were achieved through partnerships between academic research and industry. It is these links with industry that allow the knowledge and ideas generated by research to become reality and reach wider society.

USING ENVIRONMENTAL MODELS TO HELP DECISION MAKING

We now live in a 'modelled world' where major investment and governmental decisions are based on evidence from complex computer models. In fact in many fields the demands for prediction have outstripped our ability to collect empirical data to the extent that now models are often our best conception of reality. However, the uncertainties in these models are complex and make it difficult for financial institutions and policy makers to use them, or for the public to understand them. Trillion pound investment decisions ranging from how quickly we need to de-carbonise to prevent dangerous climate change, to how the economy will perform over the next five years and what technologies, such as nuclear or offshore wind power, future energy policies should include are entirely model-based.

Research within the Cabot Institute Bristol and the Willis Research Network is working to develop better models linking the environment, capital investment and regulatory frameworks, and to understand how uncertain models can be used to take better risk management decisions. One example is the DEMON project funded by the Natural Environment Research Council (NERC) at the University of Bristol. This research project will determine what new climate models can tell us about the changing risk of flooding.

This research will make a profound difference to environmental and capital risk management by providing a more comprehensive and rigorous basis for decision making. Many decisions taken with models currently do not take into account the possibility that the models could be wrong or that the data used to construct them may be imperfect. Moreover, as the decisions taken can have profound impacts for individual people, better public awareness of modelling science is becoming critical.

Professor Paul Bates is Director of the Cabot Institute at the University of Bristol and had this to say about the research:

"Environmental models now underpin much of our decision making. In many ways our view of what goes on in the environment is now not so much based on observations and data, but based on this, fused with models to create a richer picture of what's going on. These models are now informing decisions about how much money the UK insurance industry needs to put aside in order to make provision for worst case scenarios. It's quite remarkable that vast capital flows are determined by the results of environmental models. We can't prevent natural disasters, but we can be more prepared and more resilient. If we can understand what makes us vulnerable to environmental change, we can mitigate the risk.

Businesses are also increasingly using these data. The insurance industry is a good example. They are using these complex models of the environment to inform really quite large financial decisions. The insurance industry uses the outputs of the models directly, but there is also a much wider range of industries that use the outputs of the models implicitly whether they realise it or not.

These models affect almost everything that we, the general public do. Lots of decisions about what we can and can't do, and what's available to us are derived from complex mathematical models of the environment. So, a good example is how much we pay for our house insurance. In this case models are used to determine, by postcode, how much flood risk a house is susceptible to or what is its risk of subsidence. Those factors all come from environmental models and determine how much house insurance we might have to pay."

COMMERCE AND BUSINESS: FINANCE

THE RECENT FINANCIAL CRISIS plunged the UK into recession for the first time since 1991. It had another impact and that was a massive downturn in public faith and trust in the banking industry. The resulting fall out was so bad that government intervened to bailout the banks. There is, quite rightly, concern that the financial markets could again be subject to a crisis which could cause a larger recession in future.

A team of researchers from Leeds Metropolitan University are leading cutting-edge international research that is examining how corporate governance failures contributed to the 2008-10 global financial crisis and how these problems can be addressed to help prevent any similar financial crisis in the future. The research is attempting to rethink the systemic failures of corporate governance in the Anglo-American business environment in a more critical way and understand what caused the failures.

There is no doubt that world financial markets will have to change in light of the financial crisis to ensure they are less susceptible to problems in the future.

The research is moving away from traditional research in corporate governance which is trapped by thinking dominated by economic and accounting approaches. By combining experts from multidisciplinary areas in business and management, law, institutional economics and political science, this research stimulates debates and encourages critical thinking and questioning of the models and approaches currently used. This new research will have a significant impact on helping transform thinking about corporate governance. It will free researchers, policy makers, regulators, investors, corporate directors and managers to think more clearly and objectively about the best way forward.

There is no doubt that world financial markets will have to change in light of the financial crisis to ensure they are less susceptible to problems in the future. Researchers at Heriot-Watt University are taking an usual approach and are trying to determine if science can have impact on the future of financial markets.

The Financial Crisis Inquiry Commission (FCIC) report (The National Commission on the Causes of the Financial and Economic Crisis in the United States, 2011) concludes that the crisis was an avoidable consequence of a failure of banking supervision and management. It calls for greater transparency, government preparedness and a more normative approach to economics that includes ethics. The idea that ethics and morality are intrinsic to mathematics may seem strange, but the research at Heriot-Watt has established that ethics, are absolutely fundamental to the mathematical understanding of economics and finance and played a key role in the creation of science as we understand it today.

This research gives much needed clarity about how financial markets should be approached scientifically and addresses many of the issues in the FCIC report. HM Treasury is unique in being the only UK Department of State without a Chief Scientific Officer. Appointing one could be achieved very quickly and is a key way we can help prevent future financial crisis.

FOR THE FUTURE

UNIVERSITIES WEEK

WHAT'S THE BIG IDEA?